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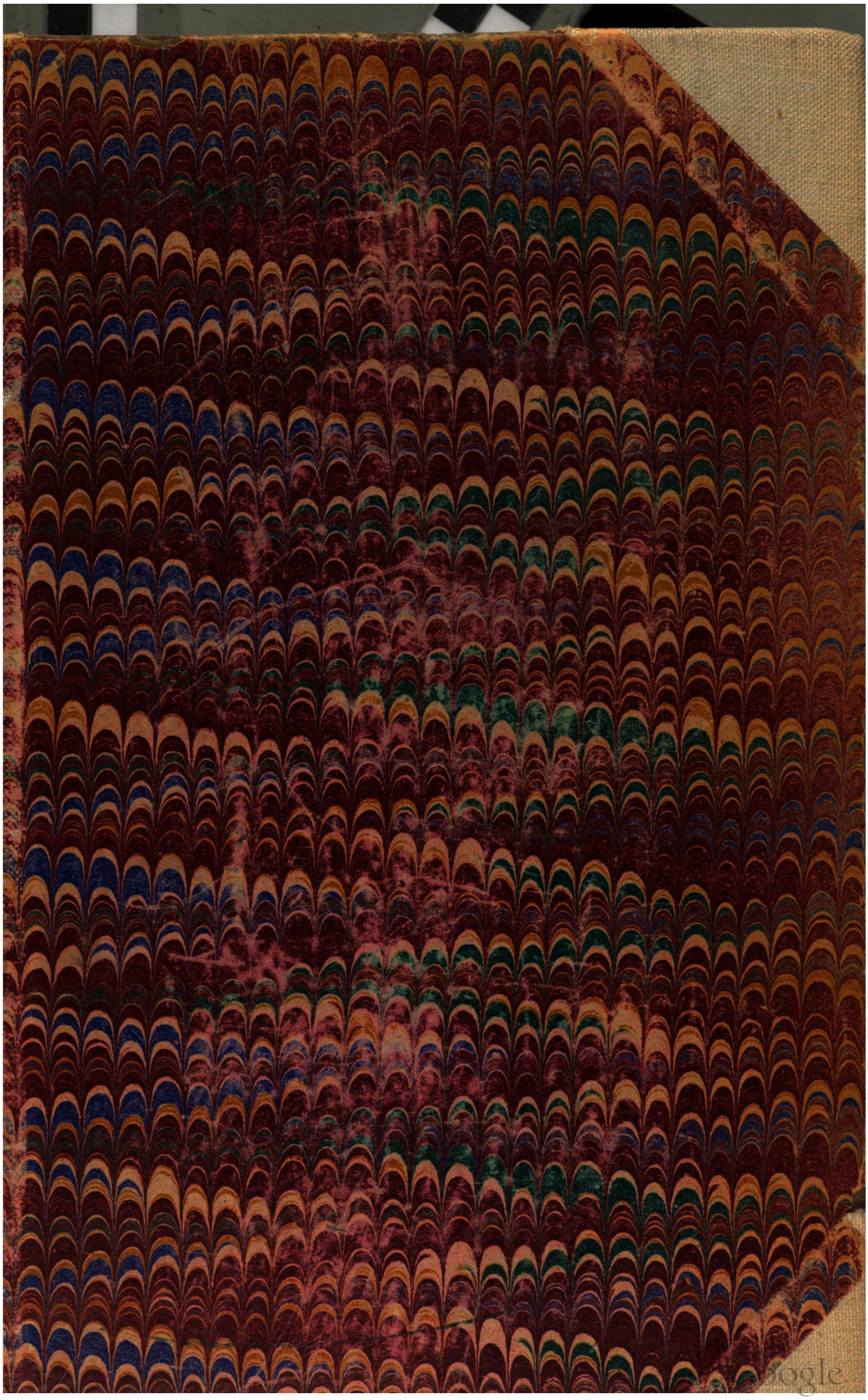

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INDEX TO "THE ELECTRICIAN."

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SPECIAL INDICES.

	PAGE
Leading Articles and Editorial Notes	6
*Contemporary Electrical Science	7
Letters to the Editor	8
Scientific Societies—Papers, &c., read before	9
*Municipal and Local Electric Lighting, &c.	9
*Trade Notes and Notices	10
*Companies (New Electrical, &c.) registered	11
*Companies' Meetings, Reports, Dividends, Statutory Returns, &c.	11

* *Entries in these Indices are not included in the General Index.*

SUB-HEADINGS IN GENERAL INDEX.

	PAGE
Appointments	2
Batteries (Primary)	2
Batteries (Secondary)	2
Central Stations	2
Dynamos	3
Electricity Works Accounts	3
Electro-Chemistry	3
Institution of Electrical Engineers	3
Lamps (Arc)	3
Lamps (Incandescent)	3
Legal Intelligence	4
Magnetism	4
Motors	4
Obituary	4
Parliamentary Intelligence	4
Police Intelligence	4
Reviews	5
Telegraphy	5
Telephony	5
Traction, Electric	6
Wireless Telegraphy	6

General Alphabetical Index.

***Italic figures* denote that the subject-matter is in the "Leading Articles" or in the "Editorial Notes."**

A

Académie des Sciences, Prize Awards, 459
Accidents (*see also* Interruptions to Supply, Explosions, Fires, &c.), (*Bradford*) *96*, 136; (*Bristol*) 287; (*City and South London Railway*) 450, *458*, 484; (*Clerkenwell*) *285*, 311; (*Glasgow*) 2, (*Hagneck*) 853; (*Halifax*) 322; (*Nancy*) 853; (*Oschersleben*) 145; (*Porthcurnow*) 450; (*Southampton*) 278, *286*, 315, 346, 458, *492*, 500; (*United States*) 145
Accounts, *see* **Electricity Works Accounts**
Adelaide, 420, 809, 845
Advertising Signs, Electric, 736
Albert Medal, The, 785
Alloys of Nickel and Iron, 888
Aluminium, 842
Ambroin, 337
American Asiatic Association, 168
American Institute of Electrical Engineers and Research Work, 322
American Municipal Electrical Association, 675, 872
American Municipality Lighting Plant, 492
American Notes (Special Correspondence), 54, 168, 203, 341, 417, 509, 652, 842, 872
American Trading in Russia, 514
Amperemeter, A New Form of, with a Long Scale, 643
Arc, Electric, The Hissing of the, 791, 832, 869, 901
Arc Lamps, *see* **Lamps (Arc)**
Arc Lighting Plant, A New Belt Driven, 253
Arcs, Alternate-current, Experiments on, by Aid of Oscillographs, 857, 893, 910
Argentine Customs Law, 172
Argentine Electrical Imports, 244
Argentine, Electrical Progress in, 809, 877
Armstrong, Lord, Experiments on Electric Discharge, 145
Arnot's Paper on Meters, *252*
Armature Baking Oven, 546
Atmospheric Electricity, Sprague's Utilisation of, *321*

Appointments—
Barking, 135
Bath, 242
Bedford, 135
Birmingham Technical School, 57
Blackburn Technical School, 844
Blackheath and Greenwich, 448
Board of Trade, 854
Brighton, 701
Bristol, 448, 585
British Insulated Wire Co., 844
British Thomson-Houston Co., 66, 337
Buxton, 772
Canterbury, 419
Carlisle, 448
Coatbridge, 448
County of London and Brush Provincial Co., 448
Derby, 87, 657
Dewsbury, 20
Dover, 448
East Ham, 242
Edinburgh, 242
Fleetwood, 206
Folkestone, 844
Gibraltar, 135
Glasgow, 171, 205
Halifax, 171
Hammersmith, 337
Hull, 844
Isle of Man Tramways, 549
Johnson and Phillips, 20
King's College, 144
King's Lynn, 701
Lancaster, 585
Leyton, 276, 735
Liverpool, 87, 448

Appointments—*Continued.*
Manchester, 448, 808
Manchester Technical School, 701, 877
Newington (London), 344
Nottingham, 353
Paisley Technical School, 772
Patent Shaft and Axletree Co., 701
Phœnix Dynamo Co., 772
Post Office, *427*, 428, *457*, 609, 772, 785, 877, 919
Plymouth, 909
Scarborough, 135
Shrewsbury, 481
Southampton, 57, 171
Southport, 585
St. Anne's, 481
St. Helen's, 549
St. Pancras, 205
Tuck and Co. (Dublin), 448
Whitechapel, 909
Wigan, 513
Wimbledon, 513
Worcester, 56, 171
AYRTON, MRS.:
The Hissing of the Electric Arc, 791, 832, (*Discussion*) 869, 901

B

Bangkok, 277, 314
BARTON, E. H.:
The Criterion for the Oscillatory Discharge of a Condenser, 836
The Equivalent Resistance and Inductance of a Wire to an Oscillatory Discharge, 509

Batteries (Primary)—
Bunsen Cells, Modified, 526
Carbon-Consuming Batteries, 676
Minor Variations of the Clark Cell, 836
Portable Testing Battery, 58

Batteries (Secondary)—
Competition for Motor Car Cells, 354, 634
Crowdus Storage Battery, 802
Individual Behaviour of Accumulator Plates, 598
Inquiry for Storage Batteries, 171
Latest Progress in the Application of Storage Batteries, 652
Tests, Storage Battery, 242
United States, Storage Batteries in the, 524
Battersea Vestry *v.* County of London and Brush Co., *491*
Belt-Driven Arc-Lighting Plant, 253
Berlin Electricity Works, 162
BLACK, R. R.:
Modified Bridge Method of Measuring Resistances containing Earth Currents, 416
Blast-Furnace Gases, Utilisation of, 32
Board of Education Bill, 1899, 882
BOSE, J. CHUNDER:
On the Influence of the Thickness of Air Space on the Total Reflection of Electric Radiation, 154
Books Received, 6, 42, 84, 129, 156, 203, 292, 310, 334, 365, 407, 440, 485, 516, 543, 573, 620, 642, 686, 721, 760, 827, 862, 896
Brazil, Electrical Progress in, 346, 449
Brighton, Breakdown at, *2*, *29*, 52, 84, *144*, 161, 201, 237, 272
British Association, 286, 562
British Chamber of Commerce (Paris), 21
British Columbia, 148, 172
British Electrical Industry, Some Aspects of, *470*
BROWN, J.:
Experiments Bearing on the Theory of Voltaic Action, 651
Buckingham Palace, 658, 878
Buenos Ayres, 346
BURKHOLDER, W. A.:
Tramway Construction over Chilkoot Pass, 333
Business, Electrical, in America, Briskness of, 872

C

Cable Specifications, 785
Cabs, Electric, *see under* **Traction**
Calcium Carbide Furnaces in Canada, 168
Calcium-Carbide Regulations, American, 396
Caldas (Spain), 878
California, Power Transmission in, 506
Call-Board, Stock Exchange, 845
CAMPBELL, ALBERT:
The Magnetic Fluxes in Meters and other Electrical Instruments, 52, 167
Canada, Electric Power Transmission in, 148, 172
Canal Haulage, 58, 128, 237
Cape Colony, 449, 783
Carbon Arc Vapours, Electrical Properties of, 535
Carbon for Carbide Furnaces, A New Source of, 254
Carbons for Electric Lighting and Other Purposes, 217, 301, 379, 439, 612, 648, 789, 855, 890; (*Erratum*) 322
Carbon Interests, Consolidation of, 509, 712
Carbon Plate, A New Capped, 736
Casing and Picture Rod Combined, 482
CARTER, F. W.:
Transformer Design, 598
Cathode Rays, Reflection of, 650
Cells (Primary or Secondary), *see* **Batteries**
Central Stations (for Tramway Stations see under **Traction**)—
Bankside, (*Extensions*) 683
Belfast, (*Automatic Stoker*) 31
Bonn, 784
Bootle, (*Opening*) 887
Calcutta, (*Opening*) 887
Buluwayo, 244
Canterbury, (*Description*) 718
Carlisle, (*Description*) 294
Colchester, (*Opening*) 215
Cork, (*Description*) 289
Eccles, (*Opening*) 215, (*Description*) *351*, 359
Folkestone, (*Inauguration*) 30, (*Description*) 68
Glasgow, (*Progress at*) 5, 496, 524, (*Pumps*) 716
Gibraltar, (*Description*) 430
Hamilton, (*Description*) 399
Hammersmith, (*Extensions*), 810
Hull, (*Opening of New Station*) 2, (*Description*) 35
Kingswood, (*Closing*) *561*, 536
Lincoln, (*Opening*) 312; (*Description*) 636, 674
Llandudno, (*Description*) 11, (*Start*) 66
Llanrwst, (*Opening*) 845
Paderno, (*Description*) 255, *351*, 361, 413
Salisbury, (*Opening*) 286, (*Description*) *351*, 356
Stockport, (*Opening*) 215
Wycombe, (*Description*) 640
Central Stations of the United Kingdom, *351*
Central Technical College, 253
Ceylon, 59, 244, 337
Chelsea, Alleged Nuisance at, *595*
Cherbourg, 878
Chicago Main Drainage Tunnel, Electric Utilisation of, 525
Chili, 137
China, 88, *145*, 243
City, Electric Lighting of the, *258*, 274, 315, 449, *561*, 582, 658, 683, 703, 774, *851*, 874, *896*; (*Board of Trade Enquiry*) 803, *851*, 874, *896*
Civil Engineering, Electricity in, *44*, 49
Clark, Latimer, 97
Clerk-Maxwell, Proposed Memorial to, 836
Cloud and Fog at Bankside Station, 683
Coherers, 634,
Constantinople, 88, 703
Cooking, Electric, Cost of, 287
Collett, Richard, Testimonial to, 68
Collision of s.s. "Anglia," 171
Combined Electric Traction and Supply Stations, *300*
Commercial and Business Aspects of Municipal Electric Supply, 79, 267, *321*, 327

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Commutation, The Effect of, on the Field of Dynamos and Motors, 328
Companies, New Electrical, of 1898, 384 (see also *Separate Index*)
Companies Wound Up, &c., in 1898, 384 (see also *Separate Index*)
Company Promotion "In Bulk," *438*
CROMPTON, R. E.:
The Institution Wiring Rules, 501, (*Discussion*) 576, (*see also 574 and 903*)
Concentric Wiring, *264*
Condenser, Criterion for the Oscillatory Discharge of, 836
Conduits, Subfluvial, 146
Congress, An International Physics, in 1900, 524
Consolidation of American Firms, 277, 509, 652, 712, *746*
Consular Reports, 551
Consulting Engineers and Contractors, *596*
Contemporary Electrical Science (see *Separate Index*)
Contractors, Payment of, *96*
Converters, Rotatory, 126, 162, 190, *228*, 230
Copper, 244, 284, 786, 880, 887
Copper Wire in Japan, Manufacture of, 887
Copyright, Alleged Infringement of, 716, 773
Costa Rica, 206
Coupling and Propeller, The "Ballot," 340
Couplings, Electromagnetic Power, 597
Crane, Electric, for Kiao-Chow, 785
Crane, Electric, 150-Ton American, 786
Cranes, New Electric, at Southampton Harbour, 123
Cuba, 910
Customs Tariff Charges, 810
Cut-Outs, Minimum, *2*, *29*, 52, 84, *144*, 161, 201, 237, 272

D

DALBY, J. H.:
High-Speed Engines, 478
DAWSON, PHILIP:
Electric Traction and its Application to Suburban and Metropolitan Railway, 764, 794 (*see also page 798*)
Decorations, Electrical, 55
Delay in Delivery of Plant, *144*, *213*, *251*, 261
Depôt Lighting, 483
Development of Electrical Engineering, *1*, 165,
Devonport Electric Supply, *427*
Diffusion of Solids Dissolved in Liquids, Rate of, 721
Diffusive Convection, The Source of Energy in, 721
Dinners 61, 83, 96, 181, 390, 452, 485, 701, 736, 759, 911; (*Institution of Electrical Engineers*) 215, (*London Chamber of Commerce*) 427, (*to Dr. Lodge*) 702, (*Institution of Civil Engineers*) 712, (*Northern Society of Electrical Engineers*) 746
Directory, Electrical Trades, *353*
DUDDELL, W. and MARCHANT, E. W.:
Experiments on Alternate-Current Arcs by Aid of Oscillographs, 857, 893 (*see also page 910*)
Dumb Waiters, Electric, 181
Dust Destructor Scheme for Hackney, *674*
Dust Destructor, Shoreditch, 17, 53
Duty on Electrical Energy in Copenhagen, 322
Dynamometer for Laboratory Purposes, 14

Dynamos—
Commutation, The Effect of, on the Field of Dynamos and Motors, 328
Jackson and Co.'s New Dynamos, 14
Lectures at Faraday House, 396
Spark Limit in Continuous Current Machines, 837
Three-Thousand Kilowatt Dynamo, 194
Unipolar Dynamo, 180, 215

E

Earth Currents and Electric Traction, *783*, *898*
Economisers, 910
Edinburgh, Overload in, *144*, *213*, *252*
Elasticity, Measurement of, 493

Electricity Works Accounts—
Aberdeen Municipal Electric Supply Works, 368
Ayr Municipal Electric Supply Works, 74
Birmingham Electric Supply Co., 262
Blackpool and Fleetwood Tramway Co., 573
Bolton Municipal Electric Supply Works, 226
Bradford Municipal Electric Light Works, 862
Brighton and Rottingdean Seashore Electric Tramroad Co., 820
Bristol Tramways and Carriage Co., 573
Burton-upon-Trent Municipal Electric Supply Works, 896
Bury Municipal Electric Supply Works, 156
Cambridge Electric Supply Co., 686
Cardiff Municipal Electric Supply Works, 368
Charing Cross and Strand Electricity Supply Corporation, 721
Chelsea Electrity Supply Co., 796
City and South London Railway Co., 760
Derby Municipal Electric Supply Works, 226
Dewsbury Municipal Electricity Supply Works, 156
Dundee Municipal Electric Supply Works, 42
Halifax Municipal Electric Supply Works, 96, (*Errata*) 116
Harrogate Municipal Electric Supply Works, 334
House-to-House Electric Light Supply Co., 796
Hove Electric Lighting Co., 686, (*Erratum*) 712
Kensington and Knightsbridge Electric Lighting Co., 646
Kingston-upon-Thames Municipal Electric Supply Works, 896
Leicester Municipal Electric Supply Works, 441
Liverpool Overhead Railway Co., 760
National Electric Supply Co. (Preston), 6
Newcastle and District Electric Lighting Co., 196
Newcastle-upon-Tyne Electric Supply Co., 862
Norwich Electricity Co., 196
Nottingham Municipal Electric Supply Works, 6
Notting Hill Electric Lighting Co., 722

Electricity Works Accounts—*Continued.*
Oldham Municipal Electric Supply Works, 116
Portsmouth Municipal Electric Supply Works, 42
Preston (National Electric Supply Co.), 6
Sheffield Electric Light and Power Co., 262
Southport Municipal Electric Supply Works, 298
St. James' and Pall Mall Electric Light Co., 606
Walsall Municipal Electric Supply Works, 74
Waterloo and City Railway Co., 573
Westminster Electric Supply Corporation, 606
Whitehaven Municipal Electric Supply Works, 298
Windsor Electrical Installation Co., 334
Woolwich District Electric Light Co., 407
Worcester Municipal Electric Supply Works, 828
Yorkshire House to House Electricity Co., 647
Electric Construction Co.'s Works at Wolverhampton, 677
"Electric Fluid" at Liverpool, 353
Electric Lighting Notices (*see* Provisional Order Notices
Electric Lighting (Clauses) Bill, 658, *711*
Electrical World, The, and the *Electrical Engineer* (N.Y.) 712, *746*
Electricity Supply Works Costs in 1896 and 1897, 372
Electricity v. Gas, 450, 573
Electricity "in Bulk," 206, *321*, 346, *353*, *427*, *438*, 483, *673*
Electro-Capillary Phenomena, 650

Electro-Chemistry—
Calcium Carbide Furnaces in Canada, 168
Calcium Carbide Regulations, American, 36
Carbon for Carbide Furnaces, A New Source of, 254
Caustic Soda, Gravity-Electrolytic Process for the Production of, 468
Electrolytic Alkali and Bleach, *536*, 539
Gold, Electro Zinc Precipitation of, 66
Le Sueur Process for the Electrolytic Production of Alkali and Chlorine, 539
Electrocution, 747
Electro-Harmonic Society, 139, 175, 452, 485, 589, 625, 739, 776
Electromagnetic Theory (Heaviside), 183, 410
Electromagnets for Raising Sunken Steel, 712
Electroplating the Hulls of Vessels, 713
Employers' Liability Act, 17, 59
Employment of Time-Expired Naval Men, *66*
Enamelled Steel Tuning, 658
Engineering Times, The, 432
Engines, High Speed, 478
Equivalent Resistance and Inductance of a Wire to an Oscillatory Discharge, 509
Errors, Some Amusing, 30, 675
EVERETT, W. H., and PEAKE, A. H.:
The Effect of Commutation on the Field of Dynamos and Motors, 328
EVERSHED, S.:
Telegraphy by Magnetic Induction, 330, (*Discussion*) 442
Exhibitions (*Agricultural Hall*) 137, 623, 514, 810; (*Automobile Club*) 857, (*Berlin*) 737; (*Brussels*) 658, 810, (*Ghent*) 59; (*Glasgow*) 448, 659; (*New York*) 288, 341; (*Pan-American*), 835; (*Paris*) 553, 813; (*Turin*) 39, 314, 495, 513
Exhibitions, (*1900 Paris*) 553, (*Glasgow*) 704
Explosions, Conduit and Surface Box, 14, 353, 492, 562, 597
Export Trade, American, 509
Exports of Electrical Apparatus and Material, 58, 87, 136, 172, 206, 243, 277, 314, 345, 388, 420, 449, 450, 483, 514, 550, 595, 623, 658, 702, 736, 773, 809, 844, 877, 910

F

Falcon Works Engineering Society, 145
Fans, Electric, 242, 886
Ferry, Proposed Electric, Across the Thames, 245
Fire Alarms, 912
Fire Extinguishers, Sand, 893
Fire-Prevention Committee's Testing Station, 493
Fire Tests, 737
Fires, 173, 482, 701, 809, 910
Fish, Electric, *746*
Fittings, Ediswan, 87
FLATHER, J. J.:
A Combination, Absorption and Transmission Dynamometer for Laboratory Purposes, 14
FORBES, Prof. GEORGE:
Long Distance Transmission of Electric Power, 233, 340, (*see also page 143*)
Foreign-made Apparatus, 53
Foundry, An Electrically Operated, 121
FOURNIER D'ALBE E. E.:
Contemporary Electrical Science (see also *Separate Index*), 10, 45, 77, 114, 147, 182, 206, 205, 288, 324, 355, 398, 503, 527, 564, 599, 645, 715, 787, 783, 822, 864, 889
France The, Trade of, 846

G

Galvanometer, The Sullivan, 713
Galvanometers and Magnetic Dip, 215
Gas Lighting, Electric, 397
Gasworks, Electric Light in, 780
Gaulard, Lucien, Memorial to, 322, 821
General Power Distributing Co.'s Bill, *352*, *673*
German Electrical Industries, 450, 880
GIBBINGS, ALFRED H.:
The Commercial and Business Aspects of Municipal Electric Supply:—
Electric Motive Power, 79
Hiring out of Motors, Arc Lamps, &c., 267
Fitting Up and Managing a Show Room, 327, (*see also 321*)
Glasgow Corporation Electricity Works, Progress of, 5
Government Office Lighting, 137
Great Central Railway, 704
GRIER, THOS. G.:
The Use of Electricity in the Spanish-American War, 341
GRIFFITHS, A.:
An Apparatus for the Determination of the Rate of Diffusion in Solids Dissolved in Liquids, 721
The Source of Energy in Diffusive Convection, 721

H

Hackney Dust-Destructor Scheme, *674*
Hamilton 20,000-volt Power Transmission, 799
Hammond, Robert, Portrait of, 387
Harbour Defences, Electric Light and, 857
HAWKINS, C. C., M.A.:
Induction Motor Diagrams, 467, 528, 610, 866
Hawthorn (Victoria), 22
HEAVISIDE, OLIVER:
Electromagnetic Theory, 183, 410
Highland Water-Power Scheme, 139, 45
High-pressure Supply, 551
High-speed Engines, 478
Hookey, James, 609
Hopkinson, Dr. John, 97, 89, 713
Hopkinson Memorial at Cambridge, 145, 713
Houllevigue Prize, 96
Human Body, Resistance of, 145
Hydrometers, Battery, 387

I

Incandescent Bodies, Candle-Power Efficiency of, 733 766
India, 21, 28, 137, 181, 704
Indian Wiring Rules, 675
India-Rubber Culture, 326
Influence Machine, 51
Inquests, 315, 450
Institution of Engineers of the River Plate, 22, 173
Institution of Junior Engineers, 3, 30, 93
Institution of Mechanical Engineers' New Quarters, 492
Institution of Electrical Engineers (*see also under* **Societies' Meetings**)—
Annual Dinner, 215.
Associate Members, Transfers, *563*
Diplomas, 597
Honorary Member, Election of, 492
New Articles of Association, 3, 180, 195, *198*, 491, *562*
Notices, 2, 3, 180, 562, 674
Premiums and Scholarships, 145, 428
Special Committees, *673*
Students' Meetings, 145
Telephony Committee, 597, *711*
Uniformity in Electrical Engineering Practice, Report on, *673*
Volunteers (R. E.), 2, 30, 180, 215, 458
Wiring Rules Committee, *574*, 594, *673*
Interruptions to Supply, *213*; (*Adelaide*) 853; (*Ayr*) 353; (*Brighton*) *2*, *29*, 52, 84, *144*, 161, 201, 237, 272, 341; (*Cardiff*) 764; (*Crystal Palace*) 2; (*Dublin*) 66, 97; (*High Wycombe*) 66; (*Hull*) 853; (*Manchester*) 97, 287 (*Norwich*) 207; (*Sheffield*) 428; (*Stratford*) 48; (*Tunbridge Wells*) 97; (*Woking*) 97; (*Wolverhampton*) 2
Iron and Steel Institute, 712, 887
Italian Machinery Industry, 138
Italy, 174, 353, 422, 624
Italy, Patent Litigation in, 821

J

Jamieson, Prof., Retirement of, 836
Japan, 128, 172, 174, 254, 450, *491*, 504, 887
Japanese and English Journal of Commerce, 338
Japanese Notes, 504
JEHL, FRANCIS:
Carbons for Electric Lighting and Other Purposes:—
Estimation of High Temperature, 855
Gas Generators, 217, 301
Soot or Lampblack, 890
The Furnace, 303, 379, 439, 612, 648, 739, (*Erratum*) 322
The Manufacture of Electrodes on a Small Scale, 856
Joule-Thomson Effect, The, 64
Journalistic Accuracy, 675

K

Kalgoorlie (W. Australia), 515
KALLMANN, Dr. M.:
A Direct Reading System for Measuring Current Leakage, 303, (*Erratum*) 322 (*see also page 286*)
KAPP, GISBERT:
The Spark Limit in Continuous Current Machines, 837
The Theory of the Rotary Transformer, 115, 152, 229
Kauffer Prize, The, 675
Kelvin, Lord, 492
King's College, 144, 353
Kingswood Lighting Station, Closure of, *561* 586

L

Labour Protection Association, 483
Lamp-Connection Diagrams, 381
Lampholders, 18
Lamp Data, Cosmopolitan, 493
Lamps (Arc)—
Davy-Improved Arc Lamp, 736
Enclosed Arc Lamp Patents, 58, 87
Regulator without a Clutch, 54
"Strela" Enclosed Arc Lamp, 58
220-Volt Enclosed Arc Lamp, 322
95-Volt Arc, 785
Lamps (Incandescent)—
Candle-Power Efficiency of Incandescent Bodies, 733, 766
Nernst's Electric Light, *523*, 545, 596, 604, 630, 766, *821*, 821, 840, 883
Nernst Lamp, Modifications of the, 821, 883
"Premier" Carbide of Silicon Lamp, 699

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Lancashire, Electric Power Schemes for, 173, 551, 586
LANGDON, W. E.:
Electric Inter-Communication in Railway Trains, 540, 617, (*see also page 596*)
Langdon's Mechanical Engineers' Paper (*see also* Vol. XL., p. 754), *1, 76*
Launches, Electric, 623, 658
Law Courts, Lighting of, 59
Lead Cable Press, 452
Leakage, Current, a Direct Reading System for Measuring, *286*, 308; (*Erratum*) 322
Lectures, 22, 209, 597, (*James Forrest*) 597
Lectures to Science Teachers 452

LEGAL INTELLIGENCE—
African Direct Telephone Co. *v.* Webb, 480
Alexander *v.* Margowski and The Automatic Telephone Co., 770
Alwyn and Craven *v.* G. Straus and Co., 240
Ashwell and Nesbit *v.* Stanton, 907
Battersea Vestry *v.* County of London and Brush Provincial Co., *491*, 510
Bilston District Council, 770
Boyce, French and Bulwer *v.* Alexandra Palace Electric Railway Co., 85
Cambridge Electric Supply Co. *v.* The Cambridge Union, 55, 241
Castner-Kellner Alkali Co. *v* Commercial Development Corporation, 653, 658, 872, 905
Christoffer and Others *v.* National Telephone Co., 240
Cooper *v.* The Electrical Installation Co., 599
Electric Construction Co. *v.* Dick, Kerr and Co., 547
Electric Construction Co. *v.* Imperial Tramways Co., 274
Electric Exploitation Co. (Petition of Sussmann Electric Miners' Lamp), 203
Employers Liability, 311
Everard *v* Higgs, 55, 548
Factory Prosecution, 770
Galloway, Earl of *v.* Elieson Lamina Accumulator Co., 199
Glover (W. T.) and Co. *v.* Glover (William James) and Co. (established 1819), 770, 806
Gold *v.* Winter, 312, 511
Harten *v.* Dublin Electric Tramway Co., 548
Henwood *v.* Howell, 807
Heyl-Dia *v.* Glover, 511
Hilary Sittings, 446
Holliday *v.* National Telephone Co., 202, 240
Holophane (Limited) *v.* O. Berend and Co., 169
Howell *v.* Howell Simplex Anti-Inductive Telephone Syndicate, 55, 547
I.E.S. Accumulator Co., 547
Illegality of Picketing, 311
Kaye *v.* Croydon Tramways Co. and Others, 85
Lammer and Geertz *v.* Clemenci, 655
Lord Mayor and Corporation of London *v* City of London Electric Lighting Co., 582
Lyons and Sons *v.* Wilkins and Others, 311
Mannesmann Tube Co. *v.* Lander and Larsson, 55
Morley Electric Co. *v.* Briscoe, 202
National Co. for the Distribution of Electricity *v* Gibbs and Ruelle, 903
National Telephone Co. *v.* Commissioners of Inland Revenue, 202, 274
Pearson *v.* Wilson-Hartnell, 17, 169
Postmaster-General *v.* Edinburgh Town Council, 479, 655
Powell *v.* Eastern Telegraph Co., 907
Radford *v.* Tasker and Sons, 873
Reed *v.* Dunn, Watson and Belshaw, 547
Savory *v.* Edward Lloyd, 239, 273
Short and Others *v.* Viola, 733
South and the Mayor of Bedford, *In re* Arbitration between, 128
Stegmann *v.* O'Connor, 416, 480, 620
Stegmann *v.* Williams, 241
Sun Insurance Co. and Another *v.* the Corporation of Dublin, 240
Vautin, Claude, 878 (*see also under* **Police Intelligence**)
Whitehead, *In re*, 806
Wild *v.* London and Brush Provincial Electric Lighting Co., 311
Williamson and Joseph *v.* Lawrence and Butcher, 202
Wilson *v.* Easton, Anderson and Goolden, 55
Licence, Electric Lighting Application for, 515
Lighthouse, An American, 367
Lightning, Omnibus Struck by, 562
Lightning, Photography of, 563
Light Railways, *see under* **Traction**
Limited Liability Undertakings, 738
LITTLEWOOD, T. H.:
The Volume Changes which accompany Solution, 509
Liverpool Engineering Society, *65*, 67
Local Authorities *v.* Companies, *321, 352*, 354, *675*
LODGE, Dr. OLIVER:
A New form of Amperemeter and Voltmeter with a Long Scale, 643
Improvements in Magnetic Space Telegraphy, 249, 305, 366, 402; (*Correspondence*) 336, 445; (*Discussion*) 442, (*see also page 251*)
Presidential Address to Physical Society, 643
London County Council, 21, 23, 60, *65*, 67, 89, 98, 138, 174, *179*, 208, 279, 316, 434, 515, 552, *561*, 581, 624, 704, 738, 810, 910
London County Council and Local Authorities, 174, *179*
London Provisional Orders, *179*
Long-distance Transmission of Electric Power, *143*, 233, 340
Lourenço Marques, 215
LOVE, S. F. J.:
The Joule-Thomson Effect and its Connection with the Characteristic Equation, and some of its Thermodynamical Consequences, 643
LYLE, Prof. THOMAS R.:
Currents in Branched and in Mutually Inducing Circuits produced by Harmonically Varying Electromotive Forces, 72, 148

M

Madagascar, 208
Magnetism—
Heating, Prolonged, Effects of, On the Magnetic Properties of Iron, 533
International Magnetic Conference, *29*, 41
Magnetic Fluxes in Meters and Other Electrical Instruments, 52, 167
Magnetic Leakage in the Alternating Current Transformer, 567, 600, 788, 833
Magneto-Optic Phenomenon, 51
"Mohegan" Disaster and Magnetic Disturbance, 8
Terrestrial Magnetism, Report on, *29*, 41
Transformer, The Alternating Current, Magnetic Leakage in, 567, 600
Magnetised Electrodes, The Action of, upon Electrical Discharge Phenomena in Rarefied Gases, 507
Magneto-Optic Phenomenon, 51
Malta, 23, 60
Manila, 174
Map of the County of London, 383
Map of Electric Supply Undertakings, *427*
MARCONI, G.:
Wireless Telegraphy, 690, (*Discussion*) 726, (*Reply*) 758; (*see also page 734*)
Maritime Electrical Association, 30
McGill University, 322
Medal, The Great Gold Gilded), 582
Merchant Venturers' Technical College, 180
Meter, The Hiecke, 581
Meter, The Long-Schattner Prepayment, 151, 180, 563, 597
Meter, The New Peloux, 635
Meters, Certified and Uncertified, *252*
Metric Screw Thread System, Defects in the, 525
Metric System, The, 738
Mica Discoveries in India, 181
Midland Electric Corporation for Power Distribution, 810
Midland Railway, New Generating Station, 433
MILLER, KEMPSTER B.:
Luminous Signal Telephone Switchboards, 309
Mining, Electrical Transmission of Power in, 225
Mining, Electricity in, 810
Model Engineers, Society of, 87
Modus Vivendi, A, *644*
"Mohegan," Loss of the, *179*
Morocco, Electricity in, 52
MORTON, Prof. W. B.:
The Propagation of Dampe l Electrical Oscillations along Parallel Wires, 167
Motor-Cars, *see under* **Traction**
Motor-Gun, 809
Motors—
Commutation, The Effect of, on the Field of Dynamos and Motors, 823
Ediswan Enclosed Motor, 773
Electric Motors, 16
Employment of Electric Motors, 16
Langdon-Davies Motor Works, 186
Induction Motor Diagrams, 467, 523, 611, 866
Induction Motor Prospects, *830*
Induction Motor, The (Wilson), 779, 801, 834, 861
Some Large Induction Motors, 222
Stroboscopic Methods of Testing Small Motors, 676
Municipal Authorities and Companies, Suggested Conference between, *524, 644*
Municipal Electric Supply Business, *762*
Municipal Electric Supply "In Bulk," *427, 534, 644*
Municipal Electrical Association, 397, 562
Municipal Electrical Transmission Plant, 675
Municipal Enterprise in Manchester, 587
Municipal Enterprise, The Cost of, *502, 763*
Municipal Honours, 90
Municipal Jacks-of-all-Trades, *408*
Municipal Trading, *408*, 459, 528, 537, 625, 675, 690, 697, 736, *762*, 912
Municipalisation Extraordinary, 421
Municipal *v.* Company Working of Electrical Undertakings, 354, *524, 644*
Museum Lighting, 484
Mutually Inducing Circuits, Branched and, 72, 148

N

Natal, 314
National Electric Light Association, 561
National Physical Laboratory, The proposed, 853
Natural Gas, Constancy of Composition of, 563
Naval Electricians, American, 712
Naval Men, Time Expired, Employment of, 61
Neugschwender's Wave Detector, 732
New Year's Honours, *351*
Niagara Falls, Electrical Utilisation of, 565, *595*, 600
Niagara Power Co., 208
Niagara Power, Further Development of, 524
Nickel-Iron Alloys, 888
Nomenclature, 287
Non-County Borough's Association, 810
Northern Society of Electrical Engineers, 2, (*see also under* **Societies Meetings**)
Northampton Institute, 253
"Norwich" Tariff System, *352*
Notices, Electric Lighting and Traction, 199, 382 (*See also* **Provisional Order Notices**)

O

OBITUARY—
Adams, Welling, 417
Beit, H. H., 358
Brown, James, 287
Clark, Latimer, 33
De Meritens, 66
De Reuter, Paul Julius, 645
Dresing P. C., 562
Forster, W. G., 525
Fowler, John, 145
Galton, Douglas, 725
Hutchins, F. L., 813
Kruesi, John, 747
Marsh, O. C., 898
McDonald, H. R., 525
McDonald, R. T., 417
Mills, J. F., 887
Obach, E. J. A., 353
Raffard, N. J., 96
Ryan, A. M., 726
Secretan, M., 726
Summers, Charles H., 180
Trott, Samuel, 726
Vogel, Julius, 726
Wiedemann, Gustav Hein ich, 799
Oil Cans, Improved, 909
Oscillations, The Propagation of Damped Electrical, along Parallel Wires, 167
Oscillograph, The Duddell, 910
Overloaded Central Stations, *144, 213, 251*
Owens College, 96, 492

P

Palermo, Water-Power Installation at, 235, *351*, 381,
Paris, Electrical Supply in, 30, 390

PARLIAMENTARY INTELLIGENCE—
Baker-street and Waterloo Railway Bill, 811, 904
Central Electric Supply Bill, 705, 767, 853, 912
County of London Co.'s Bill, 484, 769, 805, 873
General Power Distributing Co.'s Bill, 451, 598, 635
Glasgow Corporation Tramways Bill, 912
Great Northern and Strand Railway Bill, 451, 905
Hampstead, Euston and Charing Cross Electric Line, 45, 770, 912
London New Electrical Bills, 733
Municipal Trading, 697
North-West London Railway Bill, 515, 901
St. James and Pall Mall Electric Light Co.'s Bill, 422, 484, 767, 853
Telegraph (Channel Islands) Bill, 697
Telephonic Communication, 695 (*see also under* **Telephony**).
Wireless Telegraphy, 887
Parsons Steam Turbines, 328
Past Year's Work, The, 885
Patent Amendments, 242, 253, 314, 910
Patent Law, British, *158*
Patent Law in the Soudan, 775
Patent Law, United States, 452
Patent Record, 24, 61, 91, 209, 246, 280, 317, 390, 421, 846, 880, 913
Patents Expiring in 1899 *352*, 333, 839
Patents in Germany, 87
Patents, Recently Expired, 254, 892
Patents, Transformer Distribution, The Zipernowski-Déri-Bláthy, *352*, 890
Peace Jubilees, 163
Penny Post, Imperial, 89, 173, 810
Personal (*see also* **Appointments**), 20, 136, 144, 174, 206, 245, 253, 243, 286, 339, 396, 428, 451, 452, 453, 485, 513, 516, 554 562, 589, 661, 705, 736, 759, 772, 785, 854, 886
Perth (W. A.), 912
PHILIP, ARNOLD:
Running Shunt Dynamos in Parallel, 161
PHILLIPS, C. E. S.:
The Action of Magnetised Electrodes upon Electrical Discharge Phenomena in Rarefied Gases, 507
Photometer, Preece-Trotter, 48
PIDGEON, W. R.:
An Influence Machine, 51
PIGG, J.:
Rules for the Regulation of the Wiring of Premises for Connection to Public Supply Mains, 531, (*Discussion*) 576, (*see also 574* and 903)
Pipes, Leading-in, as Disease Carriers, *886*
Plants, Action of Electricity on, 562
Platinum, A new Source of, 886
Plymouth Electric Supply, *427*

POLICE INTELLIGENCE—
Alleged Fradulent Bankruptcy, 653, 702, 733, 774, 878
Allingham and Fennell, prosecution of, by Hampstead Vestry, 480
County of London and Brush Provincial Co., 620
Fraud (Alleged), 58, 137
I.E.S. Accumulator Co., 13, 90, 172, 203, 243
Obtaining Goods by False Pretences., 18, 58, 90, 137
Smoke Nuisance, 24, 775, *783*, 872
Polyphase Transmission of Power, 219
Power Distribution, Electric, Social Influence of *118*, 883
Power Distribution in the Black Country, 810
Power Transmission Scheme, American, 634
Preece, Mr. W. H., Retirement of, *491*, 532, 603, 735
PREECE, W. H.:
Œtheric Telegraphy, 495, (*Discussion*) 442, (*see also 395*)
Presidential Address to the Institution of Civil Engineers, *44*, 49, 82
Prepayment, Meter, Long-Schattner, 151
Printing Office, Electricity in the, 59
Private Bill Legislation, 422, 451, 484, 515, 538, 660, 705 738, 811, 912
Propeller, Portable Electric, for Boats, 341
Provisional Order Notices, 60, 90, 138, 173, (*Complete List for 1899*) 199, *351*, (*Corrected List for 1899*) 382
Provisional Orders, London, *179*
Provisional Orders not in Operation, *711*, 778
Provisional Order Transfers, 451, 660, 705
Prussia, Electrical Machinery in, 30
Pumps, Electrically Driven, at Glasgow, 717
Pumps, Electrically Operated, 872

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R

Radiation, Electric, Influence of the Thickness of Air-Space on the Total Reflection of, 154
Radiators, Electric, 514
Radio-Active Bodies, Energy in, 428
Railway Signalling, 146
Railway Station Lighting, 588
Railway Trains, Electric Intercommunication in, 540, *596*, 617
Railways, Electric (*see under* **Traction**)
Rangoon, 208
Rapid Transit Problem, The, 652, *798*, 872
Recording Instruments for Testing Insulation, 836
Refrigerating Plant, 622
Refrigerating Plant for Day Loads, 525
Regulations, German Safety, 20
Resistance Box, A New, 837
Resistance of the Human Body, 145
REVIEWS—
Algebra Made Easy [Houston and Kennelly], 410
Alternating Currents of Electricity and the Theory of Transformers [Still], 338, (*Erratum*) 353
Annuaire Pour l'An 1899, 538
Archives of the Röntgen Ray, 339, 458
Canalisations Electriques [Picou], 865
Chemistry in Daily Life [Lassar Cohn], 339
Comprehensive International Wire Table [Boult], 121
Dictionaire Technique Français-Anglais des Outils et Ustensiles [Lovendal], 831
Die Entwickelung der Asymptotischen Telegraphie [Blochmann], 160
Directory of Delagoa, 773
Directory of Titled Persons, 550
Distribution de l'Energie par Courants Polyphasés [Rodet], 800
Electric Traction [Wilson], 120, *238*
Electricity in Town and Country Houses [Scrutton], 831
Electricity Made Easy [Houston and Kennelly], 538
Electro-Plater's Handbook [Bonney], 801
Electro-Dynamics, The Direct-Current Motor [Carus-Wilson], 865
Export Merchant Shippers Directory, 701
Free Expansion of Gases, The [Ames], 763
Hazell's Annual, 243
Indicator Handbook [Pickworth], 121
Industrial Electricity [Graffigny], 800
Instruzione Pratiche di Servizio Sulla Telefonia Intercomunale [Brunelli], 538
Interpretation of Mathematical Formulæ [Houston and Kennelly], 410
Jahrbuch der Elektrochemie [Nernst and Borchers], 337
Kalender für Elektrochemiker [Neuburger], 121
Kalender für Elektrotechniker [Uppenborn], 339
Law and Practice Relating to Letters Patent for Invention [R. Frost], 159, (*see also* page 158)
Les Ondes Electro-magnétiques et la Telegraphie sans Fils [Della Riccia], 160
Life Story of the late Sir Charles Tilston Bright [Bright], 537
Lockwood's Price Book [Miller], 538
Michael Faraday: His Work and Life [S. P. Thompson], 575
Modern Opera Houses and Theatres [Sachs], 133
Practical Telegraphy [Jenvey], 338
Prismatic and Diffraction Spectra [Ames], 763
Soft Coal Burning [Higginson], 2
Specification, 410, 866
Street Railway Roadbed [Pratt and Alden], 120
Taschenbuch für Monteure Elektrischer Beleuchtung-anlagen [v. Gaisberg], 121
Telephone, The [Hopkins], 120
Telephone System of the British Post Office [Herbert], 410
Trigonometry at a Glance, 243
Wilding's Press Guide, 702
Wireless Telegraphy [Kerr], 160
Rhodesia, Electricity in, 60, 774, 846
ROBERTSON, G. H.:
Gravity Electrolytic Processes for the Production of Caustic Soda, 468
Robey and Co.'s Works, 690
Rock Drill, Australian, 842
Rock-Drill, The "Meisner," 525
ROGET, S.R.
Effects of Prolonged Heating on the Magnetic Properties of Iron, 530
Roller Bearings, 736
Röntgen Ray, Archives of the, 458
Röntgen Ray Burns, 781
Röntgen Rays in War, 24
Rontgen Society, 144, 254, 713
Rotary, Transformer, Theory of the, 115, 153, 229
Rotatory Converters, 126, 162, 190, *228*, 230, 842
Rotatory Converter, The, *228*
Royal Alfred Aged Seamen's Institution, 705
Royal Institution (*Announcements*), 286, 674, 784, 853
Royal Institution, Donations to, 66, 853
Royal Society (*Council and Medals*), 181; (*Papers down for Reading*) 96, 144, 214, 253, 428, 458, 494, 524, 562, 597, 702; (*Soirée*) 853
Rubber Trusts, 588
Rules and Regulations, *596*, (*see also under* Wiring Rules)
RUSSELL, ALEXANDER:
Magnetic Leakage in the Alternating Current Transformer, 567, 600, 788, 823
Russia, 60, 811

S

St. Paul's Cathedral, Lighting of, 588
Salomons Scholarship, 145
San Paulo, Electric Lighting at, 775
Scholarship, David Salomons, 286
School Governors, Proposed Association of, 524
SCHOU, PAUL:
Superheated Steam and its Application to Steam Engines, 258
Science, Contemporary Electrical (*see Separate Index*)
Schuckert and Co., 809
Seasoning, Timber, *674*
Secret Commissions, 705
Secretary to the Post Office, Appointment of, *427*, 428, *457*
SEMENZA, G.:
The Water-Power Station at Paderno 255, 361, 413 (*see also page 351*)
Shafting and Belting, Power absorbed in, *1*
Shafting *v.* Direct Driving, *76*
Shaw, Sir Eyre M., 66
Shoreditch Dust Destructor, 17, 53, *96*, 139, *144*, 705
Show Rooms, *321*, 327
Shunt Dynamos in Parallel, Running, *144*, 161 (*see also*, Brighton, Breakdown at)
SMITH, S. W. J.:
Electro-Capillary Phenomena, 650
Smithfield Club Show, 945
Smoke Question, The, 24, 775, *783*, 811
Social Influence of Electric Power, *118*
Social Influence of Electric Power Distribution, 888
Society of Arts: Medals, 144
Society of Arts: Papers before, 66 (*see also under* **Societies' Meetings**)
Society of Engineers, 253, 524
Soldering Paste, 419
Soudan, Patent Law in the, 775
South Africa, 246, 452, 553, 558
Sprague's Utilisation of Atmospheric Electricity *321*
Stage Appliances, Electrical, at Drury Lane Theatre, 325, *336*
Stageland, Electricity in, 336
Standards of Measurement; Report of the American Association Committee, 167
State Commercial Agents, 811
Statistics, Electrical Supply, *351*, 381
Steam Omnibuses, 60
Stephenson Co., The John 168
Stoker, Bennis, 31
Stroboscopic Methods of Testing Small Motors, 676
Students' Visits to Works, 16
Subfluvial Conduits, 146
Sub-Station Attendants, 81
Superheated Steam and its Application to Steam Engines, 258
Surgical Operating Table, Electrically heated, 735
Sweating in the Post Office 458
Sweetmeat Factory, Electric Power Transmission at a, 272
SWINBURNE, JAMES:
Nernst Electric Light, 545, (*Discussion*) 604 [*see also under* **Lamps (Incandescent)**]
SWINTON, A. A. CAMPBELL:
The Reflection of Cathode Rays, 650
The Wehnelt Current Interrupter, 720, 728 (*see also page 712, 864*)
Switch and Controller, 242
Switch and Fuse, New, 550
Switch, A New Accumulator, 441, 458, 510

T

Table of Electricity Supply Works, *351*, 381
Tariff Systems, *321*, *352*, 353
Tasmania, 317, 450
Technical Dictionaries, *783*
Telegraphy (*see also* **Wireless Telegraphy**)—
African Telegraph Lines, 60, 145, 180, 244, 286, 317, 346, 428, 737, 747, 845, 853, 912
All-British Cable Schemes (*see* Pacific Cable Schemes)
American Cable Schemes, 598, 634, 659, 705
American Government Cable Steamer, 469
Australia, Cable Communication with, 774
Black's Reversals Method, 547
Cable Interruptions and Repairs, 2, 30, 66, 96, 144, Cable Shares and Wireless Telegraphy, *885*
Canado-Australian Cable, The Proposed, 886
180, 214, 253, 286, 322, 353, 396, 427, 458, 492, 524, 562, 597, 634, 674, 712, 747, 774, 784, 821, 853 886
Cape to Cairo Telegraph Scheme, 145, 246, 317, 715, 747, 853
Cheaper Telegrams, 703
Chili, 910
Code Telegraphy, 87
Collett, Richard, Testimonial to, 63
Collision of c.s. "Anglia," 171
Congo, 60, 428, 586
Cuban Land-line, A New, 30
Daily Telegraph on the Telegraph Service, *457*
Dawson City, Telegraph to, 705
Earth Currents, Measuring Resistances Containing, 416
Egypt, 175, 286, 317
French Submarine Cable, A New, 597
German-American Cable, 483
German Army, Telegraph in the, 322
German Submarine Cable, Proposed, 886
German-Swedish Cable, New, 96
Germany and Japan, 911
Gibraltar-Malta-Alexandria Cable, 353
Gold Coast Telegraphs, 244
Honolulu, Cable to, 483
Imperial Cable Service, *285*, 298
Interruptions (*see* Cable Interruptions and Repairs)
Japanese Submarine Cable, 774
Klondyke, Telegraph to, 174, 380
London-Birmingham Cable, *457*, 465, 492
Night Telegraph Service, *457*
Omdurman, A Telegraphic Relic found at, 751
Operators in Cuba, 396
Pacific Cable Schemes, *285*, 389, 563, 598, *633*, 634, 659, 705, 877, 880, *895*, 886
Paper-Insulated Cables, *457*, 465
Patagonian Telegraphy, 853
Persia, Telegraphs and Telephones in, Queensland, *65*
Telegraphy (*see also* **Wireless Telegraphy**)—*Continued.*
Relic, A Telegraphic, found at Omdurman, 751
Revenue Returns, *351*
Siam, 60
Sierra Leone, 845
Sixty Thousand Words an Hour Telegraphy, 905
Submarine Cables in Time of War, 215
Telegraph and Telephone in 1898, 397
Telegraph Clerks' Grievances, 390, *595*, 625
Telegraph Poles, 280
Telegraphists' Bonds, *395*
Telegraphists' School of Science, 597
Turkey, 515
Type-printing Telegraph Apparatus, The Higgins, 223
Underground Cables, *457*, 465
Wei-Hai-Wei, 562
World's Telegraph and Telephone Wire, 871
Telephony—
American Telephone Scheme, 597
Auckland (N.Z.) Telephone Exchange, 459
Automatic Exchange Patent, 253
Automatic Telephone Exchange for Glasgow, 253
Automatic Telephone Exchanges, American, 701
Bedford, 174, 180
Brussels Telephone Service, 449
Cable, Field's, *595*
Cable, New Air-Space, 529
Central Battery Exchange, *852*
Corporation of London and the Telephone, *65*, 66, 209, 484, 515
Coup d'Etat, A Telephonic, 524
Edinburgh, 139, 209, 479
Erection of Telephone Exchanges, *852*
Exchange in New York, 55
Fiji, 59
Financial News on Telephony, 253
Fire Alarm Telephone Service in New York, 321
Foreign Countries, The Telephone Service in, 738, *745*, 748
Foreign-Made Apparatus, 515
French Telephone System, Addition to, 287
Gale and the Telephone Wires, 322
Gavey's Paper on Telephones, *852*
German Telephone Tariff, New, 635
Glasgow, 99, *144*, 174, 207, *214*, 246, 810
Government Purchase of the Telephone, 207, 273
Government Telephone Bill, *595*, *675*, *688*, 695, 716, 845, *852*, 853, 912
Independent Telephone Companies, American, 842
Institution of Electrical Engineers Committee on Telephony, *711*, 718
International Telephony, 174, 253, 821, 837
Japan, Long-Distance Line in, 396
London-Birmingham Cable, *457*, 465, 492
London County Council and the Telephone, *65*, 67, 98, 139, *144*, 174, 279, 484, 515
Long-Distance Telephony, 1-0
Luminous Signal Telephone Switchboards, 309
Manchester Corporation and the Telephone, *29*, 31, *65*, 66, 139, *144*, 175, *595*, 625, 776, 879
Municipal Corporations and the National Telephone Co., 424, 484, 515
Municipalisation, 24, 90, 139, *144*, 175, 209, 216, 484 515, *595*
National Telephone Co.'s Bills, 174, *179*, *180*, 353, 428, 451, 485, 515, 660
Nationalisation of the Telephone, 133, *427*
New Exchange, 280
New Telephone Companies, *29*, 31, 55
Paper-Insulated Cables, *457*, 465
Paris-Berlin Telephone, 821
Paris-Brussels Telephone, 174
Persia, Telegraphs and Telephones in, 5
Police Telephonic Communication, 60, 279
Post Office Telephone Competition, 705
Queensland, *65*
Select Committee, Proceedings of, *1*, *29*, 46
South Australia, 705
Spans, Length of, 485
Statistics, 458
Subscribers' "Grumble Factor," *852*
Switchboard Patent, Expiring, *396*
Sydney (N.S.W.), 60
Tariffs in the United States, *711*, 732, 747, *820*, 839, 842, 871, 872
Tax on American Telephone Poles, 529
Telephone Athletic Association, 516
Telephone Statistics, 775
Telephones and the State, *29*, 46
Telephoning over Railway Telegraph Lines, 525, 695
"The Telephone Service" (Articles in *The Times*), 434, 552
"The Telephone Tangle and the Way to Untie it," *285*
Trunk Telephone Lines, New, 174, 180, 286, 330, 396, 397, 705, 738, 747, 880, 887
Underground Cables, *457*, 465
Vacuum Telephone Transmitter, 598
Wireless Telephony, *810*
World's Telegraph and Telephone Wire, 871
Temperature Coefficients of Copper, 736
Temperature Entropy Chart, 145
Temperatures, Extreme, Measurement of, *712*
Tesla, Nikola, A Recent Patent of, 203
Tests, Manufacturers', Publication of, *674*
Thawing Water Pipes by Electricity, 785
Theatre and Music Hall Lighting, 553, 623, 625
Theatre, Drury-lane, Electrical Stage Appliances at, 325, *336*
Theatre, Kennington, Electrical Installation at the, 327, *336*
THOMPSON, Prof. SILVANUS P.:
A Magneto-Optic Phenomenon, 51
Rotatory Converters, 126, 162, 190, (*Discussion*) 230 (*see also page 228*)
Three-Phase System, Automatic Pressure Regulation on, 31
Three-phase Patents in Germany, 215
Timber-Seasoning, *674*
Tin *v.* Copper, 880

Digitized by Google

Traction, Electric—
Accidents, (*Bradford*) 96, 136, (*Bristol*) 287, (*City and South London Railway*) 450, (*Glasgow*) 2, (*Halifax*) 322, 353, (*Hamburg*) 785, (*Nancy*) 853
Accidents to Trolley Cars on Railway Crossings, 635
Accumulator Traction, Cost of, 675
Air-Brakes, 872
America, Electric Traction in, 842
American Suggestions to European Electric Tramway Builders, 225
American Tramway Data, Some Amusing, 93
Amsterdam, 21
Anderson Closed-Conduit System, 98
Automobile Club Exhibition and Trials, 837
Belgium, Experiments, 59
Berlin, Underground Railways for, 130
Blackburn Corporation Electric Tramways, 712, 752, 784
Boston, Electric Traction for the New Union Station at, 524
Boston, Proposed New Subway in, 886
British Electrical Industry, Some Aspects of, *470*
Bucharest Tramways, 389
Buenos Ayres, 58, 844
Cabs, Electric, 207, *214*
Cabs, Electric, in Paris, 821
Cab, Krieger, 449
Cape Town Tramways, *783*
Central London Railway, 703
Chamonix, Electric Railway to, 597
Chicago Metropolitan West-Side Elevated Railroad, 110
Chicago, Electric Traction in, 675
Chilkoot Pass, Tramway Construction over, 333
China, Tramway Enterprise in, 825
City and South London Railway, 96
Clubs, Motor Car, 96, 322
Collection of Current by a Tramcar, 597
Combined Electric Traction and Supply Stations, *300*, 289, 294
"Coming Electric Railroad, The," 492
Compressed Air Motor Trucks, 510
Conduit *v.* Cable and Horse Tramways, *95*, 139
Controller Governor, A New, 97
Cork Combined Electric Lighting and Traction System, 289
Dawson's Paper, Postponement of, 597
Durban, 22
Düsseldorf-Crefeld Light Railway, 181
Earth Currents, *783*, *898*
Earth Returns and Electrolysis, 97
Egypt, 536
Electric Railway and Tramway Carriage Works, The, 785
Electric Traction and its Application to Suburban and Metropolitan Railways, *745*, 764, 794
Electrolysis, Damages for, 785
European Traction Statistics, *784*
Experiments on the P. L. and M. Railway, 323
French Traction Statistics, *784*
Gas Trams, *29*
German East Africa, 536
Germany, Electric Traction in, 207, 459
Glasgow Corporation Electric Tramways, *95*, 104, (*A Correction*) 180
Gothenburg Tramways, 389
Italy, 315
"La Poste Electrique Internationale," 287
Light Railways, (*Important Decision*) 144, (*In Main Thoroughfares*) 911, (*Projected*) 204, (*Acton-Hanwell*) 624, (*Atherton*) 59, (*Barking-Beckton Gas Works*) 659, 810, (*Blyton-Frodingham*) 138, (*Bristol-Hanham*) 245, (*Camborne-Redruth*) 89, 138, 515, *Cheddleton-Hulme End*) 810, (*Cheetham Hill-Rhodes*) 701, (*Cheltenham-Cleeve*) 704, *Coatbridge-Airdree*) 89, 757, (*Colne*) 245, 577, (*Doncaster*) 587, (*Dudley - Stourbridge*) 89, 137, 704, (*Dundee-Broughty Ferry*), 911, (*Edmonton - Waltham Cross*) 624, (*Finchley-Hendon*) 624, 659, 738, 810, (*Flamborough - Bridlington*) 430, (*Grimsby - Saltfleetby*) 704, 810, (*Hanwell-Uxbridge*) 279, 552, 624, (*Hornsey*) 911, (*Kelsall-Chester*) 810, (*Kingston-on-Thames - Esher*) 59, (*Leeds-Bradford*) 587, (*Liverpool - Prescot*) 587, (*Liverpool-Bolton*) 89, (*Llandudno-Colwyn Bay*) 138, 587, 738, (*Lye-Stourbridge*) 587, (*Merthyr-Cefn*) 22, (*Middleton-Rochdale*) 22, 245, (*Portsmouth-Cosham*) 315, (*Ramsgate-Margate*) 515, (*Redditch-Astwood*) 59, (*Reigate-Redhill*) 315, (*Rhyl-Perstatyn*) 701, (*Roper-Houghton-le-Spring*) 738, (*South Staffordshire*) 704, (*Stourbridge-Kinver*) 484, (*Trowse-Beccles*) 810, (*Ventnor*) 450, (*Whitehaven-Maryport*) 775
Liverpool Corporation Electric Tramways, *95*, 93
Liverpool-Manchester Electric Railway, Proposed, 704, 775
Locomotives Act, **1898**, 323
London County Council Tramways, *596*, 910
London Electric Cab Co., *514*
London Underground Railways, 587, 588
Traction, Electric—*Continued.*
Milan-Monza Electric Railway, 869
Mont Blanc, Proposed Railway up, 96
Motor Cab, New Use for, 886
Motor Cabs and Carriages, 587
Motor Car Building, 650
Motor Car Design, 714
Motor Car Journal, The, 702
Motor Car Trials in New York, 203
Motor-Car Trials in Paris, 31
Motor Carriages, Electrical, 903
Naples Tramways, 552
New York City, Electric Railways in, 203
Notices, Electric Traction, 137, 173, 199, 882
Open-Conduit Electric Traction at Washington, 471
Ostend Accumulator Tramways, 839
Polyphase Traction, *8*
Position and Prospects of Electric Traction in the United Kingdom, 130
Paris-Aubervilliers Electric Tramway, 540
Paris Tramway, A New, 97
"Pony, Electric," 397
Power-Brakes for Street Cars, 525
Practical Points Concerning Electric Vehicles, 714
Prussia, 451
Race, Motor Car, in France, 822
Rapid Transit, 625, *798*, 872
Russia, 775
Shanghai Electric Railways, 59
Snowstorm in United States, 287, 341
Social Influence of Electric Power, *118*
Southampton, *596*
Spain, 389, 880, 912
Speed of Electric Trams, 174, 209, 515
Stages, Automobile, on Fifth Avenue, 417
Stanstad-Engelberg Electric Railway, 460
St. Helens Tramways, *95*
Storm in United States, *561*
Surface Contacts, Electric Traction by, 4, 69, 614, *654*, 653
Surface Contacts, Superficial Criticism and, *608*
Third Avenue Railroad Co., 168, 286, 341
Thompson-Walker System, 4, 69, 614, *654*, 653
Trials of Motor Vehicles for Heavy Traffic, 583
Trolley Ropes, 353
Trolley *v.* Conduit, *585*
Trolley Wire, Old, Price of 784
Underground Electric Railways, London, 346
United Kingdom, Position and Prospects of Electric Traction in the, 130
Waterloo and City Railway, 865, 524
Waterloo-Baker-street Railway, Contractors' Locomotives for, 600
Waterloo, Euston and Paddington Railway, *745*
Trade Reports, 705
Trades Union, Electrical, 244, 878
Trades Unionism, 21, 171, 588
Train Lighting, 322, 323, 588, 890
Transformer Design, 598
Transformer Distribution Patents, The Zipernowski-Déri-Bláthy, 352, 899
Transformer, Rotary, Theory of, 115, 152, 229
Transformer Sheet, Most Efficient Thickness of, *365*
Transformer, The Alternating Current, Magnetic Leakage in, 567, 600, 788, 823
Transmission of Electric Power, Long Distance, *142*, 202, 243, 340
Tramways, Electric (*see* **Traction, Electric**)
Trotter, Alexander Pelham, 854
TROTTER, A. P.:
The Minor Variations of the Clark Cell, 836
Trotter's Experiments in Cape Town, *783*
Trunk Mains, Electric Lighting, 624
Turkey, 207, 221
Turntable, An Electrically-Driven, 53
Type-Setting Installation, Electrically Driven, 353

U

Uniformity in Electrical Engineering Practice, Institution Report on, *673*
Uninsulated Middle Wire, 784

V

Vatican, Electric Lighting of the, 353, 422, 624
Vautin Claude, 88, 515, 658 878, 881 (*see also under* **Police Intelligence**)
Verband Deutscher Elektrotechniker, Annual Meeting of, 878
Vienna, 846
Volenite, 773
Voltaic Action, Experiments Bearing on the Theory of, 651
Volume Changes which Accompany Solution, 509
Volunteers, Electrical Engineers, 2, 30, 180, 215, 458

W

WALKER, MILES:
Electric Traction by Surface Contacts, 569, 614
WALLIS, F.:
Polyphase Transmission of Power, 219
Wall-Plugs, 420
War, The Spanish-American, Use of Electricity in, 341, 854
Warships, American, Use of Electricity on, 784
Watch Making Record, 136
Water-Power Utilisation in Canada, 61
Water-Power Utilisation in the Highlands, 139, 145
Wave Detector, Neugschwender's, 732
Wave-Motion near a Theoretical Herzian Oscillator, 493
Wear of Steel Rails, 424
Wehnelt Current Interrupter, *712*, *864*, (*Beattie*) 732, (*Blondel*) 870, (*Brooks*) 841, (*Fleming*) 732, (*Hill*) 766, 841, (*Marchant*) 841, (*Preston*) 766, 841, (*Swinton*) 740, 728, (*S. P. Thompson* 731, (*Elihu Thomson*) 870, 902
Willans Engines, Large, 892
Williamson and Joseph, New Works of, 543
Wills, 588, 880
Wilson's Electric Traction, 238
WILSON, Prof. E.:
The Induction Motor, 729, 731, 824, 861
Wire, High Resistance, "Beacon," 694, 736
Wire Stealing, *886*, 912
Wireless Telegraphy—
America, Wireless Telegraphy to, 886
American Government Experiments, 821, *872*
Applications of Ether Waves, 492
Board of Trade and Wireless Telegraphy, 887
Brown's Experiments *458*, 479
Cable Shares and Wireless Telegraphy, *885*
Control of Wireless Telegraph, *872*, (*Correction*) 896
First International Press Message, 785
First International Message, *852*
France, The Wireless Telegraph to, 747, 785, *819*, 827, *851*, 886
Herzian Telegraphy, *724*
Imponderable Jokes, 821
Improvements in Magnetic Space Telegraphy (Lodge), *251*, 269, 305, 366, 402, (*Discussion*) 442, (*Correspondence*) 385, 445
Neugschwender's Wave Detector, 732
Œtheric Telegraphy (*Preece*), *395*, 405 (*Discussion*) 442
Schefer's Experiments, 271
Sicily, Wireless Telegraphy to, 597
Strecker's Experiments, 428
Telegraphy by Magnetic Induction (Evershed), 330 (*Discussion*) 442, (*Correspondence*) 479
Telegraphy by Means of Ultra-Violet Light, 271
Theory of the Marconi Telegraph, 766, 903
Trinity House and Wireless Telegraphy, 821
Wireless Telegraph Companies Experiments, 286, 428, 747, *819*, 887
Wireless Telegraphy (Marconi) 660, 674, 690, *724*, *726*, 758, 766
Zickler's Experiments, *251*, 271
Wireless Telephony, *850*
Wiring, Amateur, *783*
Wiring, Interior Conduit, 844
Wiring of Premises, Rules for the Regulation of, [Pigg] 531, (*Discussion*) 576, *574*, 903
Wiring Practice, 448, *783*
Wiring Rules, *574*, *783*
Wiring Rules, Indian, 675
Wiring Rules in Germany, 253
Wiring Rules, New French, 786
Wiring Rules, Royal Insurance Companies, 514
Wiring Rules, The Institution, [Crompton] 501, (*Discussion*) *574*, 576, 903
Wiring Rules, The Regulation of, [Wordingham] 505, (*Discussion*) 576, *574*, 903
Wood-Seasoning by Electricity, 446, 515
WORDINGHAM, C. H.:
The Regulation of Wiring Rules, 505 (*Discussion*) 576 (*see also 574* and 903)
Workmen's Compensation, 625, 898
Works Costs, Electricity Supply, in 1896 and 1897, 372
Wright System in America, 353

X

X-Ray Yarn, An, 597

Z

Zeeman Effect, Converse of, 397
ZICKLER, Prof. K.:
Telegraphy by Means of Ultra-Violet Light, 271
Zipernowski-Déri-Bláthy Transformer Distribution Patents, *352*, 899
1898, 370

Leading Articles and Editorial Notes.

(In this Section LEADING ARTICLES are shown in CAPITALS.)

Accidents, 2, 29, 96, 235, 236, 458, 492
Arnot's Paper on Meters, 252
All-British Cable Schemes (*see* Pacific Cable Schemes)
Atmospheric Electricity, Sprague's Utilisation of, 321
Bradford Accident, 96
Battersea Vestry *v.* County of London and Brush Co., 491
Brighton, Supply Interruption at, 2, 29
BRITISH ELECTRICAL INDUSTRY, SOME ASPECTS OF, 470
Brown's Experiments in Wireless Telegraphy, 458
Cable Shares and Wireless Telegraphy, 885
Cape Town Tramways, 783
Central Stations of the United Kingdom, 351
Chelsea, Alleged Nuisance at, 595
China, Engineering Enterprise in, 143
City, Electric Lighting of the, 252, 561, 851, 886
City and South London Railway Accident, 458
CIVIL ENGINEERING, ELECTRICITY IN, 44
Clerkenwell Accident, 285
Coherers, 634
COMBINED ELECTRIC TRACTION AND SUPPLY STATIONS, 300
COMPANY PROMOTION "IN BULK," 438
CONCENTRIC WIRING, 264
Conduit *v.* Cable and Horse Tramways, 95
Consulting Engineers and Contractors, 596
Contractors, Payment of, 96
Cut-Outs, Minimum, 2, 29
Daily Telegraph on the Telegraph Service, 457
Dawson's Paper on Traction, *745*
Delay in Delivering Plant, 144, 213, 251
Development of Electrical Engineering, 1
Devonport Electric Supply, 427
Directory, Electrical Trades, 353
Dust Destructor Scheme at Hackney, 674
Earth Currents, 783
EARTH CURRENTS AND ELECTRIC TRACTION, 898
Edinburgh, Overload in, 144, 213, 252
Electricity Supply in Bulk, 321, 352, 427, 673
Electric Lighting (Clauses) Bill, 711
ELECTROLYTIC ALKALI AND BLEACH, 536
Employment of Time-Expired Naval Men, 65
Fish, Electric, 746
Forbes', Prof., Financial Scheme, 143
Gas Trams, 29

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Leading Articles and Editorial Notes—*continued.*

Gavey's Paper on Telephones, 852
General Power Distributing Co.'s Bill, 352, 673
Glasgow Tramways, 95
Hackney Dust Destructor Scheme, 674
HERTZIAN TELEGRAPHY, 724
INDUCTION MOTOR PROSPECTS, 833
INSTITUTION OF ELECTRICAL ENGINEERS, 198
Institution of Electrical Engineers, Special Committees
Inter-Communication in Railway Trains, 596 [of, 673
International Magnetic Conference, 29
Interruptions to Supply, 2, 29, 213
Japan, Electrical Industry in, 491
Kallmann's Paper on Testing, 286
Kingswood Lighting Station, Closing of, 531
Langdon's Mechanical Engineers' Paper, 1
Liverpool Engineering Society, 65
Liverpool Tramways, 95
Local Authorities *v.* Companies, 321, 353, 673
London Chamber of Commerce Dinner, 427
London County Council and Control of Supply Undertakings, 531
London County Council and Local Authorities, 179
London County Council Tramways, 596
London Electric Cab Company, 214
London Electric Supply Corporation, 634
London Provisional Orders, 179
Map of Electric Supply Undertakings, 427
Meters, Certified and Uncertified, 252
"Mohegan," Loss of the, 179
MODUS VIVENDI, A, 644
Municipal Authorities and Companies, Suggested Conference between, 524, 644
MUNICIPAL ELECTRIC SUPPLY BUSINESS, 762
Municipal Electric Supply, "In Bulk," 427, 644
MUNICIPAL ENTERPRISE, THE COST OF, 592
MUNICIPAL JACKS-OF-ALL-TRADES, 408
National Telephone Co's. Bills, 179, 180
Naval Men, Time-Expired, Employment of, 66
New Year's Honours, 331
Nernst's Electric Light, 523, 595, 821
Niagara Falls, Transformations at, 593
Night Telegraph Service, 457
"Norwich" Tariff System, 352
Overloaded Central Stations, 144, 213, 251
Pacific Cable Schemes, 285, 633, 835
Paper-Insulated Telegraph and Telephone Cables, 457
PATENT LAW, BRITISH, 158
Patents Expiring in 1899, 352
Pipes, Leading-in, as Disease-Carriers, 836
Plymouth Electric Supply, 427
POLYPHASE TRACTION, 8
Polyphase Traction, 745
Preece, Mr., Retirement of, 492
Preece's Paper on Etheric Telegraphy, 336
Provisional Orders, London, 179
Provisional Orders, Unworked, 711
Queensland Post and Telegraph Department, Report of, 65
RAPID TRANSIT, 798
ROTATORY CONVERTER, THE, 228
Rules and Regulations, 393
Seasoning Timber, 674
Secretary to the Post Office, Appointment of, 427, 457
Shafting and Belting, Power Absorbed in, 1
SHAFTING V. DIRECT-DRIVING, 76
Shoreditch Accounts, 96, 144
Show-Rooms, 321
Smoke Question, the, 783
SOCIAL INFLUENCE OF ELECTRIC POWER, 118
Southampton Accident, 286, 492
Sprague's Scheme to Utilize Atmospheric Electricity, 321
STAGE-LAND, ELECTRICITY IN, 336
Statistics, Electrical Supply, 351
St. Helens Tramways, 95
Storm in United States, 561
SURFACE CONTACTS, SUPERFICIAL CRITICISM AND, 638
Table of Electricity Supply Works, 351
Tariff Systems, 321, 352
Technical Dictionaries, 783
Telegraphists' Bonds, 395
Telegraphists' Grievances, 595
Telegraph Revenue Returns, 351
Telephone Bill, The Government, 595, 673, 698, 852
Telephone Cable, Field's, 395
Telephone Competition, 65, 214
Telephone Exchange, Central Battery, 852
Telephone Exchange, Erection of, 853
Telephone License, Deputation from Manchester re, 29, 65
TELEPHONE QUESTION, THE, 638
Telephone Service in Foreign Countries, 745
Telephone Situation in Glasgow, 214
Telephone Situation in Glasgow, Manchester and London, 144
Telephone Subscribers' "Grumble Factor," 852
Telephone Switchboard Patent, Expiring, 396
Telephone Tariffs in the United States, 711, 820
Telephones, Select Committee on, 129, 595
Telephones and the State, 29
Telephony, Institution Committee's Report on, 711
Temperatures, Extreme, Measurement of, 712
Terrestrial Magnetism, Report on, 29
Testing Supply Networks, 286
Tests, Manufacturers', Publication of, 674
The *Electrical World and Electrical Engineer* of New York, 746
"The Telephone Tangle and the Way to Untie it," 285
Thompson-Walker Traction System, 634
Timber Seasoning, 674
TRACTION, POLYPHASE, 8
Traction Statistics, European, 784
Traction Systems, Comparison of, 745
Tramways at Southampton, 396
Transformer Sheet, Most Efficient Thickness of, 335
Transmission of Electric Power, Long Distance, 143
Trolley *v.* Conduit, 523
Trotter's Experiments in Cape Town, 783
Underground Telegraph and Telephone Cable, 457
Uniformity in Electrical Engineering Practice, Institution Report on, 673
Waterloo, Euston and Paddington Railway, 745
Wehnelt Current Interrupter, 712
WEHNELT INTERRUPTER, THE, 884
Willans and Robinson's Half-yearly Report, 746
Wireless Telegram, First International, 852
Wireless Telegraphy, Brown's Experiments, 458
Wireless Telegraphy, Control of, 852 (*Correction*, 886)
Wireless Telegraphy, Dr. Lodge's Paper on, 251
WIRELESS TELEGRAPHY, INSTITUTION DISCUSSION ON, 724
Wireless Telegraphy, Marconi's Experiments, 819, 851
Wireless Telegraphy, Zickler's Experiments, 251
Wireless Telegraphy and Cable Shares, 835
Wireless Telephony, 820
Wire Stealing, 886
Wiring, Amateur, 783
WIRING RULES, 574
1898, 370

Contemporary Electrical Science.

ABBE, C.:
Altitude of the Aurora, 527
Absorption in a Magnetic Field, 324
Absorption of Electric Waves 889
ABT, A.:
Magnetic Iron Ore, 46
AGOSTINI, B.:
Selenium Coherers, 183
ALBERT OF MONACO:
The Azores as a Magnetic Station, 182
Alternate-Current Magnetisation, 564
Altitude of the Aurora, 527
Aluminium, Properties of, 824
Anode Rays, 715
Anomalous Dispersion of Vapours, 324
Arc Light, 355
Arc Vapours, 148
ARONS, L.:
A New Sliding Interrupter, 503
ASCHKINASS, E.
Coherers, 46
Atmospheric Electricity, Source of, 715
AUBEL, E. VAN:
Iron-Constantan Thermo-Couples, 147
AUERBACH, F.:
Resistance between Steel Spheres, 288
Aurora, Altitude of, 527
Azores as a Magnetic Station, 182
BAGARD, H.:
Electrolytes in a Magnetic Field, 599
BAUER, L. A.:
Distribution of Terrestrial Magnetism, 889
BAUM, F. G.:
New Transformer Diagram, 789
BECQUEREL, H.:
Anomalous Dispersion of Vapours, 324
Magneto-Optic Effects, 114
Properties of Uranium Rays, 854
Becquerel Rays, 288, 854
Becquerel Rays, Source of, 646
Becquerel Rays, New Sources of, 398
BEHN, U.:
Low-Temperature Properties of Metals, 78
BEHRENDSEN, O.:
Coherers, 527
BEZOLD and KYKATSCHEW:
Temporary Magnetic Observatories, 182
BIRKELAND, K.:
Magnetic Suction of Cathode Rays, 267
BOUDREAUX, E.:
Electric Lines of Force, 889
BLONDEL and REY:
Search-Light Intensities, 437
BLONDLOT, R.:
Measurement of Quantity, 114
BRANLY, E.
Gold and Platinum Coherers, 437
BRANLY and LE BON:
Absorption of Electric Waves, 889
BROCA, A.:
Zeeman Effect on a Large Scale, 519
Anode Rays, 715
BROWN, N. H.:
Photographic Studies of the Arc, 355
Brush Discharge, 564
Calcium Carbide, 324
CAMPBELL, A.:
Magnetic Fluxes in Electrical Instruments, 539
Canal Rays, 783
CANTOR, M.:
Continuous Discharges, 787
CAPELLO, J. B.:
Compound Magnetic Variation Curves, 182
Carbon Coherers, 822
Cathode, Lenard, and Röntgen Rays, 787
Cathode Rays, Interference of, 527
Cathode Rays, Magnetic Suction of, 267
Cathode Rays, Reaction Pressure of, 437
Cathode Rays, Reflection of, 396
Cathode Rays, Simple, 437
Cathode Surfaces, Mutual Influence of, 45
Cells, True Resistance of, 355
Chemical Rectification, 398
Coherers, 10, 46, 182, 217, 437, 527, 822
Coherer Sparks, 217
Colour Photography, 889
Condensation Nuclei, 398
Condenser Losses, 600, 715
Conductivity and Luminosity of Flames, 324
Conductivity Method of Studying Solutions, 266
Conservation of Matter, 324
Constant of Gravitation, 147
Contact Electricity, 182
Continuity of Wave Theories, 77
Continuous Discharges, 787
COOK, E. H.:
Brush Discharge, 564
COOLIDGE, W. D.:
Wire Waves, 854
COTTON, A.:
Absorption in a Magnetic Field, 324
CROOKES, Sir W.:
Source of Becquerel Rays, 646
Crystallisation in a Magnetic Field, 147
Crystals, Magnetisation of, 503
CURIE, Mme. CURIE and BÉMONT:
New Sources of Becquerel Rays, 398
Dark Light, 646
D'ARSONVAL:
Wehnelt's Interrupter, 922
DESLANDRES, H.:
Simple Cathode Rays, 437
Dielectric Conduction, 503
Dielectric Constants, 147
Dielectric Strength of Insulators, 355
Dielectrics under Tension, 217
Diffraction Galvanometer, 839
Dispersion Model, 266
DITTE, A.:
Properties of Aluminium, 824
DONNAN, F. G.:
Hall Effect in Liquids, 147
DORN, E.:
Visibility of Röntgen Rays, 503
DUCRETET, E.:
Wireless Telegraphy across Paris, 182
DUSSAUD:
Loud Transmission of Sound, 283
Earth Currents, 216, 217
Earth's Magnetic Potential, 216
EBERT, H.:
Consumption of Energy in Vacuum Tubes 854
Electric Charges of Rain and Snow, 889
Electric Cohesion, 398
Electric Dispersion, 182, 288
Electric Lines of Force, 889
Electric Quantity, 114
Electric Spark, 646
Electrolytes in a Magnetic Field, 599
Electrolytic Interrupter, 715, 822, 854
Electrolytic Iron, 599
Electromagnetic Waves, Polarised, 78
Electrothermal Relations, 398
ELSTER AND GEITEL:
Becquerel Rays, 288
Electric Charges of Rain and Snow, 889
Emissivity of Platinum, 114
ERSKINE, J. A.:
Determination of Dielectric Constants, 147
FAWCETT, F. B.:
Standard High Resistances, 114
FÉRY, C.:
Sensitiveness of Galvanometers, 822
Flames, Luminosity of, 324
Galvanometer, Diffraction, 839
Galvanometers, Sensitiveness of, 822
GEITLER, J. R. VON:
Röntgen and Cathode Rays, 45
Gliding Sparks, 564
Gold and Platinum Coherers, 437
Gravitational Constant, 147
GRAY, T.:
Dielectric Strength of Insulators, 355
GUILLET, A.:
A Simple Magnetometer, 599
GUTHE, K. E.:
True Resistance of Cells 355
Hall Effect in Liquids, 147
HENRY, J.:
Magnetic Deflection of Vacuum Discharges, 147
Hertz Experiments, New Form of, 503
Hertzian Wire Telegraphy, 527
HESS, W.:
Induction Coils, 564
HEYDWEILLER, A.:
Contact Electricity, 182
HOULLEVIGUE, L.:
Electrolytic Iron, 599

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Contemporary Electrical Science—*(continued).*

HUTCHINS, C. C.:
Vacuum Tubes, 715
Hysteresis at Low Temperatures, 787
Induction Coils, 564
Influence Machine, New, 266
Interference of Cathode Rays, 527
Intermediate Conductors, 78
Interrupters, 508
Interrupter (Electrolytic), 715, 822, 854
Ions Mobility of, 564
Iron-Constantan Thermo-Couples, 147
JACKSON, H.:
Phosphorescence,
JAUMANN, G.
Interference of Cathode Rays,
Kathode Rays, *see* Cathode Rays
KALLIR, L.
Chemical Rectification, 398
KELVIN, LORD:
Continuity of Wave Theories,
KNOTT, C. G.:
Strains due to Magnetisation, 216
KOENIGSBERGER, J.
Magnetic Susceptibilities, 288
KOHLRAUSCH, F.:
Mobility of Ions, 564
KÖNIG W.:
Slow Oscillations, 854
LE BON, G.
Dark Light, 646
LEICK, W.:
Dielectric Conduction, 508
LEMSTRÖM, S.:
Earth Currents and Magnetic Disturbances, 216
LONDE, A.:
An Exploring Radioscope, 890
LÖWE, K.
Electric Dispersion, 182
Low-Temperature Properties of Metals, 78
Luminescence Lamps, 10
LUTTEROTH, A.:
Magnetisation of Crystals, 508
MACALUSO and CORBINO:
A New Magneto-Optic Effect, 45
MACGREGOR and ARCHIBALD:
Conductivity Method of Studying Solutions, 266
Magnetic Phenomena, Mechanical Reproduction of, 216
Magnetic and Meteorological Analogies, 564
Magnetic Deflection of Open-Air Discharges, 265
Magnetic Deflection of Vacuum Discharges, 147
Magnetic Elements, Secular Variation of, 216
Magnetic Field, Crystallisation in, 147
Magnetic Fluxes in Electrical Instruments, 599
Magnetic Hysteresis, 10
Magnetic Iron Ore, 46
Magnetic Observatories, Temporary, 182
Magnetic Potential, Earth's, 216
Magnetic Suction of Cathode Rays, 267
Magnetic Susceptibilities, 288
Magnetic Variation Curves, 182
Magnetisation of Crystals, 508
Magnetometer, Simple, 599
Magneto-Optic Effect, New, 45
Magneto-Optic Effects, 114, 715
MALAGOLI, R.:
Photography of Coherer Sparks, 217
MARGULES, M.:
Solution of Noble Metals,
MARX, E.
Electric Dispersion, 288
MATTHEWS, C. P.:
Photometer Records, 855
MERRILL, J. F.:
Resistance and the Surrounding Dielectric, 788
MERRITT, E.:
Reflected Cathode Rays, 398
MERRITT and STEWART:
Arc Vapours, 148
MOISSAN, H.:
Calcium Carbide, 324
MORIZE, H.:
Röntgen Rays, 46
NEUGSCHWENDER, A.:
A New Wave Indicator, 645
NIETHAMMER, F.:
Magnetic Hysteresis, 10
Open-Air Discharges, 265
Oscillations, Slow, 854
PANICHI, U.:
Dielectrics under Mechanical Tension, 217
PELLAT, H.:
Atmospheric Electricity, 715
Wehnelt's Interrupter, 822, 854
PETAVEL, J. E.:
Emissivity of Platinum, 114
Phosphate, Reduction of, 889
Phosphorescence, 148
Photo-electricity, 822
Photographic Studies of the Arc, 355
Photography of Coherer Sparks, 217
Photometer Records, 355
Physiological Effects of Current, 822
PIDGEON, W. R.:
A New Influence Machine, 266
Point Discharge, Genesis of, 78, 266
Polarised Electromagnetic Waves, 78
Potential Gradient in Vacuum Tubes, 78
PRECHT, J.:
Magnetic Deflection of Open-Air Discharges, 265
New Form of Hertz Experiments, 503
PRESTON, T.:
Radiation in a Magnetic Field, 715
PREVOST and BATTELI:
Physiological Effects of Current, 822
Propagation of Waves along Wires, 787
Pyro-electricity, 503
Radiation in a Magnetic Field, 114, 715
Radiophony, 599
Radioscope, An Exploring, 890
Rectification, Chemical, 398
RENAULT, A.:
Reduction of Phosphate by the Arc, 889
Resistance and the Surrounding Dielectric, 788
Resistance between Steel Spheres, 288
RICHARZ and KRIGAR-MENZEL:
The Constant of Gravitation, 147
RIECKE, E.:
Electrothermal Relations, 398
Reaction Pressure of Cathode Rays, 437
RIGHI, A.:
Vacuum Tubes *v.* Coherers, 10
RIJCKEVORSEL, VAN:
Magnetic and Meteorological Analogies, 564
Röntgen Ray Ions, Charge of, 355
Röntgen Rays, 46
Röntgen Rays, Currents Generated by, 10
Röntgen Rays, Corpuscular Theory of, 10
Röntgen Rays and Cathode Rays, 45
Röntgen Rays and Spark Discharges, 527
Röntgen Rays, Visibility of, 503
Röntgen Rays, Secondary, 716
ROSA and SMITH:
Condenser Losses, 600, 715
RUTHERFORD, E.:
Uranium Radiation, 399
SAGNAC, G.:
Secondary X rays, 716
SANFORD and RAY:
Conservation of Matter, 324
SCHMIDT, A.:
Secular Variation of Magnetic Elements, 216
SCHMIDT, J. C.:
Photo-Electricity, 822
SCHUSTER, A.:
Earth's Magnetic Potential, 216
Earth Currents, 217
SCHUSTER and HEMSALECH:
Constitution of the Electric Spark, 646
Search-Light Intensities, 437
Selenium Coherers, 182
SELLA, A.:
Radiophony, 599
Slow Oscillations, 854
SMITHELLS, DAWSON and WILSON:
Conductivity and Luminosity of Flames, 824
Solution of Noble Metals, 182
SOMMERFELD, A.:
Propagation of Waves along Wires, 787
Sound, Loud Transmission of, 288
Source of Atmospheric Electricity, 715
Standard High Resistances, 114
STARK, J.:
Intermediate Conductors, 78
STARKE, H.:
Röntgen Rays and Spark Discharges, 527
Strains due to Magnetisation, 216
Stratified Brush Discharge, 216
String Interrupter, 503
STUPART, R. F.:
Toronto Magnetic Observatory Thermo-couples, 147
SUTHERLAND, W.:
Cathode, Lenard, and Röntgen Rays, 787
Terrestrial Magnetism, Distribution of, 889
THIESSEN, A. H.:
Hysteresis at Low Temperatures, 787
THOMSON, J. J.:
Charge of Röntgen Ray Ions, 355
TOEPLER, M.:
Stratified Brush Discharge, 216
Gliding Sparks, 564
TOLLENAAR, D. F.:
Mutual Influence of Cathode Surfaces, 45
TOMMASINA, T.:
Carbon Coherers, 822
Electric Cohesion, 398
Toronto Magnetic Observatory, 437
Transformer Diagram, New, 787
TURPAIN, A.:
Hertzian Wire Telegraphy, 527
Uranium Radiation, 399, 854
Vacuum Discharges, Magnetic Deflection of, 147
Vacuum Tubes, 715 (and Coherers), 10 (Potential Gradient in), 78, (Consumption of Energy in) 854
VINCENT, J. H.:
Dispersion Model, 266
VOIGT, W.:
Pyroelectricity, 503
WAITZ, K.:
Polarised Electromagnetic Waves, 78
WALTER, B.:
Corpuscular Theory of Röntgen Rays, 10
WARBURG, E.:
Genesis of the Point Discharge, 266
Wave Indicator, New, 645
Waves, Electric, Absorption of, 889
Wave Theories, continuity of, 77
WEHNELT, A.:
Canal Rays, 788
Electrolytic Interrupter, 715
WEISS, P.:
Diffraction Galvanometers, 839
Wehnelt Interrupter, 715, 822, 854
WESENDONCK, K.:
Point Discharges with Oscillating Currents, 101
WEYHER, C.:
Mechanical Reproduction of Mag. Phenomena, 216
WIEDEMANN, E.:
Luminescence Lamps, 103
WIEDEMANN and SCHMIDT:
Potential Gradients in Vacuum Tubes, 78
WIEN, M.:
Alternate Current Magnetisation, 564
WILSON, C. T. R.:
Condensation Nuclei, 393
WINKELMANN, A.:
Currents Generated by Röntgen Rays, 10
Wire Waves, 854
Wireless Telegraphy across Paris, 182
WOOD, R. W.:
Colour Photography, 889
WRIGHT and KREIDER:
Crystallisation in a Magnetic Field, 147
X Rays, (*see* Röntgen Rays)
Zeeman effect on a Large Scale, 559
(*See also* Magneto-Optic Effect

Letters to the Editor.

Accumulator Switches ..... BAILY, FRANCIS G., 510
Black's Reversal Method ..... MURPHY, WALTER J., 517
Brighton Breakdown ..... DALLAS, J. D., 84; FLEMING, J. A., 237; "INTERESTED," 341; PHILIP, ARNOLD, 52, 237; QUIN, R. C., 201, 272; TAPPER, W. C. P., 52
Canal Haulage ..... ALLEN, A. H. 128; GALLICT, F., 53; HUGHES, T. VAUGHAN, 237
Candle Power Efficiency of Incandescent Bodies..... ROBERTSON, C. J., 733
Electrical Motor Carriages ..... OPPERMANN, C. 903,
Finance of Electricity ..... ALLEN, HORACE, 202
Foreign-made Apparatus ..... CHAMBERLAIN and HOOKHAM, 53
Government Telephones ..... PROVAND, A. D., 732, 839, 871
Induction Telegraphy..... WHITEHEAD, C. S., 445
Lodge's Soundboard Telephone ..... LODGE, O. J., 385
Marconi Telegraph, Theory of the..... "CONDUCTION," 76; ERSKINE-MURRAY, J., 766; SULLIVAN, H. W., 993
Nernst Electric Lamps ..... JOHNSTON, T. J., 840; THOMSON, ELIHU, 766
Neugschwender's Wave Detector ..... LODGE, OLIVER J., 73
Railway Telephony ..... SPAGNOLETTI, C. E., 695
Rotatory Converters ..... W. B. SAYERS, 842
Shoreditch Dust Destructor ..... BAKER, T. W., 53; KERSHAW, H. E., 17; ROBINSON, H. MANSFIELD, 1
Thompson-Walker Surface Contact System ..... AYRTON, W. E., 653; HOLLAND, C. E., 653; TAYLOR, A. M., 653; WALKER, MILES, 653
Wehnelt Interrupter ..... BEATTIE, ROBERT, 732; BROOKS, E. E., 841; FLEMING, J. A., 732; HILL, ALEX., 766; MARCHANT, E. W., 841; PRESTON, S. TOLVER, 766, 841; THOMPSON, SILVANUS P., 731; THOMSON, ELIHU, 90
Wilson's Electric Traction ..... SALTER, J. E., 238; "THE REVIEWER," 23
Wireless Telegraphy ..... BROWN, A. C., 479

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Scientific Societies—Papers, &c., read before.

American Association for the Advancement of Science.
A Combination Absorption and Transmission Dynamometer for Laboratory Purposes, 4 ..... FLATHER, J. J.

American Institute of Electrical Engineers.
Transformer Design, 508 ..... CARTER, F. W

Associazione Elettrotecnica Italiana.
The Water-Power Installation at Paderno, 255, 361, 413 SEMENZA, G.

Chicago Electrical Association.
The Use of Electricity in the Spanish-American War, 341 GRIER, THOS. G.

Elektrotechnischer Verein
The Spark Limit in Continuous-Current Machines, 837 KAPP, GISBERT.

Institution of Civil Engineers.
Presidential Address, 49, 83 ..... PREECE, W. H

Institution of Electrical Engineers.
Dr. Wehnelt's Electrolytic Current Interrupter, 728 .. SWINTON, A. A. C.
Electric Inter-Communication in Railway Trains, 540, 617, (*Discussion*) 620 ..... LANGDON, W. E.
Electric Traction by Surface Contacts, 569, 614, (*Discussion*) 615 ..... WALKER, MILES
Experiments on Alternate-Current Arcs by Aid of Oscillographs, 857, 873 ..... DUDDELL, W., and MARCHANT, E. W.
Improvements in Magnetic Space Telegraphy, 269, 305, 366, 402, (*Discussion*) 442, (*Correspondence*) 385, 415 LODGE, Dr. OLIVER.
Œtheric Telegraphy, 405, (*Discussion*) 442 ..... PREECE, W. H.
Rotatory Converters, 126, 162, 190, (*Discussion*) 280.. THOMPSON, Prof. SILVANUS P.
Rules for the Regulation of the Wiring of Premises for Connection to Public Supply Mains, 531, (*Discussion*) 576 ..... PIGG, J.
Telegraphy by Magnetic Induction, 330, (*Discussion*) 442, (*Correspondence*) 479 ..... EVERSHED, S.
The Hissing of the Electric Arc, 791, 832, (*Discussion*) 869, 90 ..... AYRTON, Mrs.
The Induction Motor, 729, 891, 824, 861 ..... WILSON, Prof. E.
The Institution Wiring Rules, 501, (*Discussion*) 576 .. CROMPTON, R. E.
The Regulations of Wiring Rules, 503, (*Discussion*) 576 WORDINGHAM, C. H.
Wireless Telegraphy, 690, (*Discussion*) 726, (*Reply*) 758 MARCONI, G.

Northern Society of Electrical Engineers.
Presidential Address, 165 ..... RAWORTH, J. S.
Superheated Steam and its Application to Steam Engines, 258 ..... SCHOU, PAUL

Physical Society.
A Magneto-Optic Phenomenon, 51..... THOMPSON, Prof. S. P.
A New Form of Amperemeter and Voltmeter with a Long Scale, 643 ..... LODGE, Dr. O. J.
An Apparatus for the Determination of the Rate of Diffusion in Solids Dissolved in Liquids, 721 ..... GRIFFITHS, A.
An Influence Machine, 51 ..... PIDGEON, W. R.
Presidential Address, 643 ..... LODGE, Dr. O. J.
The Criterion for the Oscillatory Discharge of a Condenser, 836 ..... BARTON, Dr. E. H.
The Equivalent Resistance and Inductance of a Wire to an Oscillatory Discharge, 509 ..... BARTON, Dr. E. H.
The Joule-Thomson Effect, and its Connection with the Characteristic Equation, and some of its Thermo-Dynamical Consequences, 643 ..... LOVE, S. F. J.
The Magnetic Fluxes in Meters and Other Electrical Instruments, 52, 167 ..... CAMPBELL, ALBERT
The Minor Variations of the Clark Cell, 886..... TROTTER, A. P.
The Propagation of Damped Electrical Oscillations along Parallel Wires, 167 ..... MORTON, Prof. W. B
The Source of Energy in Diffusive Convection, 741.... GRIFFITHS, A.
The Volume Changes which accompany Solution, 509 LITTLEWOOD, T. H.
The Wehnelt Current Interrupter, 720 ..... SWINTON, A. A. C.

Royal Society.
Effects of Prolonged Heating on the Magnetic Properties of Iron, 539 ..... ROGET, S. R.
Electro-Capillary Phenomena, 650..... SMITH, S. W. J.
Experiments bearing on the Theory of Voltaic Actions, 651 ..... BROWN, J.
On the Influence of the Thickness of Air-Space on the Total Reflection of Electric Radiation, 154 ..... BOSE, J. CHUNDER
The Action of Magnetised Electrodes upon Electrical Discharge Phenomena in Rarefied Gases, 507 ..... PHILLIPS, C. E. S.
The Reflection of Cathode Rays, 650..... SWINTON, A. A. C.

Société Internationale des Électriciens.
The Ostend Accumulator Tramways, 839 ..... SARCIA, JULES

Society of Arts.
Electric Traction and its Application to Suburban and Metropolitan Railways, 764, 794 ..... DAWSON, PHILIP
Long Distance Transmission of Electric Power, 233 .. FORBES, Prof. G.
Nernst's Electric Light, 545, (*Discussion*) 604 ..... SWINBURNE, JAMES

Verein Deutscher Elektrotechniker.
A Direct Reading System for Measuring Current Leakage, 303, (*Erratum*) 222 ..... KALLMANN, Dr. M.

Municipal and Local Electric Lighting, &c.

Aberdeen, 171, 449, 514, 623, 658, 702
Aberyswith, 172
Accrington, 314, 550
Acton, 449, 736, 809
Airdrie and Coatbridge Electric Tramways, 206
Albury (Guildford), 551
Aldershot, 389, 551
Ambleside, 910
Arbroath, 58, 737
Argentina, 877
Aston, 58, 595
Asuncion (Paraguay), 449
Aylesbury, 206
Ayr, 172, 277, 774

Bangor, 136, 551, 702, 809, 910
Bangor-Donaghadee Electric Tramway, 737, 774
Barmouth, 346, 910
Barnes, 623
Barnsley, 58, 314, 483, 586, 737
Barrow-in-Furness, 88, 551, 809
Basingstoke, 136, 277
Bath, 58, 514, 586, 809, 878
Batley, 737
Battersea (London), 88, 172, 551, 623, 702
Beccles, 910
Beckenham, 277
Bedworth, 278
Belfast, 58, 244, 315, 623, 910
Bermondsey (London), 315, 623, 910
Bettws-y-Coed, 702
Bexhill, 514
Birkdale, 702
Birkenhead, 21, 278, 514, 515
Birmingham, 172, 346, 586, 623, 703
Blackburn, 244, 315, 586, 703, 737, 774, 844, 878
Blackpool, 278, 315, 551, 586, 623, 844
Blairgowrie, 278
Bognor, 21
Bolton, 21, 315
Bootle, 878
Bournemouth, 878
Bradford, 21, 421, 483, 586, 737, 878, 910
Brecon, 449
Brentford, 58, 315
Brentwood, 58
Bridge of Allan (N.B.), 774
Brierley Hill, 88, 389
Brigg, 88
Brighton, 21, 88, 172, 206, 315, 421, 514, 551, 623, 658, 737
Bristol, 21, 137, 449, 586, 658, 737
Broadstairs, 623
Bromley, 244
Burnley, 172, 658
Burslem, 551
Burton-on-Trent, 421, 551, 658, 703, 878
Bury (Lancs.), 809
Bury St. Edmunds, 21, 88, 315, 389
Buxton, 244, 658

Camberwell (London), 172, 514
Camborne, 315
Canterbury, 137, 278, 586, 844
Cardiff, 737, 910
Carlisle, 80, 244, 278, 315
Chatham, 315
Chatsworth, 449
Chelmsford, 514, 737
Chelsea (London), 21, 58, 137 244, 278, 623
Cheltenham, 21, 88, 910
Cheriton, 703
Chester, 244, 315, 551, 586, 774
Chesterfield, 421, 586, 878
Chichester, 58, 586
China, Tramway Enterprise in, 625
Chiswick, 278
Chorley (Lancs.), 88
Coatbridge, 21, 737
Colchester, 137, 703, 878
Colwyn Bay, 173, 389, 586, 774
Cork, 172, 315, 623
Coventry, 737
Crewe, 137, 389, 844
Croydon, 172, 206, 346, 483
Darfield, 737
Darlington, 551, 815
Darwen, 172, 206, 586, 703
Datchet, 449
Dawlish, 449
Derby, 21, 88, 278, 389, 551, 845
Devonport, 278, 315, 450, 551
Dewsbury, 21, 244, 346, 389, 586
Diss, 59, 88
Doncaster, 278, 623
Dorking, 389, 483
Douglas (Isle of Man), 878
Dover, 421, 810
Dublin, 59, 172, 315, 389, 551, 658, 774, 910
Dudley, 22, 24, 389
Dudley, Sedgley Tramways, 137
Dudley-Wolverhampton Tramways, 59
Dumfries, 22
Dunblane, 900
Dundalk, 551
Dundee, 88, 206, 389, 586, 658, 737
Durham, 88, 878

Ealing, 22, 315, 551
Earl's Colne (Essex), 206
Eastbourne, 278, 551, 624, 845, 878
East Barnet, 22
Eccles, 703
Edinburgh, 172, 244, 315, 450, 515, 703, 774, 845
Edmonton, 421
Enfield, 88
Epsom, 315, 316
Erith, 59
Exeter, 244, 737

Falkirk, 278
Farnborough, 659, 774
Farnham, 22
Farnworth (Lancs.), 878
Faversham, 22
Finchley, 137
Fleetwood, 22
Formby (Lancs.), 88
Fulham (London), 88, 878

Gainsborough, 173
Galashiels, 586
Garston, 389, 421, 586, 878
Gateshead-on-Tyne, 22, 389
Glasgow, 88, 137, 173, 207, 315, 346, 389, 421, 450, 484, 551, 586, 659, 703, 737, 774, 845, 911
Glossop, 59, 88
Gloucester, 315, 450
Gosport, 586
Govan, 346
Grantown (N.B.), 659
Gravesend-Northfleet Electric Tramways, 22
Grays, 59, 315, 484, 774
Great Grimsby, 88, 173, 450, 845
Great Yarmouth, 59, 137, 421
Greenock, 173, 207, 278, 315, 551, 774, 878, 911

Hackney (London), 659
Halifax, 88, 450
Hammersmith (London), 208, 244, 421, 484, 704
Hampstead (London), 22, 89, 315, 551, 624
Hampton, 390, 421, 737
Hanley, 278, 450, 845
Hants, 178
Hanwell, 515, 659
Harrogate, 704, 878
Hartford (Cheshire), 421
Harwich, 737
Hastings, 89, 244, 450, 515, 624, 659
Haulbowline (Cork), 450
Hawick, 74
Heckmondwike (Yorks.), 89, 138, 173, 244
Hendon, 624
Hereford, 22, 390, 815, 878
Herne Bay, 278
Hill of Howth Tramways, 22
Hornsey (Middlesex), 22, 704, 911
Hove, 586
Hoylake and West Kirby, 515
Huddersfield, 22, 346, 450, 586, 659, 737
Hull, 22, 59, 89, 138, 515, 659, 845, 911
Hurstpierpoint (Sussex), 450
Hyde, 278
Hythe, 89

Ilford, 911
Ilfracombe, 59, 390, 586
Ilkeston, 138, 278
Ingleton, 586, 659, 911
Ipswich, 586
Islington (London), 22, 89, 138, 173, 244, 551, 774, 811, 911

Keighley, 810
Kendal, 738
Kensington (London), 22, 586
Killarney (Ireland), 89
Kilmainham (Dublin), 879
Kingston-on-Thames, 346, 659, 704, 844
Kingstown, 89
Kingstown (Dublin), 845
Kingswood (Bristol), 138, 704
Kirkcaldy, 59

Lambeth (London), 59, 278
Lancashire (*Electric Power Schemes for*), 173
Lancaster, 484, 624, 659
Leamington, 421, 624, 774
Leatherhead, 208, 624, 775
Lee (London), 450, 515, 695
Leeds, 89, 138, 244, 279, 390, 515, 552, 624, 738
Leigh (Lancs.), 138, 845
Leith, 138, 390, 552, 775
Lewes, 22
Lewisham (London), 174
Leyton, 89, 279, 587, 911
Limehouse (London), 315
Limerick, 174, 208
Lincoln, 59, 245, 315, 552, 587
Littleborough, 659
Liverpool, 89, 174, 208, 245, 552, 660, 775, 879
Liversedge, 245
Llandudno, 60, 316
Llanelly, 90, 245
Llanrwst, 316, 704
London, City of, 88, 172, 244
London County Council, 89, 174, 208, 245, 279, 316, 484, 552
London (*Underground Electric Railways in*), 246, 346
Lowestoft, 316, 879
Lucan-Leixlip (Dublin) Electric Tramway, 810
Lye (Stourbridge), 23

Maidstone, 90, 587, 911
Malvern, 245
Manchester, 23, 90, 138, 208, 245, 390, 484, 515, 738, 775, 879, 911
Manchester Improvements, 208
Mansfield, 279
Margam (Glam.), 587
Marylebone (London), 23, 90, 174, 280, 316, 421, 450, 515, 775
Melbourne, 515
Merthyr, 138, 421
Middlesbrough, 738
Middleton, 421
Mile End (London), 912
Montrose, 775
Morecambe, 174, 316, 587, 660
Moss Side, 316
Motherwell, 93, 845
Musselburgh, 138, 174, 845

Nelson, 90
Newcastle (N.S.W.), 346
Newcastle-on-Tyne, 279, 450, 484, 552, 625, 660, 704, 775, 879, 912
Newhaven, 625
Newington (London), 60, 138, 845
New Malden (Surrey), 775
Newmarket, 60, 775
Newport (I. of W.), 279
Newport (Mon.), 811
New Swindon, 704
Newton Abbot, 316
Neyland (Glam.), 587
Northallerton (Yorks), 90, 174, [279

Digitized by Google

Municipal and Local Electric Lighting, &c.—*(continued).*

Norton (Stockton), 625
Norway, 138
Nottingham, 422
Nuneaton, 422

Ogmore and Garw, 279, 450
Oldham, 24, 245, 275, 460, 845
Orrel (Liverpool), 60
Osweatry, 390, 552, 704, 912
Oystermouth, 422

Paddington (London), 138, 316, 450, 775, 912
Paignton (Devon), 553, 912
Paisley, 90, 133, 422, 587
Partick (Glasgow), 625, 705, 733
Pembroke (Dublin) 24
Penarth, 553
Penzance, 245
Perth, 208, 553, 625, 811, 880
Peterborough, 484
Plumstead (London), 537
Plymouth, 422, 553, 738
Pokesdown (Bournemouth), 451
Poplar (London), 138, 316, 421, 451, 515
Port Adelaide, 660
Portobello, 60
Portsmouth, 174, 316, 588

Queenstown (Cork), 24, 422

Radcliffe, 451, 738
Ramsbottom, 880, 912
Ramsey, 138
Ramsgate, 245, 811
Rathmines (Dublin), 60, 90
Rawmarsh, 174
Reading, 139, 705
Redditch, 208, 279, 390, 553, 625
Reigate, 422, 588
Retford, 60
Rhyl, 279, 660
Richmond (Yorks.), 279, 912
Ripley, 912
Rochdale, 139, 553
Rotherham, 245, 515
Rothesay, 553
Runcorn, 24

St. Anne's-on-Sea, 24, 139
St. Giles (London), 485
St. Helens, 90, 280
St. Luke (London), 316, 451
St. Olave's (London), 346
St. Pancras (London), 90, 139, 209, 317, 346, 451, 515, 588, 811, 845, 912
St. Saviour's, Southwark (London), 845
Sale, 90
Salford, 139, 246, 422, 451, 485, 705
Saltburn, 451, 660
San Paulo, 775
Seaham Harbour, 660
Sedgley, 705
Sevenoaks, 660
Sheffield, 60, 280, 390, 422
Sheringham (Norfolk), 246
Shirebrook (Notts.), 280
Shoreditch (London), 60, 159, 317, 451, 625, 811, 845, 912
Shrewsbury, 280, 880
Sleaford, 60, 90, 174, 280
Southampton, 60, 346, 452, 776, 811
South London (*Electric Lighting in*), 551
Southport, 90, 280, 490, 452, 485, 588, 625, 880
Southport - Lytham Electric Tramway, 174, 390
South Shields, 280 660, 845
South Staffordshire (*Electric Pumping in*), 244
Southtown (Gt. Yarmouth), 117
Southwold, 625
Spain, Tramways in, 880
Stanford-le-Hope, 246
Stirling, 588, 705
Stockport, 174
Stockton-on-Tees, 588, 660
Stoke Newington (London), 209
Stoke 705
Stoke-on-Trent, 660
Stourbridge, 24
Stretford, 139, 174, 880
Stratton, 811
Sunderland, 139, 317, 845
Surbiton, 317, 625
Swansea, 280, 488, 738
Sydney (N.S.W.), 60

Tamworth, 175
Tanfield (Yorks.), 90
Taunton, 588
Teddington, 390 625, 912
Tobermory (N.B.), 139
Torquay, 246
Towyn, 317
Tunbridge Wells, 139. 390. 705
Twickenham, 60, 209, 590, 588

Vaynor (Glam.), 139
Ventnor (I. of W.), 553, 776

Wakefield, 738
Wallasey, 24
Walsall, 280, 553, 588, 880
Warrington, 390, 912
Warwick, 280
Waterloo (Liverpool), 90
Watford, 91
Wath, 91
Wakefield, 246
Walthamstow, 209
Wednesbury, 175, 705
Wellingborough, 452
West Bromwich, 558
West Ham, 347, 705
West Hartlepool, 91
West London (*Electric Traction in*), 244
Weston-super-Mare, 24, 347, 811
Whitby, 422, 553
Whitchurch, 175
Whitechapel (London), 91, 139, 209, 246, 317, 452, 846
Whitehaven, 209
Whitfield (Glossop), 390
Wigan, 175, 317, 516, 846
Willesden, 24, 175, 846
Wimbledon, 422, 776
Windsor, 209, 660, 811
Windsor Castle, 139, 485
Winsford, 61, 209
Woking, 175, 588, 811, 912
Wolverhampton, 61, 245, 317, 458
Worcester, 705, 739, 880
Wormit, 739
Worthing, 246, 553
Wrexham, 280, 317, 347, 553

Yeadon, 422
York, 390, 705

Trade Notes and Notices.

Agency, 622
American Export Trade, 585
Appointments (*see* **General Index**)
Appointments Vacant, 20, 57, 86, 135, 171, 205, 242, 276, 314, 344, 387, 419, 448, 481, 513, 549, 584, 622, 657, 70 735, 771. 808, 844, 877. 909
Asylum Lighting, 88, 314, 345, 551, 586, 623, 658
Automotor Pocket Book, 420
Babcock-Wilcox Boilers, 449
Bankruptcies, 20, 57, 87, 135, 206, 242, 277, 314, 344, 345, 387, 419, 448, 482, 513, 550, 585, 622, 657, 701, 735, 772, 808, 844, 877, 909
Book Catalogue, 623
Books, (*Forthcoming*) 22, (*Sale of Electrical*) 535
British Chamber of Commerce (Paris), 21
Business Notices, 20, 57, 87, 135, 171, 206, 276, 344, 357, 419, 448, 513, 585, 622, 657, 701, 735, 772, 844, 877, 909
Calendars, &c., 213, 272, 314, 345, 328, 420, 449
Cassier's Magazine, 58, 243, 388, 514, 702, 844
Catalogues, &c., (*Babcock and Wilcox*) 206, (*A. J. Beaumont & Co.*) 58, 585, (*British Thomson Houston Co.*) 420, (*Chloride Electrical Storage Synd.*) 277, 482, 658, (*Connolly Bros.*) 21, (*Crompton & Co*) 277, 585, (*John Davis & Son*) 482, (*W. P. Dennis & Co.*) 172, 419, (*Drake and Gorham*) 87, (*Edison and Swan Co.*) 388, 449, 513, (*Electrical Co.*) 550, (*E.P.S. Co.*) 419, (*Estler Bros.*) 482, (*General Electric Co.*) 345, (*Green and Boulding*) 136, (*John J. Griffin & Sons*) 206, 844, (*Jas. Guthrie & Co.*) 136, (*Hart Accumulator Co.*) 513, (*Holden and Brooke*) 701, (*J. C Lyell & Co.*) 206, (*Marshall & Co.*) 345, (*Newsome, Pinching & Co.*) 58, (*New Phonopore Telephone Co.*) 701, (*Newton Electrical Works*) 585, (*G. A. Nussbaum*) 345, (*C. Olivetti*) 21, (*Peto and Radford*) 550, (*Polland & Co.*) 206, (*Prism Globe Syndicate*) 419, (*H. Pynegar*) 58, (*S. Schreiber*) 387, (*John Shaw & Co.*) 773, (*Shippey Bros.*) 243, (*Snowdon, Sons & Co.*) 814, (*Southgate Engineering Co.*) 21, (*John Spencer*) 585, (*Sunbeam Lamp Co.*) 136, 701, (*A. Vandam & Co.*) 206, (*Ward and Goldstone*) 172, (*W. H. Willcox & Co.*) 550, (*Williamson and Joseph*) 585
Caution, A, 387
Christmas Postal Arrangements, 278
Church Lighting, 58, 774
Colliery Lighting, 88
Company, New, 279
Crossley Gas Engines, 419
Discounts on Price of Current, Increased, 484
Dissolutions of Partnership, 20, 57, 135, 276, 314, 419 481, 513, 550, 657, 701, 735, 909
Dock Lighting, 910
Dockyard Lighting, 22
Electric Heating Apparatus, 449
Electric Plant Contracts, 772
Electric Power Plant, 137
Electrical Standardizing, Testing and Training Institution, 877
Electrical Trades' Directory and Handbook, 844
E.P.S. Battery Calculator, 809
"Engineering Magazine," The, 87, 242, 388, 585, 702 877
"Engineering Times," 243
"Engineers' Diary," 136
Exhibition Lighting, 173
Gold Mining, Electricity in 703
Hospital Lighting, 22, 421, 515
Infirmary Lighting, 245, 278, 879, 911
Jandus Arc Lamp Patents, 242
Journal of the Institution of Electrical Engineers, The, 773, 909
King's College (London), 844
Langdon-Davies Motors, 773
Launches, Electric, 207, 877
Liquidation Petition, 58
Liquidations, 20, 57, 58, 87, 135, 171, 206, 242, 276, 277 314, 344, 387, 419, 448, 482, 513, 550, 622, 657, 701, 772, 808, 877, 909
Local Government Annual, 449
Meters, Prepayment, 357
Mill Lighting, 90, 912
"Model Engineer," The, 277
Money Orders, Telegraph, to Germany, 24
Municipal Trading, Cost of, 736
Oil Cans, Improved, 909
Oxford Engineering Laboratory, 552
Paints, Indestructible, 550
Past Year's Work, The, 483, 514
Penny Postage, 316
Plant for Sale, &c., 20, 58, 136, 171, 242, 277, 314, 387, 482, 513, 550, 585, 658, 701, 736, 772, 808, 844, 909
Power, Supply, 279
Practical Methods of Calculation, Lectures on, 585
Railway Diary and Officials' Directory (1899), 277
Railway Guide, 206
Refuse Destructors, 314
Scholarship Examinations, 485
Scrap Platinum, 5 8
Seasonable Presents, 345
Shades, Shade Carriers, &c., 585
Shanghai, 139
Siemens and Halske's Manufactures, 535
Soiree, Sunbeam Lamp Co.'s, 422
Tariff Changes (*W. Australian*) 175, 452, (*Hawaiian Islands*) 624
Telephone Directory, Supplement to, 449
Trade Reports, 705
Universal Engine, The, 449
Village Lighting, 553, 811
Watches, "Strand," 910
Will, 880
Workhouse Lighting, 24, 61, 91, 139, 175, 280, 45 , 484, 553, 625, 660, 705, 738, 846
Works, New, 587

Tenders Invited, Received and Accepted—
(*Tenders Accepted are shown in Italics.*)

Aberdeen, *57, 86, 513,* 656, 700, 734, 735, *735,* 771, 808, *843, 876*
Accrington, *419, 700*
Almodovar del Campo (Spain), 876
Ambleside, 657, 700
Anzin (France), 135
Aurich (Germany), 135
Austrian Post and Telegraph Authorities, 481
Barking, 699, 734. 771, *909*
Barnsley, 170, *170,* 205 241, *513*
Barrow-in-Furness, 19, 57, 86, *276,* 344
Battersea (London), 876, 908
Beckenham, 134 170, 205, 222, 513, *584,* 734
Bedford, 57
Belfast and Northern Counties Railway Co., 512
Belfast Corporation, *19,* 57, 86, *387,* 418, 447, 481 512, 549, 584, 621, 657, *657,* 700, *735,* 807, 843, 875
Belfast Harbour Commissioners, 19, 57, 86
Betanzos (Spain), 622
Bexhill, *19*
Birmingham, 735
Blackpool, 86, 134
Bolton, *20, 205, 386, 447*
Bournemouth, *135*
Bradford, *20, 276,* 447, 807, 843
Braila (Roumania), *344*
Bridgewater Trustees (London). *700*
Brighton, *513, 549,* 584, 621, 657, *876*
Bristol, *513, 586,* 734, 808, 843
British Electric Traction Co., 57, 86, 808
Bucharest, 205
Burnley, *57,* 276, 313. 344, 735
Burton-on-Trent, *276,* 447, 481, *876*
Bury, *205,* 584, 700, 734, *876*
Bury St. Edmunds, *584*
Buxton, 205, 447, 480, 512, *513, 622*
Cairo, *584*
Canterbury, 583, 621, 657, 700, *876*
Cardiff, *549,* 621
Cebreros (Spain), 57
Cheltenham, *276*
Cheshire Lines Committee, 57
Cie Generale de Traction (Brussels), 419
City and South London Railway Co., *481*
Cleaver, H., 447
Cleveland and South Durham Assets Co., 31
Clyde Navigation, 549
Commercial Cable Co., *584*
Coventry, 170, *513,* 771
Cumberland and Westmoreland Asylum, 276, 31 , 444
Darlington, 876, 908
Derby, *513, 657*
Dewsbury, *19.* 700
Doncaster, 700, 734, 771
Doncaster Guardians, *700*
Douglas (Isle-of-Man), *513*
Dublin, 276, 313, 584, 876
Dublin United Tramways Co., 86, 134, 170, 205
Dundee, *20,* 583, 621, 656, 700, *876*
Ealing, 418, 447, *549, 622,* 908
East Indian Railway Co., 19, 57, 86
Ecclesall, 584
Edinburgh, 19, 57, 86, *170,* 276, 313, 314, 386, 477, 481, 512, 549, 583, 584, *584,* 621, 657, *657,* 700, 734, 771, 808, 843 876, 908
Edmonton, 57
Egyptian Lighthouse Administration, 242
Emmanuel Church (S. Croydon), 771
Enniscorthy District Asylum, 481, 512
Epsom, 843, 876, 908
Exeter, *481, 700, 735*
Ferrol (Spain), 908
French Post and Telegraph Administration, 1 5 2, 584, 700, 908
Fulham (London), 481, 512, *657, 771,* 896
General Accident Insurance Corporation, 447
Gillingham, 735
Glasgow, 56, 57, 86, 134, 170, 205, 276, 313, 344, 386 418, 481, 512, *549,* 622, 656, 700, 843, *909*
Gloucester, *20,* 512, 549, 584, 622, 876, *909*
Govan, 386, 418, 447
Great Central Railway Co., 656, 700
Great Northern Railway Co., 134, 170, 205
Great Northern Railway Co (of Ireland), 56, 86, 735 *344,* 622, 656, 700, *771,* 808, 843, 876
Great Yarmouth, *135*
Greenock, 584, 622, 656, 700, *771*
Halifax, 170, 313, 447, 735
Hammersmith (London), 549, 621, 657, 700, *876*
Hampstead (London), 512, 843, 875, 908
Hants County Council, 313
Harrogate, 19
Harwich, 481, 512, 549, 584, 622, 657, 700
Hastings, *622*
Heidelberg (Germany), 205
Hereford, *549*
Hornsey, 19, 57, *171*
Huddersfield, 583, 622
Hull, *20,* 57, *135,* 276, 313, 447 51
Hull School Board, 843, 876, 90
Inverness Lunacy Board, *735*
Ipswich, *86*
Ipswich Guardians *808*
Irish Board of Control, 134, 170, 205, *735*
Irish Board of Public Works, 86
Isle of Wight County Asylum,
Islington (London), *622, 90*
Islington (London) Guardians, 205, 313, 549, 584
Kimberley (S. A. R.), 276
Kingston-on-Thames, 481 512, 5 9
Kirkcaldy, 622
Lancashire and Yorkshire Railway, 771, 808
Leatherhead, 19, 57, 86, 135
Leeds, 241, 276, 313, 386, *651* 808

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Trade Notes and Notices—(*continued*).

Tenders Invited, Received and Accepted (*Continued*)—

Lewes, 584, 622, 657, 700, 734
Leyton, *86*, 481, *657*
Leyton School Board, *735*
Lincoln, *700*, *735*
Liverpool, *170*, *242*, *276*, *513*, *876*
Llanrwst Electricity Supply Co., *514*
London County Council, 344, 386, 418, 447, 481, 512, *622*, *771*, 843
London Electric Wire Co., *549*
London School Board, *344*, *808*
Londonderry, 276, 313, *584*
Lowestoft, 386, 418, 447, 481, 512, *657*
Manchester, 19, 57, 276, 549, 584
Marylebone (London) Guardians, 508
Merbes le Chateau (Belgium), *344*, 447
Metropolitan Asylums Board, 418, 447, *584*
Middlesbro', 19, 56, 86, 135, 170, *549*
Midland Railway Co., 86
Mons, 584
Morecambe, 19, *314* 771
Morley (Yorks.), 908
Moscow, 657
Nelson, 481, 512, 549
Newcastle-on-Tyne Y.M.C.A., 447
North Eastern Railway Co., 170, 205
Norwegian State Railways, 313, 700
Norwegian State Telegraph Administration, 447, 512
Nottingham, 19
Oldham, 549, 584, 622
Oystermouth, 549
Paddington (London) Guardians, 699, 734, 771
Pernambuco (Brazil), 584

Tenders Invited, Received and Accepted (*Continued*)—

Perth (W. Australia), 700
Peterborough, 734, 771, 808, 843, 876
Piedrahita (Spain), 549, 584
Plymouth, *19*, 512, 701, *700*, 735, *876*
Poplar (London) Guardians, 671, 656, 734, 771
Poplar (London), 734, 771, 808, 843, 876, 908
Port Louis (Mauritius), 735
Preston Electric Railway and Tramway Carriage Works, 386
Prussian State Railway Authorities (Erfurt), 584
Rathmines (Dublin). *135*, 447
Redditch, 19, 56, *205*
Reigate, 843, 875, 876, 908
Rheims, 86
Rhyl, 771, 803
Rochdale, 344, 386
Rochdale Guardians. 771, 808, 843
Rothesay, 700, 734, 771, *876*
Roumanian Post and Telegraph Authorities, 19, 344
Sailors' Orphans' Homes (Kilmalcolm), 57
Salford, 19, 56, 85, 134, 170, 205, 241, 771, 808, 875, 908
San Severa (Italy), 481
Santiago (Spain), 700
Shanghai, 86, 134, 170, 205, 241, 276, 313, 344, 386, 419
Sheffield, *57*, *549*
Shoreditch (London), 57, 170, 205 242, *314*, 447, 549, 584, 622, *628*, *843*, *909*
Shoreditch (London) Guardians, 512, 549, *700*
South African Republic, 57, 86
Southampton, 86, *242*, 386, 418, 512, 549, 657, 700, 908, *909*
Southampton County Asylum, 19, 57, *549*

Tenders Invited, Received and Accepted (*Continued*)—

Southend, 657, 700, 734, 771
Southport, 447, *584*
South Shields, *276*, 843, *844*, 876
Spanish General Director of Public Works, 622
Spanish Post and Telegraph Authorities, 19
St. Helens, *86*, 843
St. Pancras, *447*, *513*, 908
Stirling, 241, 270, 313, 344, *387*, 418, 447
Stockport, 512, 622, 657, 734, 843, 876
Stockport Sunday School, 621, 656, 700, 734
Sunderland, 19, 241, 275, 313, 418, 447, 513, 699, 734, 771
Tanfield (Yorks.), 170
Tarifa (Spain), 909
Toronto 19
Tunbridge Wells, *135*, 313, *700*
Tynemouth, 734, 771, 803, 813, 876
Victorian Postmaster-General, *344*
Villarrubia de los Ojos (Spain), 657
Wallasey, 908
Waterloo-with-Seaforth, *135*
Watford, *170*, *481*, *700*
Welch, Margetson & Co., 387
West Ham, 807, 843, 876, 908
West Hartlepool, 481, 512, 549, 657, *657*, 771, *771* 808, 843
Whitechapel (London), 447, *700*
Wimbledon, 19, 57, *170*, *628*, *771*
Wincanton (Bath), 135
Winchester, 135, 657, *876*
Wolverhampton, 512, 771, *771*, 808
Yorkshire Bacon Curing Co., 276

Companies (New Electrical, &c.), Registered.

A.B.C. Electric Arc Lamp and Incandescent Mantle Co., 348
Aberdeen Electrical Co., 348
Adams-Randall Telephone Patents, 914
American Automobile and Motor Co., 816
Angus Electric Light and Power Co., 816
Argentina Electric Traction Co., 816
Auckland Electric Tramways Co., 816
Automatic Magneto-Electro Ignition Co. (France and Belgium), 816
Bedford Motor Car Syndicate, 882
Bersey (W. C.) and Co., 210
Blackburn, Starling and Co., 848
Booth (Joseph) and Sons, 424
British Pioneer Electric Light & Power Co. of India, 670
British Schuckert Electrical Co., 248
British Thermophor Syndicate, 630
Buck and Co., 848
Bute Electrical Manufacturing Co., 92
Canadian, British Columbian and Dawson City Telegraph Co., 182
Chamberlain and Hookham, 318
Clark (E. J.), 318
Clayton Engineering and Electrical Construction Co., 318
Commercial Telegraph Construction Syndicate, 630
Compass Trading Co., 914
Cotsworth Arc Lamp and Electric Lighting Syndicate, 848
Crystal Palace Light Railways and Tramways Co., 176
Davis and Timmins, 779
Doulton and Co., 248
Dowsing Radiant Heat Co., 782
Drummond Art Metal Works, 92
Dutton and Co., 92
Electric Auto-Mobile Syndicate, 248
Electric Canal Haulage Co., 520
Electric Resistance and Heating Company, 392
Electric Tested Lamp Co., 232
Electric Timber Seasoning and Preservation Co., 882
Electromotors, 670
Electro-Smelting Co., 26
Engineering and Electric Works Co., 424
Engineering Undertakings, 318
English De Laval Steam Turbine Co., 282
Ferrolite Electric Syndicate, 882
Freshwater & Totland (I. W.) Electrical Supply Co., 779
Garston and District Electric Supply Co., 591
General Water Power, 26
Giffre Electro-Chemical and Power Co., 498
Glover (William James) and Co. (established 1818), 630
Hamilton, Motherwell and Wishaw Light Railways Co., 92
H. Aron Elektricitäts Zahlerfabrik, 591
Hart Accumulator Co., 318
Heaton and Smith, 914
Himalaya Electric Railway, 176
Hiram S. Maxim Electrical Corporation, 248
Indian Mica Co., 248
Ingleton Electric Lighting and Power Co, 670
Interchangeable Flash Sign Syndicate, 848
International Telephone Manufacturing Co., 779
John Jenkins and Sons, 816
Kalgoorlie Power Syndicate, 454
Kidderminster and District Electric Lighting and Traction Co., 848
Lancashire Dynamo and Motor Co., 914
Land and Water Electric Power Syndicate, 318
Leecoll Electric Battery Co., 424
Lindsay, Browning and Co., 630
Longford Wire Co., 882
Lux Syndicate, 816
Macroom and District Electric Lighting Syndicate, 670
Mather and Platt, 498
Medical Electro-Thermic Generator Co., 591
Mica Boiler Covering Co., 591
M'Laughlin and Harvey, 816
Middleton (P. C.) and Co., 232
National Conduit and Cable Co., 26
Neild's Sleeve Electric Joint Syndicate, 882
Nernst Electric Light, *596*, 630, 670
New Electro-Chemical Manufacturers' Association, 210
New Rottingdean Syndicate, 630
New St. Helens and District Tramways Co., 92
Nile Syndicate, 318
Northallerton Electric Light and Power Co., 65
Nuneaton and District Light Railway Co., 424
Payne and Bates, 62
Pearson Fire Alarm System, 348
Pioneer Electric Light and Power Co for China, 670
Pioneer Electric Light and Power Co. for Japan, 670
Poole and District Electric Traction Co., 882
Recording Telegraphs, 498
Rubber and Vulcanite, 520
Search Light Syndicate (of America), 558
Smith, Thomson and Co., 92
South American Electric Co., 210
Steady Arc Lamp Co., 558
Surprise Arc Lamp Syndicate, 670
Suspended Electric Railway Co., 520
Swansea Motor Omnibus Co., 454
Telephonic Bell Push Syndicate, 26
Telephone Construction Co., 248
Telephone and Switchboard Syndicate, 816
Tourtel Manufacturing Co., 176
Trafford Power and Light Supply Co., 520
Ungarische Accumulatoren Aktien Gesellschaft, 210
Van Hinden (S. M.) Electrical Co., 282
Vaughan and Son, 914
West Kent Electricity Supply Co., 92
Wray (Cecil) and Co., 176
Yale Electric Power Co., 558
Yorkshire District Light Railway Syndicate, 816
Young and Marten, 882

Companies' Meetings, Reports, Dividends, Statutory Returns, &c.

African Direct Telegraph Co.—318
African Transcontinental Telegraph Co.—424
Akkumulatoren Fabrik Aktien-Gesellschaft.—26
Alderley and Wilmslow Electric Supply Co.—63, Stat. 282
Allgemeine Electricitäts Gesellschaft—63, 248
Alliance Electrical Co.—Stat. 348
Amazon Telegraph Co.—349, Rpt. 454, Stat. 518, 780
American Lighting Trust—488
Anglo-American Telegraph Co.—Div. 488, Rpt. 520, Mtg. 554, 558, Stat. 780, 832
Anglo-Argentine Tramways Co.—915
Anglo-Portuguese Telephone Co.—Mtg. 848
Aron Electricity Meter—Mtg. 318, 742
Automatic Telephone Co.—Mtg. 348, 520, 848, Stat. 488
Babcock and Wilcox—816
Baker-street and Waterloo Railway Co.—630
Barcelona Tramways Co.—488, 708
Barrow-in-Furness Tramway Co.—26
Berry's Electrical Co.—Stat. 520
Binko, Ridsdale and Co.—Stat. 520
Birmingham Electric Supply Co.—Rpt. 670, Mtg. 708, Stat. 915
Blackheath and Greenwich District Electric Light Co.—780
Blackpool and Fleetwood Tramroad Co.—425, 488, Mtg. 590
Bordeaux Tramways and Omnibus Co.—92
Bournemouth and District Electric Supply Co.—Rpt. 708
Bournemouth and Poole Electricity Supply Co.—670; Rpt. 708, Mtg. 740
Brazilian Submarine Telegraph Co.—Mtg. 25, Div. 248, 318, Div. 670
Bright's Light and Power—Stat., 520
Brisbane Tramways Co.—282
Bristol Tramways and Carriage Co.—558, Mtg. 791
British Continental Electricity Co.—780
British Columbia Electric Railway Co.—177, 849, Stat. 915
British Columbia Telephones—Stat. 915
British Electric Traction Co.—Mtg. 210, 455, Rpt. 741, Mtg. 741
British and Foreign Oxolin Co.—521
British Insulated Wire Co.—455, Rpt. 708, Mtg. 741
Bromley (Kent) Electric Light and Power Co.—Stat. 558
Brompton and Piccadilly Circus Railway Co.—248
Brush Electrical Engineering Co.—Stat. 211, 558, Rpt. 671
Budapeste Allgemeine Elektricitäts Gesellschaft—742
Buenos Ayres and Belgrano Electric Tramways Co.—Rpt. 742, Mtg. 790
Callender's Cable and Construction Co.—Div., 27
Camborne Electricity Supply Co.—Stat., 177
Cambridge Electric Supply Co.—Rpt. 557, Mtg. 628, Stat. 780
Canadian, British Columbian and Dawson City Telegraph Co.—248, 282, 318
Canadian Niagara Power Co.—817
Cape Electric Tramways—Mtg. 247, 282, 349
Cape Town—708
Carbon Manufacture in Russia—92
Central Electric Supply Co.—Stat. 558
Central London Railway Co.—282, Rpt. 557, Mtg. 592
Chamberlain and Hookham—488
Charing Cross and Strand Electricity Supply Corporation—392, 488, 521, Rpt. 629, Mtg. 669
Chatham, Rochester and District Electric Lighting Co.—Stat. 392
Chelmsford Electric Lighting Co.—Stat. 558
Chelsea Electricity Supply Co.—93, 141, 282, Rpt. 670, Mtg. 706
Chilian Electric Tramway and Light Co.—Stat. 232
City and South London Railway Co.—455, Rpt. 488, Mtg. 518, 708, 742
City of Birmingham Tramways Co.—Mtg. 848
City of London Electric Lighting Co.—Rev. 27, 282, 392, Div. 558, Rpt. 628, Mtg. 662, Stat. 882
Clayton Engineering and Electrical Co.—318
Commercial Cable Co.—248, 671, Div. 708, 780, 817
Compagnie Centrale d'Electricité de Moscou—211
Compagnie de l'Industrie Electrique (Geneva)—63
Company Reform—592
Connolly Bros.—Stat., 392
Consolidated Telephone Construction and Manufacturing Co.—Mtg. 913
Continental Water and Electrical Power Syndicate—Stat. 631

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Companies' Meetings, Reports, Dividends, Statutory Returns, &c.—*(continued).*

County of London and Brush Provincial Electric Light Co.—455, 521, 742, Rpt. 779, Mtg. 814
Coventry Electric Tramways Co.—592
Cox (Harry W.)—Stat. 318
Crompton and Co.—Div. 392
Crystal Electric Lamp and Rose and Bird—177, Stat. 848
Cuba Submarine Telegraph Co.—93, Rpt. 141, Mtg. 175, 883, Rpt. 914
Davis and Timmins—780
Dawson City, Telegraph to, 47
Deutsche Kabelwerke vorm. Hirschmann & Co.—630
Direct Electric Generator (Foreign Rights) Syndicate—Stat. 630
Direct Electric Generator Syndicate—Stat. 630
Direct Spanish Telegraph Co.—Div. 671, Rpt. 741, Mtg. 776
Direct United States Cable Co.—Div. 425, Rpt. 488, Mtg. 517, Stat. 670, Div. 817
Direct West India Cable Co.—282, Stat. 630
Doe Portable Electric Light and Power Syndicate—Stat. 630
Dorman, Long and Co.—177
Douglas Southern Electric Tramways—849, Stat. 680
Doulton and Co.—211, 248, 282, 892
Dover Electricity Supply Co.—Rpt. 708, Mtg. 740
Drake and Gorham Electric Power and Traction (Pioneer) Syndicate—Stat., 92
Dublin and Lucan Steam Tramway Co.—521
Dublin United Tramways Co.—455, Rpt. 557, Mtg. 592
Dudley and Wolverhampton Tramways Co.—591
Eastbourne Electric Light Co.—Rpt. 780, Mtg. 815
Eastern Telegraph Co.—Div. 249, Rpt. 424, Mtg. 453, 486, 558, 742, Stat. 780
Eastern and South African Telegraph Co.—141
Eastern Extension, Australasia and China Telegraph Co.—Mtg. 25, Div. 249, 455, 817, Div. 883, Rpt. 914
Edison and Swan United Electric Light Co.—141; Div. 592
Edison Electric Illuminating Co. (New York)—708
Edmundson's Electricity Corporation—282
Edward's Air Pump Syndicate—Rpt. 882, Mtg. 914
Electric and General Investment Co.—211
Electric Construction Co.—211, 282, 349, 425, 455
Electric Light and Power Co.—Stat. 92
Electric Railway and Tramway Carriage Works—Stat. 92
Electric Tramway and Railway Traffic Receipts—27, 63, 93, 141, 177, 211, 248, 283, 319, 249, 393, 425, 455, 489, 521, 559, 593, 631, 671, 709, 743, 781, 817, 849, 883, 915
Electrical Development and Finance Corporation—Stat. 318
Electrical Joint Stock Enterprise—488
Electrical Power Distribution Co.—Stat. 177
Electricity Supply Company for Spain—211
Electro-Chemical Co.—283
Electroid Gas Light Syndicate—630
Elmore Amalgamation—177
Elmore Copper Companies—93
Elmore's German and Austro-Hungarian Metal Co.—Rpt. 882
Evered and Co.—780, Mtg. 848
Exploration Co.—780
Folkestone Electricity Co.—Mtg. 848
Fort William Electric Lighting Co.—27
Gas, Water and General Investment Trust—Mtg. 815
Gateshead and District Tramways Co.—558, 671
General Electric Co. (of America)—425, 592
German Atlantic Telegraph Co.—742
German Electrical Firms, Proposed Combination of—93, 141
Gesellschaft für Elektrische Unternehmungen—592, 743
Giant's Causeway, Portrush and Bush Valley Railway and Tramways—708
Giffre Electro-Chemical and Power Co.—489
Globe Telegraph and Trust Co.—455, Div. 883
Glover (W. T.) and Co.—558
Glover (Wm. James) and Co. (established 1818)—743, 817
Great Horseless Carriage Co.—249
Great Northern and City Railway Co.—558
Great Northern Railway Co. of Ireland—592
Great Northern Telegraph Co.—283, 521, 592, 817, 914
Guernsey Railway Co.—630
Guildford Electricity Supply Co.—Mtg. 781, 848
Halifax and Burmudas Cable Co.—283, Stat. 392
Hampstead Electric Supply Co.—63, Mtg. 176, 425, 455, Stat. 488, 489, 592, 781
Hastings and St. Leonard's-on-Sea Electric Light Co.—455
Henley's (W. T.) Telegraph Works Co.—558, Rpt. 629, Mtg. 667
Hodges and Todd—Stat. 848
Hornsby (R.) and Sons—141, 177, 249
House-to-House Electric Light Supply Co.—Rpt. 664, Mtg. 706
Hove Electric Lighting Co.—Rpt. 630, Mtg. 707
Howell's Simplex Anti-Inductive Telephone Syndicate—211, Stat. 425
Imperial Tramways Co.—Mtg. 665
India Rubber—558
India Rubber, Gutta Percha and Telegraph Works Co.—Rpt. 591, Mtg. 627
Indo-European Telegraph Co.—Rpt. 882
Ipswich Tramways Co.—249
Isle of Man Tramways and Electric Power Co.—Rpt. 742 Mtg. 815
Jamaica Electric Light and Power Co.—521, 592
Jungfraubahn Gesellschaft—349
Kelvinside Electricity Co.—Mtg. 349
Kensington and Knightsbridge Electric Lighting Co.—Rpt. 591, Mtg. 626, Stat. 780
Killarney Electric Lighting Co.—708
Leatherhead Electric Lighting and Power Co.—849
Linotype Co.—63
Liverpool District Lighting Co.—Rpt. 742, Mtg. 816
Liverpool Overhead Railway Co.—489, Rpt. 520, Mtg. 590
Liverpool Stock Issue—849
London Electric Omnibus Co.—Mtg. 453, Stat. 591
London Electric Supply Corporation—249, Rpt. 628, Mtg. 634, 664
London Electrical Cab Co.—Rpt. 210, 214, Mtg. 247, Stat. 591
London Electric Wire Co.—Stat. 849
London-Platino-Brazilian Telegraph Co.—630
London Tramways Co.—Mtg. 665
Mackey's Electric Lamp Co.—Stat., 177
Mather and Platt—Stat. 318
Metropolitan Electric Supply Co.—Div. 671, Rpt. 707, Mtg. 739, 853
Metropolitan Railway Co.—489
Mexico Electric Tramways—349
Middlesbrough Town and Lands Co.—177
Monte Video Telephone Co.—Rpt. 27, Mtg. 62, Stat. 282
Motor Aktien Gesellschaft für Angewandte Elektricität—743
Municipal Issues—(*Birkenhead*) 849, (*Liverpool*) 849, (*Portsmouth*) 883
National Electric Supply Co.—Mtg. 592, Stat. 780
National Electric Free Wiring Co.—Mtg. 813, 914
National Telephone Co.—249, 283, 489, Rpt. 557, Mtg. 625, Stat. 882
Nernst Electric Light Co.—596, 630
New British Incandescent Electric Lamp Co.—Stat. 670
Newcastle and District Electric Lighting Co.—558, Mtg. 592, Stat. 780
Newcastle-upon-Tyne Electric Supply Co—Mtg. 629. Stat. 882
New Italian Electrical Companies—349, 425
New St. Helens and District Tramways Co.—249
New York Lighting Trust—393
New Zealand Electrical Syndicate—27
Northampton Electric Light and Power Co.—Rpt. 591, Mtg. 671, Stat. 780
Northern Commercial Telegraph Co.—917
North Staffordshire Tramways Co.—27, 742
Northwich Electric Supply Co.—671, Stat. 882
Norwich Electricty Co.—Mtg. 767, Stat. 915
Notting Hill Electric Lighting Co.—Rpt. 628, Mtg. 665, Stat. 883
Oriental Telephone and Electric Co.—27, Div. 883, Rpt. 914
Oxford Electric Co.—Mtg. 742
Pacific and European Telegraph Co.—819, Stat. 780
Paisley Tramways Co.—319, 521
Penny-in-the-Slot Electric Supply Syndicate—631
Perth and District Tramways Co.—319
Perth (W. Australia)—177
Pontypool Electric Light and Power Co.—Mtg. 781
Porous Accumulator Co.—63
Portable Electric Lamp Co.—Stat. 780
Potteries Electric Traction Co.—141, Mtg. 453, Stat. 780
Primitiva Gas Co.—249
Richmond (Surrey) Electric Light and Power Co.—Rpt. 741, Mtg. 816
River Po Electric and Power Syndicate—425
Robey and Co.—781, Mtg. 816
Rockhampton (Queensland) Gas and Coke Co.—743
Roller-Bearings Co.—283
Royal Electric Co. of Montreal—709, 781
Royce (F. H.) and Co.—742
Ryde Electric Light and Power Co.—Stat. 780
Russia, Electrical Enterprise in, 849
Sax (Julius) and Co.—Stat. 848
St. James's and Pall Mall Electric Light Co.—319, 489, Rpt. 520, 522, Mtg. 555, Stat. 780, 883
Salisbury Electric Light and Supply Co.—Mtg. 393, Stat. 591
Sandgate and Hythe Electric Co.—Stat. 177
Scarborough Electric Supply Co.—Rpt. 559, Mtg. 631, Stat. 780
Sheffield Electric Light and Power Co.—283, 319, Mtg. 347, 393
Siam, Electrical Engineering in—521
Siemens and Halske Actien Gesellschaft—349, 393
Smithfield Markets Electric Supply Co.—249, Rpt. 318, Stat. 488, Rpt. 742
Société anonyme l'Accumulateur Sec - 915
South American General Electric Supply Co.—559
South London Electric Supply Corporation—Rpt. 741, Mtg. 778
Southport Tramways Co.—592
South Staffordshire Tramway Co.—559
Steady Arc Lamp Co.—559
Stewart Electrical Syndicate—849
Stock Exchange Notices—(*Blackheath and Greenwich District Electric Light Co.*) 177, 454; (*Brazilian Submarine Telegraph Co.*) 425, 593; (*Brisbane Tramways Co.*) 817; (*British Aluminium Co.*) 283; (*British Electric Traction Co.*) 177, 233, 559, 671, 849; (*British Insulated Wire Co.*) 559, 743, 817, 915; (*Buenos Ayres and Belgrano Tramway Co.*) 63; (*Calcutta Electric Supply Corporation*) 709, 849; (*Callender's Cable and Construction Co.*) 319; (*Chelsea Electricity Supply Co.*) 559, 781, 849; (*City and South London Railway Co.*) 593, 631, 781; (*Commercial Cable Co.*) 211, 249; (*Crompton and Co.*) 631; (*Costa Rica Electric Light and Traction Co.*) 319, 559; (*County of London and Brush Provincial Electric Light Co.*) 631; (*Davey, Paxman and Co.*) 893; (*Davis and Timmins*) 915; (*Doulton and Co.*) 559, 781, 817, 849, 915; (*Eastern Telegraph Co.*) 27, 63, 631, 709; (*Edison and Swan Co.*) 425, 671; (*Folkestone Electricity Co.*) 283; (*Great Northern and City Railway Co.*) 93, 319; (*House to House Electric Light Supply Co.*) 559, 709; (*London Electric Supply Corp.*) 283, 319; (*Metropolitan Electric Supply Co.*) 319; (*National Telephone Co.*) 319, 454; (*New General Traction Co.*) 521, 671, 743, 849; (*Potteries Electric Traction Co.*) 425; (*Telegraph Manufacturing Co.*) 283; (*W. T. Henley's Telegraph Works Co.*) 709, 781; (*Willans and Robinson*) 27
Submarine Cables Trust—849, Rpt. 914
Sulphide Corporation (Ashcroft's Process)—249
Sunbeam Lamp Co.—Stat., 28
Svenska Aktiebolag Siemens and Halske—425
Sweden, Electrical Engineering in—558
Telegraph Construction and Maintenance Co.—559, Rpt. 629, 631, Mtg. 666, Stat. 883
Telegraph Improvement Co.—Stat. 780
Telegraph Manufacturing Co.—Stat. 211, 425, 743, 849
Thames Ironworks and Shipbuilding Co.—848
Tramways Union Co.—709
Union Elektricitäts Gesellschaft—27, 709, 781
Urban Electric Supply Co.—Stat., 591
Venezuela Telephone and Electrical Appliances Co.—63, Mtg. 92, Stat. 282
Waterloo and City Railway Co.—489, Rpt. 520, Mtg. 557
Werner Cadmium Electric Accumulator Syndicate—Stat. 177
West African Telegraph Co.—631
West India and Panama Telegraph Co.—Rev. 63, 177, 249, 319, 425, 455, 559, 631, 709, 781, Div. 141, 211, Rpt. 248, Mtg. 281, 849, 915
Western and Brazilian Telegraph Co.—Rev. 27, 63, 93, 141, 177, 211, 249, 283, 319, Div. 63, Rpt. 92, Mtg. 139, 455, 489
Western Union Telegraph Co.—Rpt. 211, Div. 283, Rpt. 393, 709, Rpt. 848
Westminster Electric Supply Corporation—Rpt. 519, Mtg, 589, Stat. 780
Willans and Robinson—141, 743, Rpt. 746, 770, 779, Mtg. 811
Windsor Electrical Installation Co.—Rpt. 629
Wireless Telegraph and Signal Co.—27, Stat. 282
Wolverhampton Tramways Co.—593
Woodlands Electric Co.—Mtg. 914
Yorkshire House-to-House Electricity Co.—Mtg. 176, Rpt. 454, 487, 593

Supplements to Volume XLII.

January 6, 1899	Supplement Sheet Table of Electricity Supply Works of the United Kingdom—1898-99.
January 20, 1899	Supplement Coloured Sketch Map of London and Provincial Electric Supply Stations.
January 27, 1899	Supplement Sheet Table of Electric Railways and Tramways—1898-99.

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THE ELECTRICIAN:

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CONTENTS OF THE CURRENT NUMBER.

NOTES	1	A Combination Absorption and Transmission Dynamometer for Laboratory Purposes. By J. J. Flather	14
Meetings of Scientific Societies.	3	New Dynamos of Messrs. P. R. Jackson and Co. Illustrated	14
The Thompson-Walker System of Electric Traction. Illus.	4	Electric Motors	16
Progress of Glasgow Corporation Electricity Works	5	Correspondence	17
Telegraphs and Telephones in Persia	5	Legal Intelligence	17
Electricity Works Accounts	6	Police Intelligence	18
POLYPHASE TRACTION	8	Trade Notes and Notices	18
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe	10	Companies' Meetings & Reports	24
Llandudno Municipal Electric Supply Works. Illustrated	11	New Companies, &c.	26
		City Notes	27
		Companies' Share List	28

NOTES.

COMMENCING a new volume of *The Electrician* this week, it may not be inappropriate to call attention to the main developments of electrical engineering which seem likely to take place in the immediate future. Some of these are foreshadowed in articles that are to be found in the present issue. The Thompson-Walker system of traction, for example, developing a device not altogether new, is one indication of a very widespread effort which is being made by engineers to provide an efficient and satisfactory substitute for the overhead trolley. Notwithstanding this, however, an enormous amount of trolley construction is being pushed forward in the provinces. In the Llandudno municipal electric supply works, described on a later page, we have an illustration of the belated adoption of electric lighting by many of the smaller local authorities in the United Kingdom—this arousing from prolonged apathy being, in not a few instances, stimulated by the prospect of an early advent of electric traction within their borders. On Wednesday next the electric light works at Folkestone will be inaugurated. Simultaneously with the commencement of the new volume comes the announcement of the opening of important extensions to the municipal electric supply works at Hull; while only last week we recorded still more extensive additions to the works at Belfast. Glasgow also is the scene of a vigorous extension of electric generating and distribution plant, as will be gathered from an article we publish this week. Indeed, in all directions the electric supply business is growing so rapidly that not a small part of the work of the near future must consist in extending works that have already been in operation for some time past.

A BLUE-BOOK of 580 pages has now been issued, containing the complete minutes of evidence taken before the Select Committee on Telephones, together with the Chairman's draft report and the final report. Having given an account of each day's proceedings during the course of the inquiry, and reprinted the report in full, commenting both on it and on the evidence, it is needless to give a further *resumé* here. One incident, which occurred during the discussion on the Chairman's draft report is, however, of interest to note. It was proposed by Mr. GRIFFITH-BOSCAWEN to recommend that local authorities should, on starting telephone exchanges, be given a guarantee that either their plant should be purchased at a fair valuation in 1911, or their licences extended beyond that date; the draft report, and subsequently the final report, recommended that these licences should expire in 1911, at the same time as the licence of the National Telephone Co. The Committee was evenly divided on this point, and the amendment defeated only by the casting vote of the Chairman. This is significant, as showing the disposition—or we might even say pre-disposition—of a large section of the Committee to favour municipal telephony even at the cost of inconvenience to the public. With the exception of two experts, whose position as independent consultants must naturally, if unconsciously, bias them towards independent telephony, none of the witnesses with practical experience in the establishment and management of telephone exchanges advocated the erection of municipal systems.

THE autumn session of the Institution of Mechanical Engineers was inaugurated at Westminster on Wednesday last, when Mr. W. E. LANGDON read his Paper on "Electric Installations for Lighting and Power on the Midland Railway, with notes on Power absorbed by Shafting and Belting." The communication elicited a most useful discussion, principally on the subject indicated by the latter part of the title. Electric driving of machine tools and mills was advocated by numerous speakers, the efficiency of ordinary shaft-and-belt transmission being stated to be as low as 28 per cent. at the Midland Railway workshops, and in many other places being no higher than 20 per cent. Considerable differences of opinion were expressed as to the relative advantages of separate-driving and group-driving. Mr. LANGDON advocates separate-driving wherever more than one horse-power is needed; but Mr. HARRIS and other speakers observed that questions of capital cost often rendered it inadvisable to use a

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separate motor for each machine, even when these were of considerable size. Mr. JEREMIAH HEAD brought out an important aspect of the subject, when he said that the question was often not merely one of substituting electric for mechanical transmission between a main engine and a number of machines, but involved the much wider question as to the substitution of one system driven by a single efficient engine, in place of a number of isolated plants each driven by a separate, small and inefficient engine, and often by separate boilers.

AN unfortunate accident occurred at the Brighton electricity works on Thursday last week, causing an interruption of the supply from 9:10 to 9:30 p.m. A 220-kilowatt armature developed a sudden short-circuit in its windings, and for some unexplained reason all the dynamos running at the time immediately dropped their minimum cut-outs. As a consequence the whole supply of 9,000 amperes, which was going out at the time, was interrupted. Fortunately Thursday was "early closing night," so practically all the shops escaped inconvenience, and by a lucky chance two of the theatres were having voluntary intervals at the time. Nevertheless, private consumers must have suffered considerably.

THIS occurrence raises a point of immense importance to central station engineers. The practice at Brighton and at several of the largest supply stations in this country is to use no excess-current cut-outs between the dynamos and the 'bus bars, but only minimum cut-outs. On the face of it this system would appear to afford an absolute safeguard against exactly what occurred at Brighton. One can easily conceive that, if excess-current cut-outs or fuses were used in series with each dynamo, a certain sluggishness in the minimum cut-out, in the case of an armature short-circuit, would blow the excess-current cut-outs of all the other machines. But for all of the minimum cut-outs to act it was essential that the current from the dynamos must have been enormously *reduced*, and, as there was no storage battery across the mains to send a back current, the explanation can only be sought in the behaviour of the dynamos themselves. If it could be assumed that the short-circuit sufficed to pull the machines up "dead" for an instant, the cause of the phenomenon would be clear; but this hypothesis appears hardly a probable one. Yet the speed will have been enormously reduced, and the reaction of the large current started in the armatures will have tended to weaken the fields, and it is just conceivable that these two causes inter-acting may have reduced the E.M.F., and therefore the current, sufficiently to release the cut-outs before the cut-out of the disabled machine had cleared its contacts. Another fact, not yet mentioned, might, by a remote possibility, have contributed to the remarkable result. Two machines of a smaller size were also running in parallel with the others, these being provided with ordinary fuses and no minimum cut-outs. The fuses of these machines did not blow. It may be that the speed of these dynamos was less affected than that of the larger ones, and that their higher E.M.F. also contributed to lessen the current from the larger generators.

WHATEVER the explanation may be, the most important question is how a recurrence of such a mishap is to be guarded against. To replace the minimum cut-outs by return-current cut-outs would probably be effectual, but there seems to be a prejudice against their shunt-winding. To separately excite the dynamos might lessen the probability of such an accident, although it is not certain that it could be depended on as an absolute safeguard. For the present it is probable that engineers of large continuous-current stations will be content to tie up their minimum cut-outs, and insert in place of them extremely heavy excess cut-outs, until more light is thrown on the matter. Experiments with artificial short-circuits might settle the question, but the risk of their damaging the plant is probably prohibitive.

Accident on a Glasgow Electric Car.—Early yesterday morning the trolley-arm of a double decked car in Parliament-road, Glasgow, broke. There were 20 passengers on the top of the car at the time, but no injury was done.

Cable Interruptions.—	Date of Interruption.
Bissao—Bolama	Aug. 3, 1898
St. Louis and Noronha	Oct. 17, 1898
Gibraltar—Tangier	Oct. 18, 1898
Pernambuco—Ceara	Oct. 19, 1898

Opening of a New Electric Supply Station at Hull.—On Monday last, the 24th inst., the new station for the Kingston-upon-Hull municipal electric supply works, in Sculcoates-lane, was formally inaugurated by the mayor. We shall present our readers with a description of these works in an early issue.

Institution of Electrical Engineers.—The opening meeting of the session will be held on Thursday, November 10th, when a Paper will be read by Prof. Silvanus P. Thompson on "Rotatory Transformers." We learn that the annual dinner will take place in the Grand Hall of the Hotel Cecil on Wednesday, December 7th, and that the invitations are likely to be issued during the coming week.

The Northern Society of Electrical Engineers.—At the meeting of this society on Tuesday, Mr. J. S. Raworth, the president, occupied the chair, and there was a large attendance. It was announced that the Council had sent letters of condolence to the relatives of Dr. John Hopkinson and of Mr. James Morton. The president then delivered his address on "The Rapid Development of Electrical Engineering in the year 1898."

Interruptions to Supply.—At about half-past seven on Saturday evening the electric supply at Wolverhampton was interrupted for a couple of hours. We have not ascertained the cause of the interruption.——At the Crystal Palace theatre last Tuesday afternoon the electric light on the stage and auditorium went out in the middle of the last act of the play. This was probably owing to a local fuse blowing, as the lights in the main building were not affected.

Soft Coal Burning.—The publishers of the *Railway Master Mechanic*, of Chicago, have recently issued the fifth edition of a useful little brochure, entitled "Soft Coal Burning," by C. M. Higginson. While the writer lays no claim to having made any original discovery in the matter, he has collected in convenient form and compiled in intelligible language the results of practice and methods extending over a long period. Engineers who are desirous of obtaining information in regard to smokeless and economical combustion of soft or bituminous coal will find in this little pamphlet many hints and items of advice that should serve their purpose.

The Electrical Engineers Volunteers.—An order is issued in the *London Gazette* with relation to the certificates of efficiency to members of the corps of Electrical Engineers, Royal Engineers (Volunteers). A certificate of efficiency, according to Army Form E, has been added for captains and subalterns, and another for non-commissioned officers and men. The forms of certificate of efficiency for the volunteer divisions of Submarine Miners, Royal Engineers, have also been

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amended with regard to the technical qualifications required for the "Test Examination Certificate for recruits before being classed as Trained men," and "the laying out of cables" is inserted in the qualifications required of "Trained men."

The Institution Articles of Association.—Notice has been given that a special general meeting of the Members only of the Institution of Electrical Engineers will be held at Victoria Mansions, 28, Victoria-street, London, S.W., on Wednesday next, Nov. 3rd, at 4 o'clock in the afternoon, for the purpose of considering, and if thought fit, of passing the following resolution:—

That the Articles of Association contained in the printed document submitted to the meeting, and, for the purpose of identification, subscribed by the Chairman thereof, be, and the same are hereby approved; and that such Articles of Association be, and they are hereby, adopted as the Articles of Association of the Institution; and that Article Number One do come into operation forthwith, and that the remaining Articles, numbered Two to Eighty, both inclusive, with the schedules thereto, do come into operation on and from Jan. 1, 1889.

Should the resolution be passed by the requisite majority, it will be submitted for confirmation as a special resolution to a second special general meeting of the members which will be subsequently convened.

The "Moheghan" Disaster and Magnetic Disturbance.—The suggestion which has been put forward that the "Mohegan" disaster was caused by disturbance of the compass, due to the existence of magnetic rocks in the neighbourhood, has elicited the following interesting letter from Prof. A. W. Rücker, which we extract from *The Times* of Monday last:—

As the suggestion that the wreck of the "Mohegan" may have been due to a local deviation of the compass is again referred to in a letter which appears in your columns to-day, you will perhaps allow me to point out that such deviations are more likely to occur on land, where the needle may be within a few feet of the disturbing cause, than at sea, where they must be separated by a greater or less depth of non-magnetic water. During the magnetic survey of the United Kingdom, carried out by Dr. Thorpe and myself, observations were made at 12 places in Cornwall. Of these Lizard Down, Porthallow, and Falmouth were the nearest to the scene of the disaster, and at all of them the deviation of the compass from the normal magnetic meridian was extremely small. The largest disturbance of this kind which was observed in Cornwall occurred at St. Levan, near the Land's End, and only amounted to 11min. of arc, or less than two-tenths of a degree. The largest disturbance of the dipping needle was at Mullion, and was only 14min.

It is true that it is not impossible that the compass of a ship in relatively deep water might be appreciably affected for a distance of three or four miles by a concealed centre of magnetic disturbance. The best-known case of this sort is that of Port Walcott in North-West Australia, which was fully described by Captain Creak in the *Philosophical Transactions* for 1896. In that case, however, a compass on the neighbouring coast was affected, not as in Cornwall to the extent of a few minutes of arc, but through a range of 10deg.

To the improbability of such a source of danger as that suggested having escaped the notice of naval surveyors in a district so well known as the neighbourhood of the Manacles, we must, therefore, add the improbability of a great magnetic focus existing near land on which the magnetic disturbances are as small as they are in Cornwall. It is, of course, possible that here and there in that county there may be centres of magnetic disturbance greater than any we discovered, but from evidence collected in districts, such as the West of Scotland, where magetic rocks abound, I have no hesitation in saying that in general such causes could not affect the compass of a ship at a distance of a couple of hundred yards, and that though cases such as that above referred to are known to which this generalisation does not apply their number is small.

The Institution of Junior Engineers.—In his presidential address to the members of this Institution, on the 21st inst., Sir William H. White compared the growth and development of civil engineering to that of a tree, whose roots strike deep and stretch far, while the trunk enlarges and strengthens, and the branches multiply in all directions. He continued:—

Modern engineering has many branches, starting from the trunk-idea of utilising the great forces of nature for the service of man. Its roots strike deep, and reach far in the fruitful soil of science, drawing thence renewed vitality and fresh ideas, with which to meet the heavier and more varied tasks imposed upon the engineer by the ever-increasing needs of civilised life. Apart from the aid of science the engineer could not have solved many of the problems presented to him. He now welcomes the mathematician, the chemist, and the physicist as essential and valued allies. Scientific method is becoming more and more established in engineering practice and in experimental research. There is no exclusion of engineers from the ranks of scientific men. And there are numerous instances of men distinguished no less as scientists than as engineers.

This led Sir William to a sympathetic reference to the loss sustained by science and engineering in the death of Dr. John Hopkinson, and to the generous gift bestowed by Mrs. Hopkinson to Cambridge University. After giving instances of cases in which research work undertaken originally for scientific purposes only had largely influenced engineering practice, the speaker expressed his approval of the examination system adopted by the Institution of Civil Engineers, and then attacked the question of specialisation:—

Under modern conditions the strongest bond of a union between all branches of engineering will be found on the scientific side. Specialisation in individual practice has already gone far and is likely to extend; but the scientific basis of engineering will always have much that is common to all departments. . . Most men are content to choose a line and to endeavour to win distinction therein. It is a good thing, under these circumstances, that there should still remain some ground of common interest, such as science provides. Specialisation in engineering practice is inevitable. It should never be permitted to degenerate into isolation. Divergent as the branches of modern engineering undoubtedly are, they remain closely related. Many of them cannot have their lines of demarcation exactly defined. No branch has become so distinct that those engaged in its practice may not find it possible to benefit by taking an intelligent interest in what is being done in other departments. While no man can hope to keep himself fully informed on all sections of engineering, or to assimilate the enormous mass of current technical literature, he may advantageously study the general lines of advance, and will often find valuable, if unexpected, suggestions bearing on his own work. I desire to record my equally strong conviction that for the "average man" an early specialisation of practice is advantageous, and generally leads to greater success. Probably for many of the members of this institution there has been no alternative, and it has been necessary to undertake work in some department of engineering at an early period. Provided the preliminary education has been satisfactory there is not, in my judgment, any reason for regret if this necessity has arisen.

Sir William White devoted the remainder of his address to the subject of the education of engineers. He advises that a boy should commence his practical work in the shops directly he leaves school, "at a time when 'roughing it' becomes easy and observation is quick, while the facility of acquiring handicrafts and manual dexterity is greatest":—

During this period of practical training it is most desirable that scholastic knowledge should be maintained or extended. Unfortunately, this is often neglected and the loss is serious. In many cases arrangements can be made by which boys need not be subjected to such extreme physical exertion as would prevent evening study: and in all great industrial centres suitable evening classes are now established in which instruction can be obtained. If this programme is carried out a young man finishes his practical course without loss of educational knowledge; and if he has the means and the capacity, he is well prepared for entry into a technical college, at an age which permits him to obtain the full benefit of theoretical training and laboratory work. . . . Perhaps the ideal system of training is that which permits an engineering pupil to continue his scholastic training side by side with the preliminary practical experience, as the medical student attached to a hospital does. . . . The system of training adapted by the Admiralty for its staff of constructors and naval engineers approximates to this ideal.

In conclusion we quote the following suggestions of a course which might well be followed by more colleges and engineering firms than it is at present:—

It must be admitted that in many directions a department of the State can do what is impossible to private enterprise . . . Still, Admiralty experience shows the advantages of that concurrent study, and it is a matter worth consideration whether something of the same kind might not be done for students in technical colleges, most of which are situated in great industrial centres. Subject to suitable regulations and limits, providing against injury or embarrassment to the business of private firms, it would not seem impossible to provide facilities by which at least senior students should keep closer touch with the practical side of their future work. Cases have come under my own observation where such facilities have been granted by important firms with excellent results.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, October 28th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Agenda:—(1) "An Influence Machine," by W. R. Pidgeon; (2) "The Repetition of an Experiment on the Magneto-optic Phenomenon discovered by Righi," by Prof. Silvanus P. Thompson, F.R.S.; (3) "The Magnetic Fluxes in Meters and other Electrical Instruments," by Albert Campbell.

TUESDAY, November 1st.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. First Ordinary Meeting, when Mr. W. H. Preece, the President, will deliver an Address, after which the Medals and Prizes awarded by the Council will be presented.

THURSDAY, November 3rd.

INSTITUTION OF ELECTRICAL ENGINEERS.

4 p.m. Special General Meeting for Members only, at 28, Victoria-street, S.W., to consider the proposed revision of the Articles of Association.

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THE THOMPSON-WALKER SYSTEM OF ELECTRIC TRACTION.

Quite the latest development in electric traction is the surface-contact system jointly invented by Prof. Silvanus P. Thompson and Mr. Miles Walker. During the past week we have been afforded opportunities of examining the details of construction and working of this system on a short length of tramway which has been laid down near Willesden. A technical description of the Thompson-Walker system appeared in our issue of September 30th last (*The Electrician*, Vol. XLI., p. 751), in a reprint of a Paper communicated by the inventors to the British Association. It will be unnecessary to repeat the details of that description now, but it may assist the reader to understand the system if we give some account of what we saw at Willesden.

Car and Portion of Track near Willesden, equipped on the Thompson-Walker Surface-contact System of Electric Traction.

It must be borne in mind that the main objects of a surface-contact system of electric traction are to obviate, on the one hand, overhead construction in the form of poles and trolley wires and trolley masts on the cars, and, on the other hand, to dispense with slots or other cavities in the road surface. The ideal surface-contact system consists of an insulated series of conductors laid flush with the road surface, each individual conductor being made electrically alive only immediately when the car passes over it. In practice, the contact-pieces cannot be quite flush with the roadway surface, as it is necessary that they should come into contact with a sliding bar or skate carried beneath the car; they must, therefore, project a little above the surface. In practice also hitherto it has been very difficult and almost impossible to guarantee that the contact-pieces shall be rendered inert or non-electrified after the car has passed. The dangers attendant upon live plugs occurring at random upon the road is so great that the Board of Trade would not sanction any system in which there was the remotest possibility of such an event occurring, It is claimed for the Thompson-Walker system that although "it will, of course, be said that in every traction system there must be *some* risk; in this system that risk is upon the happening of something which is inconceivable." While we think this is putting it rather strongly, we nevertheless concede that the mechanism below the contact road plug is much less liable to get out of order, in a way that would keep the plug live after the car had passed in any other surface-contact system we have as yet seen. In order to throw one of these plugs into electrical connection with the mains, it is absolutely essential that a live piece of iron or other highly magnetic substance at a pressure of something like 500 volts should be immediately over and in contact with the plug. Other systems have depended upon the proximity of either a piece of iron or of an electrified conductor; but in the Thompson-Walker system the conductor must be both electrified and be composed of iron. Thus the chance of any ordinary vehicle enlivening a knob is reduced to a very small minimum—practically, indeed, to an impossibility.

One of the defects which has to be guarded against in a surface-contact system is the maintenance of electrical contact between the plug and the feeder by leakage. In the Thompson-Walker system all parts, which are either live or which become live when the car is passing over the stud, are so surrounded by permanently-earthed metal that any leakage must escape to the earth and cannot raise the electrical pressure of the knob. So that, even should leakage occur, the knobs are not rendered dangerous. If, therefore, from leakage, or from any other cause, an excessive current passes a fuse within the plug box is blown and the plug is isolated.

The mechanism within the plug box is completely enveloped in paraffin oil, and is thus prevented from sticking either through rust or the accumulation of dirt. The contacts are made by means of mercury cups shunted by carbon breaks. The main current is never broken at the mercury cups, but these are opened first and immediately afterwards the carbon breaks open the circuit. Thus no flashing occurs at the mercury surface.

The experimental line which has been laid down near Willesden consists of a short length of single track, with a turn-out at one end and a sharp grade curve at the other end. The car is an ordinary double-decked car, capable of carrying as many as 60 persons, and when operated fully loaded ran smoothly and satisfactorily over the line in either direction. There is provided on the car a small 500-volt accumulator connected with an additional plug on the controller, by means of which the skate can be made live to the required pressure in the event of the car passing over a dead plug, and thus losing electrical pressure from the mains. The operation of throwing the skate on to the battery can be performed so quickly as to make no noticeable change in the speed of the car. When, through breaking a fuse or from any other cause, it is necessary to replace the mechanism below the plug, it is simply necessary to undo three screws on the surface and lift out the plug and the mechanical gear below it, the whole coming out bodily. We timed this operation, and found that it could be completely carried out in 37sec., while a plug could be removed and a new one put in in about 1min.

One of the objections commonly raised against all traction systems that rival the overhead trolley is the very much greater cost of these rival systems. From figures supplied to us in a pamphlet which has been circulated, we learn that the relative costs of the Thompson-Walker surface-contact system, the overhead trolley system, and the open conduit system are as follows:—

COST PER MILE OF SINGLE TRACK.

I.—*Overhead Wire System.*

Trolley wire and adjuncts	£300
Poles	400 to 1,200
Permanent way and paving	3,500
Feeders	4,000
	£8,200 to 9,000

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II.—*Open Conduit System.*

Cost of conduit under favourable conditions, including conductor rails, insulators and drainage	£3,900
Permanent way and paving	3,500
Feeders	4,000
	£11,400

III.—*Surface Contact System.*

180 to 360 boxes costing, say, £5 apiece	£900 to 1,800
Permanent way and paving	3,500
Feeders and adjuncts	4,200
	£8,600 to 9,500

From these figures it will be seen that it is claimed that the new system is but slightly more expensive than the overhead equipment. As, however, the new system has never been made the subject of actual practical contracting work, it still remains to be seen whether it can be put in profitably at the price stated.

In conclusion, we may observe that since the Thompson-Walker system is operated at the same pressure as the ordinary overhead trolley, viz., 500 volts, it can easily be combined with the latter. In other words, cars might be equipped to work on the Thompson-Walker system in narrow streets where overhead equipment might be prohibited, and to run on the overhead trolley system in suburban and outlying districts where the overhead equipment would be permissible. Indeed, it seems to us that in the event of the new system proving suitable for ordinary commercial tramway work this will be found to be its most useful feature.

PROGRESS OF GLASGOW CORPORATION ELECTRICITY WORKS.

Any one who has recently had occasion to be much about the streets of Glasgow cannot fail to have noticed the large extensions that are being carried out in connection with the electric lighting of the city, even if they are not interested in the subject itself. When the matter is looked into more carefully these extensions appear all the more startling. It is, of course, admitted on all sides that the lighting of Glasgow, and the general electrical arrangements were very much behind hand, and when Mr. Chamen was appointed less than a year ago he had a very serious position to face. The present station is now as full of plant as it can possibly be, and only holds some 3,000 to 4,000 H.P. even at that, and last winter even with the assistance rendered it with the two large batteries of accumulators that were put down whenever there was a little extra tax on it due to fog, &c., the voltage would fall to, from the consumers' point of view, an almost negligible quantity. Seeing that consumers have been added in considerable numbers since, it will be seen that it was imperative that further plant should be got ready to prevent serious consequences as far as a continuance of the supply was concerned.

Within a very short time of his appointment Mr. Chamen has formulated his general scheme for the lighting of the city, and obtained the approval of the Corporation to it. Generally speaking, this scheme consisted in laying down two stations, one on the north side of the river Clyde for a possible output of 30,000 H.P., and one on the south side of the river for a possible output of 20,000 H.P. It was, of course, impossible to have these stations in any way ready for this winter's load; it was, therefore, decided to advertise for plant, amounting to a total of 2,000 to 3,000 H.P. in any sized units, the only stipulation being the question of delivery; and there was offered and accepted for delivery this autumn a large marine engine coupled to a German dynamo, an American engine coupled to two American dynamos, and two small English high-speed sets. Foundations have been put down for these plants in the new engine house on the north side at Port Dundas, and a temporary shed erected over them, steam being supplied by a couple of Babcock boilers, which are fitted to form part of the permanent battery. This work is well forward now, and as it will not be long after these lines are in print that the plant will be ready for taking up part of the load of the city, and so relieving the present station, a few words will not be amiss as to the general arrangements of the station. The ground secured for the station on the north side is adjoining the Forth and Clyde Canal, which is the property of the Caledonian Railway; the configuration of the ground is such that the level of the canal is the same as the coal store which is over the boiler room, thus the coal can be delivered directly either from the barges or railway trucks right into the hoppers to feed the automatic stokers if required. The boilers are arranged in one long line running parallel with the canal bank, and alongside this runs the engine room. The building is made up of three sections; in the centre what may be termed the main portion, consisting of one-third of each of the boiler room and engine room, with in front a central block running up into a tower, containing the engineer's office, &c., and on either side of this the battery rooms; it is this portion that is now being pushed on with; the other two portions consist simply of extensions of the boiler and engine rooms in either direction. This arrangement even in its incomplete form makes a very compact and handsome building, but when completed it will probably rank as the finest electric light station in the kingdom.

So much for the station buildings; now as to the mains and cables. The system of distribution is, of course, a three-wire system, but it is, we believe, the first town to take the full advantage of the Board of Trade permission, and lay down a supply of 250 volts or 500 volts across the outers. The first step was made some little time ago, when a large part of the town was changed over from the 100 volt supply to the 200, but as soon as the new plant is at work a large section will be further increased to 250 volts, and as the new station gradually takes up the load the present station will be shut down. The distribution may be termed a purely feeder distribution, the network being of comparatively small section, but being very liberally supplied with feeders; at present there are some 20-30 triple concentric feeders being laid from the new station to various points on the north side, one of them being carried across the river to form a junction with the south side station. These feeders are all of 1in. × 1in. × 4in. section. The contract for them was divided between the British Insulated Wire Co., of Prescot, and Messrs. Callender, of Erith. Both feeders and network are plain lead covered, and are being laid in heavy earthenware troughing, and filled in solid with bitumen. This will make a very sound and permanent piece of work.

TELEGRAPHS AND TELEPHONES IN PERSIA.*

The first telegraph line in Persia was established about 36 years ago, and in the beginning was vigorously denounced and opposed by the priests as being a species of magic, and closely allied to other evil principles greatly subversive of religion and the best interests of the State, and as such not to be permitted to have a place in the economy of Government. This opposition, however, was overcome, and the class which resisted so stoutly at the first now use the telegraph with the greatest indifference. In the year 1862 the construction of a telegraph line from India to England through Persia, Russia, and Germany was commenced, and it began working on January 1, 1870. Some work had, however, been carried on for three or four years by a line through the Euphrates valley; but according to the United States Vice-Consul at Teheran, this was not by any means of a satisfactory character, and serious errors, delays, and interruptions occurred. The line is still used occasionally. The Indo-European is a well-constructed and efficiently-managed line. From Bushire to Karachi there is both a cable and a land line. This line provides the local native administration with one wire which can always be depended upon. The local lines, with the exception of the one wire mentioned above, are the property of the Persian Government. The ownership was acquired by the cost of construction, and has been maintained by defraying the expenses of preservation. The actual administration is deputed to one man, who, until very recently, contributed to the Government, £2,400 a year. This royalty has now been raised to £6,000 a year. The yearly receipts of the telegraphs have been about £12,000, and the expenditure equals, if not exceeds, the income. In consequence, certain reforms are to be initiated in the direction of compulsory payments. It is stated that fully 50 per cent. of the telegrams are sent free. Officials of the Government

* From the *Journal* of the Society of Arts.

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(central and local), priests, expounders of the law, relatives of persons connected with the working and the administration, and everyone who can provide himself with a reason or excuse, send their telegrams free of expense. As this system has been growing for many years past, and most of those who have benefited by it are in a position to give trouble, the management find it difficult to introduce changes necessary for their own protection. The Persian local system comprises about 3,100 miles of wire and 86 offices for the receipt and despatch of messages. The wire provided by the Indo-European administrations, gratis, is about 1,300 miles long, and extends from the Persian Gulf to the Russian frontier. Stamps are not used for any purposes in Persia, except for letters. Messages are restricted to 10 words, at a charge of 2½ krans (about 9d.). The actual charge for the message is 2 krans, and the half kran is for the paper on which it is written. In case the message extends to a large number of words it is calculated at the rate of 10 words to the two krans, and not 2½ krans. This tariff is the same for any distance in Persia; there is only one charge. The Persian newspapers rarely contain information of sufficient importance to be sent by telegraph, consequently there is no Press rate, and, indeed, there are very few Press messages. There are four newspapers in Persia printed in the vernacular, and under Government control. These should be issued once a fortnight, but they are often issued at longer intervals; they are in no sense considered as leaders or exponents of the ideas or feelings of the people. As regards telephones, the late Nasredin Shah on December 8, 1889, granted to the then Minister for Foreign Affairs a concession for electric lighting, the introduction of telephones, phonographs, and the application of electricity to industrial purposes to the whole of Persia, with protection to the monopoly for the period of 60 years. This concession was transferred to an American citizen for a certain valuable consideration, but for want of means the purposes of the concession have not been put into execution. In order to protect the concession from lapsing, two or three wires were put up and kept in a workable state, and are now in use. Five years ago the railway and tramway company commenced erecting private wires for anyone who would undertake the expense, and they established an exchange office on their own premises at Teheran. It has not been extended to any other town. So far, no records have been kept of the number of miles of wire erected, but the Vice-Consul says that from his observation he should estimate it at about fifty miles—this is including the wires into villages of summer resort, and those to different parts of the city. At the present time there are 15 owners of private wires, each of whom pays the company about 8s. 6d. per month for keeping the wires in repair, and the instruments in order. The receipts about balance the expenditure, but this only includes the free use of the lines by the Company, who provide the only office there is in the city, and two in the country during the summer months. As messages are not received from the public, no tariff has been formulated. Subscribers are put into communication, and use the telephones as long as they wish. As a more extended use of the telephone would interfere with the receipts of the telegraphs, permission to use it has not been granted to distances appropriated by the telegraphs.

BOOKS RECEIVED.

"A Treatise on the Law and Practice Relating to Letters Patent for Inventions." By Robert Frost. Second edition. (London: Stevens and Haynes.)

"The Official Gazette of the United States Patent Office." No. 1. Vol. LXXXV. Published by Authority of Congress. (Washington: Government Printing Office.)

"Calendar of the University College of North Wales" for the year 1898-9. (Manchester: J. E. Cornish.)

"Street Railway Roadbed." By M. D. Pratt and C. A. Alden (New York: Street Railway Publishing Co.)

ELECTRICITY WORKS ACCOUNTS.

Nottingham Municipal Electric Supply Works.

The electrical undertaking of the Nottingham Corporation, the accounts of which form the subject of our first table this week, was started in September, 1894; it has, therefore, completed its third year of working, and, moreover, in a manner which indicates very satisfactory progress, both as regards output and economy of working.

The borrowed capital amounts to £77,865, raised at rates varying from 3 per cent. to 2⅝ per cent., while the expended capital has reached £75,996, representing £79 per kilowatt capacity of generating plant. An increase in the number of consumers from 334 to 480 during the year has resulted in an increased equivalent lamp connection of 48 per cent., or from 25,725 to 38,140. The corresponding increase in the output in units sold is 61·6 per cent. on 297,185, bringing it up to 480,881 for the year ended March 31st last. A substantial diminution of the costs of 1896-7 has been effected, lowering them to 1·83d. per unit—a value which has not been beaten by any station we have yet analysed of the same or lower output. Both works costs and management and property charges, but especially the latter, have conduced to the total reduction effected.

A working profit of no less than £7,067 has been made, the total costs bearing the low ratio of 34 per cent. to the revenue, £8,503 has been carried to the depreciation fund, £1,897 to the sinking fund and towards repayment of loans, and £2,168 paid as interest on loans.

As giving some indication of the progress of the concern, it may be stated that for the year 1895-6 the number of units sold was 171,654, of which 11,564 were for public lighting. The revenue was £6,638, and the expenditure £2,090, with an equivalent number of lamps connected of 17,400.

The National Electric Supply Company (Preston).

This Company commenced the supply of electricity in Preston in August, 1892; therefore, the last accounts analysed in the table are those of the fifth year of working. Of the total capital received, viz., £66,794, £39,694 is by shares and £27,100 has been borrowed on Four and a-Half per Cent. Debentures. The total amount expended as capital is £70,201, being at the rate of £117 per kilowatt of generating capacity.

The number of consumers have been increased by 50 during the year and the (8 c.p.) equivalent lamp connection by 27 per cent. or to 23,300, as compared with 18,300 in 1896. A large proportion of this increase in the connections to the mains occurred towards the end of the year, so that the improvement due to the extended custom was not to be expected in the accounts for 1897. The output for the year has reached 371,301 units sold—an increase nearly 16 per cent. A total revenue of £7,829 was received showing an average price per unit of 5·06d. We regret to notice that the total costs per unit have risen by nearly 0·4d. This is due, however, chiefly to the management charges; salaries having risen by nearly 0·3d., and one or two abnormal special charges which have been included under management causing a further increase. The works costs have fallen perceptibly. A working profit of £4,118, together with £500 previous balance, allows of £700 being paid in respect of depreciation, £1,188 as interest on loans, and a dividend of 5s. per share being paid on the ordinary shares which absorbs £2,713, leaving £18 balance carried forward. A small alternating plant has been added to the machinery to supply current to the outlying districts.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Bedford (Municipal)	Mar. 4	Islington (Vestry)	June 24
Belfast (Municipal)	Sept. 23	Kensington & Knightsbr'ge (Co.)	Sept. 30
Blackpool (Municipal)	Oct. 7	Kingston-upon-Hull (Municipal)	Aug. 19
Bournemouth (Company)	June 3	Kingston-upon-Thames (Mun.)	Mar. 25
Bradford (Municipal)	May 20	Lancaster (Municipal)	Oct. 21
Brighton (Municipal)	May 6	Leeds (Company)	April 8
Bristol (Municipal)	July 29	Leyton (Municipal)	Sept. 23
Burnley (Municipal)	Sept. 16	Liverpool (Municipal)	Aug. 12
Burton-upon-Trent (Municipal)	April 15	Manchester (Municipal)	July 29
Cambridge (Company)	June 17	Newcastle-upon-Tyne (Co.)	April 29
(Central) Kensington (House-to-House (Company)	Sept. 30	Northampton (Company)	April 15
Charing Cross (Company)	April 22	Notting Hill (Company)	Mar. 11
Chelsea (Company)	May 20	Oxford (Company)	April 1
Cheltenham (Municipal)	Oct. 7	Reading (Company)	Sept. 16
Chester (Municipal)	Oct. 14	Richmond (Company)	Mar. 4
Clerkenwell (Company)	Mar. 18	Scarborough (Company)	April 1
Dover (Company)	Mar. 11	St. James' & Pall Mall (Company)	July 1
Eastbourne (Company)	July 22	St. Pancras (Vestry)	May 13
Edinburgh (Municipal)	Oct. 14	Shoreditch (Vestry)	May 27
Exeter (Municipal)	Aug. 5	Southampton (Municipal)	June 3
Glasgow (Municipal)	Aug. 12	Stafford (Municipal)	Oct. 21
Guildford (Company)	May 13	Sunderland (Municipal)	Aug. 19
Hammersmith (Vestry)	June 10	Taunton (Municipal)	Aug. 5
Hampstead (Municipal)	Sept. 9	Tunbridge Wells (Municipal)	July 22
Hanley (Municipal)	April 8	Wandsworth (Company)	Mar. 18
Harrow (Company)	Sept. 9	Westminster (Company)	April 22
Hastings & St. Leonard's (Co.)	April 29	Wolverhampton (Municipal)	July 15
Hove (Company)	May 6	Worcester (Municipal)	May 13
Huddersfield (Municipal)	Mar. 25	Yarmouth (Municipal)	June 17

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	NOTTINGHAM.		PRESTON.	
Undertaking Worked by	Nottingham Corporation.		The National Electric Supply Co. (Limited).	
Date of Commencement of Supply	1894.		1892.	[teries, and partly alt.-cur.
System of Supply	3-wire continuous-current with batteries.		Partly 3-wire and 2-wire con.-cur. with bat-	
Chief Engineer	H. Talbot.		J. H. Tonge.	
YEAR ENDED	MAR. 31, **1897.**	MAR. 31, **1898.**	DEC. 31, **1896.**	DEC. 31, **1897.**
QUANTITIES—				
Units generated	316,638	511,935	349,920	408,111
„ **SOLD (TOTAL)**	**297,185**	**480,381**	**320,500**	**371,301**
„ sold to consumers	285,622	468,728	289,751	332,305
„ sold for public lighting, &c.	11,563	11,653	30,749	38,996
„ used on works	3,621	5,957	12,500	12,500
UNITS SOLD PER 8 C.P. LAMP CAPACITY	10	16	17	19·7
Maximum supply demanded	400 kilowatts	737 kilowatts	—	—
Number of public lamps	8	9	42 arc, 18 glow *	42 arc
Number of consumers	334	480	406	450
Connections to mains in 8-c.p. lamps	25,725	38,140	18,300	23,300
CAPACITY OF PLANT IN 8-C.P. LAMPS	29,700	30,000	18,800	18,800
CAPACITY OF PLANT IN KILOWATTS	950	957	602	602
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£85,000 / £89·5	£85,000 / £99	— / —	— / —
Share	— / —	— / —	£100,000 / £166	£84,944 [g] / £141
Loan (including Debenture charges)	85,000 / 89·5	85,000 / 99	— / —	— / —
RECEIVED (TOTAL)	**72,265 / 76·1**	**77,865 / 82·2**	**78,735 / 131**	**66,794 / 111**
Share	— / —	— / —	54,735 / 90·9	39,694 / 66·0
Loan (including Debenture charges)	72,265 / 76·1	77,865 / 82·2	24,000 / 39·9	27,100 / 45·0
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	**12,735 / 13·4**	**7,135 / 7·46**	— / —	— / —
Share (unissued)	— / —	— / —	45,250 / 75·2	45,250 / 75·2
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	12,735 / 13·4	7,135 / 7·46	— / —	— / —
REPAID (TOTAL)	764 / 0·804	1,764 / 1·844	— / —	— / —
RESERVE OR SINKING FUND	2,734 / 2·88	3,172 / 3·32	— / —	— / —
DEPRECIATION FUND	453 / 0·477	3,956 / 4·14	819 / 1·36	2,019 / 3·35
EXPENDED (TOTAL)	67,762 / 71·3	75,996 / 79·4	70,681 / 117	70,201 / 116·6
Lands and buildings	25,260 / 26·6	25,261 / 26·4	6,569 / 10·9	6,650 / 11·05
Plant	21,395 / 22·5	24,680 / 25·8	33,177 [a] / 55·1	29,416 [d] / 48·9
Mains	18,946 / 20·0	23,894 / 25·0	28,601 / 47·5	31,739 / 52·8
Miscellaneous	2,161 / 2·27	2,161 / 2·26	2,335 / 3·88	2,397 / 3·98
BALANCE OF CAPITAL ACCOUNT	4,503 / 4·74	1,869 / 1·95	8,054 / 13·4	−3,407 / −5·66
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	**£7,357 / 5·940d.**	**£10,738 / 5·365d.**	**£6,726 / 5·038d.**	**£7,829 / 5·060d.**
Revenue from supply	6,764 / 5·462d.	10,056 / 5·025d.	6,129 / 4·590d.	6,952 / 4·490d.
„ meters, &c.	237 / 0·191d.	339 / 0·169d.	208 / 0·156d.	240 / 0·155d.
„ public lighting	324 [a] / 0·262d.	283 [b] / 0·141d.	375 / 0·281d.	629 / 0·407d.
„ sale of lamps, &c.	24 / 0·019d.	60 / 0·030d.	14 / 0·010d.	8 / 0·005d.
„ miscellaneous sources	8 / 0·006d.			
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	**£2,724 / 2·200d.**	**£3,671 / 1·833d.**	**£2,710 / 2·030d.**	**3,716 / 2·402d.**
WORKS COSTS	**1,633 / 1·319d.**	**2,428 / 1·214d.**	**1,728 / 1·284d.**	**1,986 / 1·283d.**
Generation of electricity	*1,570 / 1·268d.*	*2,283 / 1·141d.*	*1,508 / 1·129d.*	*1,643 / 1·062d.*
Fuel (including cartage, &c.)	703 / 0·568d.	1,071 / 0·535d.	509 / 0·381d.	533 / 0·345d.
Oil, waste, water, stores	154 / 0·124d.	219 / 0·109d.	134 / 0·100d.	126 / 0·081d.
Wages at station	476 / 0·385d.	699 / 0·349d.	708 / 0·530d.	657 / 0·425d.
Repairs and maintenance at station	237 / 0·191d.	294 / 0·147d.	158 / 0·118d.	328 / 0·212d.
Distribution of electricity	*31 / 0·025d.*	*111 / 0·055d.*	*114 / 0·085d.*	*156 / 0·101d.*
Wages, &c.	13 / 0·011d.	31 / 0·016d.	15 / 0·011d.	156 / 0·101d.
Repairs, renewals of mains, &c.	18 / 0·015d.	79 / 0·039d.	99 / 0·074d.	
Public lighting	*32 / 0·026d.*	*34 / 0·017d.*	*106 / 0·079d.*	*187 / 0·121d.*
Attendance	32 / 0·026d.	34 / 0·017d.	106 / 0·079d.	187 / 0·121d.
Renewals				
MANAGEMENT AND PROPERTY CHARGES	**1,091 / 0·881d.**	**1,243 / 0·621d.**	**982 / 0·736d.**	**1,730 / 1·118d.**
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*239 / 0·193d.*	*222 / 0·111d.*	*296 / 0·222d.*	*249 / 0·161d.*
Management	*852 / 0·688d.*	*1,021 / 0·510d.*	*685 / 0·513d.*	*1,481 / 0·957d.*
Salaries	631 / 0·510d.	739 / 0·369d.	417 / 0·312d.	939 / 0·607d.
Stationery, &c.	35 / 0·028d.	43 / 0·021d.	50 / 0·037d.	51 / 0·033d.
Establishment charges	115 / 0·093d.	91 / 0·046d.	68 / 0·051d.	64 / 0·041d.
Law charges, &c.	71 [c] / 0·057d.	148 [d] / 0·074d.	150 [b] / 0·112d.	427 [e] / 0·276d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	**£4,632 / 7·62%**	**£7,067 / 9·83%**	**£4,015 / 5·83%**	**£4,113 / 5·84%**
Sum carried to Depreciation Fund	453 / 0·746%	3,503 / 4·88%	400 / 0·581%	700 / 0·994%
Sum carried to Reserve or Sinking Fund	356 / 0·586%	1,397 / 1·94%	— / —	— / —
Net interest on loans (incl. Debenture charges)	1,539 / 2·53%	2,168 / 3·02%	1,116 / 1·62%	1,188 / 1·686%
BALANCE FROM LAST ACCOUNT	−2,284 / −3·76%	— / —	−1,000 / 1·45%	500 / 0·710%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	nil / —	— / —	1,499 [e] / 2·18%	2,725 / 3·87%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	5s. per Sh. / —	5s. per Sh. / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	37·05%	34·16%	40·3%	47·5%
Expenditure per kilowatt capacity	£2. 17s. 5d.	£3. 16s. 8d.	£4. 10s. 0d.	£6. 3s. 5d.
REVENUE PER KILOWATT CAPACITY	**£7. 15s. 0d.**	**£11. 4s. 5d.**	**£11. 3s. 5d.**	**£13. 0s. 0d.**
Expenditure per 8-c. lamp capacity	1s. 10d.	2s. 5½d.	2s. 10½d.	3s. 11½d.
REVENUE PER 8-C.P. LAMP CAPACITY	**4s. 11½d.**	**7s. 2d.**	**7s. 1¾d.**	**8s. 3¾d.**
REVENUE PER 8-C.P. LAMP CONNECTED	**5s. 8½d.**	**5s. 7½d.**	**7s. 4¼d.**	**6s. 8½d.**
Price charged for lighting, per unit	6d. to 3d.	6d. to 4d. [e]	7d. to 4d.	7d. to 4d. [f]
Price charged for power, per unit		3d.	3½d.	3½d.
Price charged for public lighting	—	—	—	—

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POLYPHASE TRACTION.

The question of electric traction is now so much to the fore in England, particularly in technical circles, that it is by no means surprising that polyphase working in this connection should attract very considerable attention. The polyphase system has already been tried to a certain extent for traction purposes on the Continent and in America; and, indeed, in one instance, namely the Dublin installation, in the United Kingdom. Nevertheless, the amount of experience gained has been so small that the relative advantage of the system as compared with the almost universal continuous-current overhead-trolley system is still a matter of keen debate. The question is still further complicated by the fact that there are two distinct polyphase systems in the field; and if the experience of polyphase traction as a whole has been very limited, the experience of each of the systems considered individually has been even more limited still. The first of the two systems is what may be called the combined polyphase and continuous-current system, and the second the polyphase-motor system. In the former the power is transmitted from the generating station to various sub-stations by means of high-potential polyphase currents, which in the sub-stations are transformed by means of rotary transformers to continuous currents of 400 to 500 volts' pressure, and with these the car-motors are supplied in the ordinary way by means of trolley wires. In the latter system the power is, as before, transmitted to sub-stations by means of high-potential polyphase currents; but in the sub-stations, in place of the rotary transformers, stationary transformers are employed which merely reduce the potential to a safe value, the current remaining polyphase and the car-motors being, consequently, also polyphase. In discussing the relative merits of the three competing systems—the ordinary continuous current, the combined polyphase-continuous-current and the polyphase-motor—the first and perhaps most important question that arises is, How do they severally stand as regards interference with telephones, telegraphs and observatories, and as regards electrolytic action upon neighbouring pipes and metal work? Accurately speaking, however, this is not a

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single question, but rather three separate ones, for the magnetic disturbance due to the outgoing and return metallic circuits is quite distinct from the disturbance due to currents leaking from the return circuit through the earth; and, in turn, these magnetic effects are quite distinct from the electrolytic effects of the earth currents. As regards the first of these, the polyphase-motor system seems to be at a great disadvantage as compared with either of its rivals, which are of equal merit in this respect providing that in both cases concentric feeders are employed; the magnetic effect of a concentric cable carrying equal currents in opposite directions being, of course, nil. In both systems the disturbance due to the currents in the trolley wire and in the rail return are similar, since in both cases similar continuous currents are supplied to the motors on the cars. But when polyphase motors are employed, though the feeders may be concentric, the currents to and from the motors must be carried by two trolley-wires and by the rails, and since these currents are alternating the disturbance they create is much greater than in the case of the continuous currents of the direct-current or combined systems. In confirmation of this we find that at Lugano, where polyphase motors are employed, the telephone system has been thrown into the greatest confusion; while on the new Jungfrau railway, though the telephone wires which, are carried on the same poles as the three-phase current circuit, are crossed every 550 yards, the disturbance is still too great for the satisfactory transit of messages. Further, should it be decided to use an insulated return, as may very well happen in this country where a drop of only seven volts is allowed, or an uninsulated return, and where vested interests in telephones, pipes, &c., are so carefully protected, the continuous current system might possibly be worked with double trolley wires; whereas the three-phase motor system, which, even employing the rails as one of the circuits, and using the double trolley, would find that the complexity introduced by a third trolley-wire made satisfactory working almost impracticable. Two trolleys are a sufficiently exasperating condition; three would be prohibititive. As regards the effects upon telephones, &c., of leakage currents through the earth from an uninsulated return, the polyphase-motor system would again be at a great disadvantage; for the earth currents would be alternating, and consequently their magnetic effects, at least, would be much greater than with continuous currents. With respect, however, to the third source of trouble, the electrolytic action of the leakage currents, the polyphase-motor system would undoubtedly be superior to the others, since the electrolysis set up by alternating currents seems to be practically negligible as compared with that due to continuous currents. It is strange, by the way, that the question of alternate current electrolysis should have attracted so little attention from investigators; very little seems to be known about it. But it must be borne in mind that, should the other systems adopt the insulated return, electrolytic troubles would be entirely done away with, and these systems would be, if anything, better in this respect than the polyphase-motor arrangement which cannot adopt the overhead return on account of the complexity of circuits which would ensue.

But leaving the disturbance effects of the different systems, let us consider their relative values from the engineering, which is ultimately the economic, point of view. In the first place the polyphase motor has the advantage of requiring only collecting rings, and not a commutator, as is the case when direct currents are employed; and, beyond all doubt, this is an advantage, though, of course, not of such great importance as at once to give the polyphase system preference over the others. Again, the polyphase motor can be more compactly and mechanically constructed owing to the simplicity of its parts and their symmetrical arrangement, and a leading Continental manufacturer informs us that it is a matter of practical experience that for the same speed and output it can be made lighter than the continuous-current motor. Finally, the polyphase system, as compared with the combined polyphase continuous-current system, has the advantage of requiring only stationary transformers in the sub-stations, thereby effecting a saving both in first cost and in the annual charge for attendance. This advantage, however, is not so great as it might at first sight seem to be, since the rotary transformer requires remarkably little attention; at Dublin, indeed, it has been found possible to leave the sub-stations in the charge of boys. Again, though the polyphase motor may be lighter than the corresponding continuous-current machine, this does not necessarily imply that it is cheaper, for its magnets have to be laminated, and this adds greatly to the cost. Likewise in the matter of regulation the continuous-current motor has the advantage, since its speed and torque can be varied without appreciable loss of energy, by shunting more or less of the series field coils and by adopting the series-parallel system with two motors to each car; whereas with polyphase currents the general method of regulation, at least at present, is by the insertion of non-inductive resistance in the rotor circuit, which leads to the direct loss of energy in heat. But it should be remembered that Mr. C. E. L. Brown advocates regulation, at all events in part, by means of alteration of the stator circuits from the star to the mesh formation, and by cutting out a certain number of the poles and thereby altering the speed of synchronism. On the whole it is perhaps too early to say that the efficient regulation of the polyphase motor is impossible, even for ordinary tramway work in crowded thoroughfares where frequent stoppages and slow speeds are necessary; although at present there can be no question that the system is better suited for light, or indeed even heavy, railway work, where long runs at approximately full speed are the general rule, than for the varying conditions of the ordinary street tramway. But in so far as what has been called the power factor of the polyphase motor is always less than unity,—or, putting the same thing in other words in so far as the current in the trolley wires has to be greater than that corresponding to the power developed in the motor—owing to the lag between E.M.F. and current, and the area of the trolley wires has to be increased for the same percentage loss in the line—the polyphase motor system must be inferior to systems employing continuous currents.

To sum up, we may say that, on the whole, both from the point of view of inductive and earth-current disturbance and of economical and practical working, the advantage, at any rate at present, lies with the continuous-current motor. Of the two continuous-current motor systems, however, the combined polyphase-continuous-current will in general be the most economical to adopt—that is to say, that whenever the feeders are necessarily of considerable length, owing to the length of rail to be worked, or to the desirability of having the generating station in a locality where land is cheap, or where there are exceptional facilities for procuring fuel and water, or where water power is available, it will be found that the saving in the capital expended on copper in the feeders, owing to the use of a high potential, more than compensates for the extra cost of the rotary transformer sub-stations, and the small annual charge for maintaining them: though, of course, each particular case must be considered on its own particular merits.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Luminescence Lamps.—The alleged economy of luminescent or fluorescent sources of light is based upon the fact that the maximum energy radiated by them lies in the visible spectrum, and that the infra-red heat rays are practically absent. But before jumping to the conclusion that the luminescence lamp is the "light of the future" it is necessary to determine by what expenditure of energy its pure light can be produced. Balmain's luminous paint reproduces about 5 per cent. and a fluorescein solution about 1 per cent. of the incident light. E. Wiedemann has determined both the heating and the lighting up of a luminiscent screen by the impact of cathode rays, by introducing into the vacuum tube a thinner tube with a bulb containing water, and painted with Balmain's paint or other luminescent material. The calorimeter tube was open to the air and contained a thermometer for observing the heating effect of cathode rays impinging upon the luminous paint. At the same time, the luminous energy was photometrically determined by comparison with an amyl-acetate lamp. It was found that the heating accompanying a brightness of one Hefner candle was about 1 gr. cal. per second. This means that only about 5 or 7 per cent. of the incident energy is converted into light. In a Puluj lamp, painted with Sidot's blende, the heating per candle-power was three watts, that being very nearly the same ratio as in incandescent lamps, and the same efficiency as in photoluminescent substances.

[Wiedemann, *Wied. Ann.*, No. 9, 1898.]

Vacuum Tubes v. *Coherers.*—A. Righi appears at last to have invented a vacuum tube which is capable of seriously rivalling the coherer as an electric wave indicator. The details of its construction are not given, the reason being that they are "too complex," but the tube has the peculiarity of showing a continuous streak of light between the two electrodes, which breaks up under the influence of electric waves into the accustomed succession of positive strata, dark space, and cathode light. The cathode is a wire, and the anode a disc, and under ordinary circumstances a cone of light extends from one to the other. This condition is resumed after the electric radiation has ceased. The curious thing is that the effect is produced also when the radiation impinges upon some portion of the circuit of the vacuum tube not too far away from the tube. Hence it is probable that the influence of the radiation does not affect the gas in the tube, but only the electrodes. But besides the optical phenomenon, which is in itself a valuable indicator of the presence of electric waves, there is a change of resistance, as in the coherer, which is indicated by a galvanometer. Often, the current is increased to three times its original strength when the tube lights up, and that effect might, of course, be multiplied indefinitely by suitable relays. The advantage of not requiring a special mechanism for restoring the original resistance is obvious, but, on the other hand, Righi does not seem to have experimented with transmissions longer than seven yards.

[Righi, *Nuovo Cimento*, July, 1898.]

Currents Generated by Röntgen Rays.—In 1897 Perrin succeeded in obtaining differences of potential between two different metals when exposed to X rays, and even observed a small constant current of about 10^{-8} amperes on joining them by a wire. A. Winkelmann has made further observations on this interesting subject. He placed a Röntgen apparatus in a leaden box with an aluminium window. In front of the window he mounted an aluminium plate, and behind that a copper plate. On working the apparatus and connecting the two through a galvanometer, a small current was indicated, which was increased by reducing the distance between the plates. A battery of plates could be constructed by mounting plates of the two metals alternately one behind the other, taking care, however, that the insulator between them was not, like mica, for instance, impervious to X-rays. The resistance of one such battery was found to be 180 million ohms, and to increase as the battery was moved away from the Röntgen apparatus, evidently owing to the lesser degree of ionisation of the more distant air. Further, the resistance of the layer of ionised air diminished as the thickness of the layer was diminished, down to a certain minimum. At very small thicknesses the recombination of the ions is so rapid that the current intensity is thereby diminished. The author calculates the proportion of ionised molecules of air in the total number of molecules at $4{\cdot}6 \times 10^{-12}$ at least, in a position of maximum conductivity.

[Winkelmann, *Wied. Ann.*, No. 9, 1898.]

Magnetic Hysteresis. — F. Niethammer examines the behaviour of sheet iron when put through a magnetic cycle, not step-by-step as in the older experiments, but in rapid succession, by means of alternating currents. He finds that Steinmetz's formula $A_v = \eta B^{1\cdot6}$, expressing the relation between the hysteresis work and the induction, only holds within narrow limits and even there only approximately. The coefficient η is different for different kinds of magnetisation, such as the magnetostatic, the alternate current, and the rotating-field method. The curves of magnetisation and permeability are much lower for alternate-current than for static magnetisation, and they are the lower the greater the rate of alternation. Hence it is possible to impart a stronger magnetisation by means of a steady field than by means of a varying one. On the other hand, the hysteresis work is greater when using an alternate current. It does not matter whether the curves of the latter are flat or sinusoidal, but the hysteresis work is much diminished in the case of pointed curves, when the maximum induction is the same in both cases. When a body is made to rotate in a magnetic field, the work of magnetisation per cycle increases up to a certain high induction close to saturation, and then decreases. At B = 14,000, the rotatory hysteresis is sometimes double the linear hysteresis. But for higher values, the rotatory hysteresis gradually becomes the smaller of the two.

[Niethammer, *Wied. Ann.*, No. 9, 1898.]

Corpuscular Theory of Röntgen Rays.—The most popular theory of cathode rays at the present moment is a corpuscular one, while the most popular theory of Röntgen rays is the undulatory or "hedge-firing" theory elaborated by J. J. Thomson and Johnstone Stoney. The Dutch physicists, Vosmaer and Ortt, recently proposed a tentative corpuscular theory of the Röntgen rays, which, however, was somewhat roughly handled on its appearance. Before seeing their Paper B. Walter worked out a theory on very similar lines, which has a large number of considerations to recommend it, so much so, indeed, that its truth appears obvious and palpable at first sight. It consists in supposing that Röntgen rays are discharged cathode particles. It follows at once that they are not deflected by a magnet. After impinging upon the anti-cathode or other body and discharging themselves, the corpuscles are reflected in a diffuse manner and penetrate the walls of the tube. That they are able to do so is not surprising, considering that even the charged cathode particles are capable of penetrating a sheet of aluminium. Besides, since it is known that the ratio of the electric charge of a cathode particle to its mass is about 1,000 times that of the electrolytic charge of a hydrogen ion to its mass, it is evident that we have here to deal with particles much smaller than the electro-chemical ions. The only novelty lies in postulating the possibility of a divorce between the cathode particles and their charges. That Röntgen rays have a superior penetrating power is due to their electric neutrality. A copper bullet would have a greater chance of penetrating a forest of magnets than an iron bullet. The proportionality between absorption and the density of the absorbent is obvious. Ionisation of gases may be considered as a mechanical destruction of gaseous molecules by the impact of swift particles. When these particles are charged, like the cathode particles, the ionisation will be greater, as is indeed found to be the case. Porter's objection that the photographic activity of Röntgen rays is not affected by their transmission through a charged plate deserves consideration, but it is merely negative, and not in any way a crucial test.

[Walter, *Wied. Ann.*, No. 9, 1898.]

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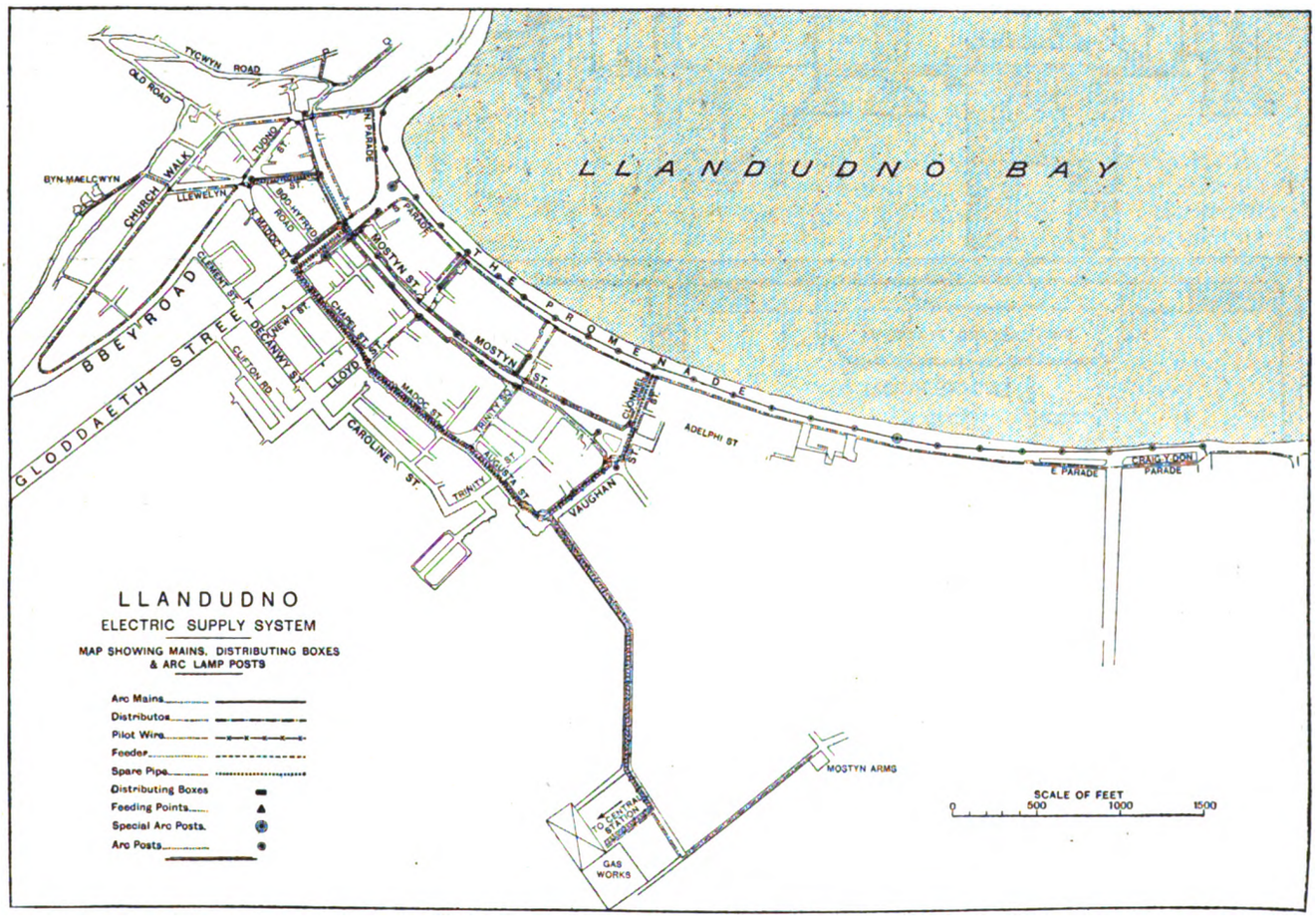
LLANDUDNO MUNICIPAL ELECTRIC SUPPLY WORKS.

The motto "It is never too late to mend" appears to have been the guiding principle of the Llandudno District Council in the matter of providing a system of electrical supply. After having allowed the pier and several of the principal and largest hotels to be lit by independent, isolated electric light plants, and thus, having first cut away a considerable portion of the ground from under their own feet, the local authorities have carried to practical completion a scheme of public lighting and electricity supply, under the able direction of Mr. A. H. Preece, their consulting engineer.

After the extensive and important department of street lighting, there remains principally the work of supplying current for lighting the numerous hotels and boarding houses of that fashionable North Wales watering place, the business custom and motor loads being of quite subsidiary importance. This, of course, may be altered if a now projected scheme should be developed for supplying current to the electric railway which, in a short time, will run through Llandudno. But, at the present time, there seems considerable uncertainty as to whether the Company which will run this line will take current from the local authorities, through whose areas the line will pass, or will merely pay to those local authorities a certain annual sum for permission to generate their own current.

The electric supply works at Llandudno, although not yet officially opened, are practically in a position to run on a load and to supply the already considerable demand for current. The works are situated on a site adjoining the municipal gas works and some distance inland from the town. The accompanying map shows the position of these municipal works relatively to the town and system of mains. The electric supply station has been designed to work in conjunction with a refuse destructor plant, although it is not intended that the generation of steam shall depend entirely upon refuse destruction. There are three Babcock-Wilcox boilers, two of which are fired from Messrs. Beaman and Deas' destructors, the third being arranged only for hand firing; but all three boilers can be fired with coal or coke by hand if required. The location of the station close to the gas works enables coke fuel to be obtained cheaply and conveniently to both the electric light and gas departments, thus reducing the costs of these municipal undertakings.

The Beamen and Deas' refuse destructor is one of the most modern and generally used form of destructor, and has already been erected at numerous works throughout the United Kingdom. The general arrangement of the destructor relatively to the boiler plant is shown in the accompanying longitudinal section of the works. The refuse is carted up an incline to the tipping platform, and tipped direct into the mouth of a hopper about 18in. square, from which it falls down to a firebrick hearth carried on T irons, the hearth being set at an inclination of 52deg. Falling from this the refuse rests upon a fire grate of about 5 sq. ft. area, the firebars of which are of the ordinary stationary type with spaces of about $\frac{3}{32}$in., allowing fine ash to pass through. The gases pass over a firebrick bridge into a combustion chamber whence they pass through a short flue to the front lowermost flue of the Babcock boiler, and then take the usual course through the tube stack to the main flue leading to the economiser. We may add that a full description and account of the working of the Beaman and Deas' destructor is to be found in a recently published work, entitled "The Removal and Disposal of Town Refuse," by Mr. W. H. Maxwell. The Babcock-Wilcox boilers each have 1,741 sq. ft. of heating surface, and 86½ sq. ft. of grate area. Each is constructed in seven sections, each section containing seven tubes 16ft. in length; and there are two steam and water drums 36in. in diameter in each boiler. The boilers work at 150lb. pressure, and are



Map of Llandudno Municipal Electric Supply System, showing positions of Mains, Public Lamps, Distributing Boxes and the Generating Station.

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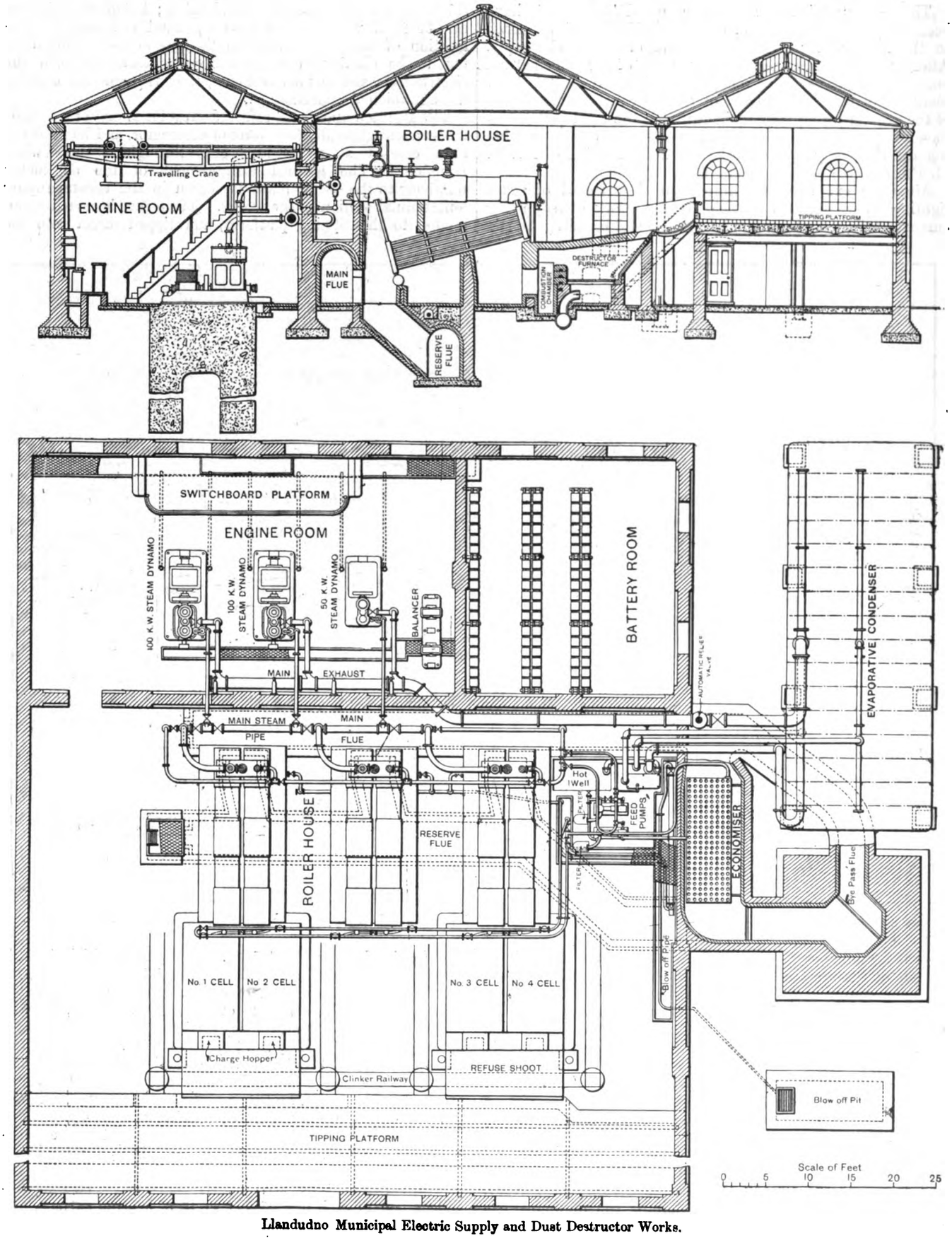
each capable of evaporating 5,000lb. of water per hour. In conjunction with the boiler plant there is a furnace economiser by Messrs. E. Green and Son, consisting of 192 pipes arranged in one group, fitted with deflectors at the back. Adjoining the economiser in the boiler house is a small recess used as a pump room, which is equipped with steam feed pumps by the Blake-Knowles Steam Pump Works, of the type described in our issue last week in connection with the Belfast municipal electric supply works, where they are also used. Immediately outside the boiler room a Ledward evaporative condenser is being erected. This, when completed, will be capable of condensing 7,500lb. of steam per hour. The condenser is of the usual tubular type, and is erected over a large cast-iron tank, having a capacity of 4,000 gallons. The air and circulating



Llandudno Municipal Electric Supply and Dust Destructor Works.

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pumps for the condensing plant are driven direct by a vertical compound engine, this portion of the plant having been built and erected by the Sunderland Forge Co.

The engine room may be entered from the boiler room, and is on the same level. It is at present equipped with two 100-kilowatt steam dynamos and one 50 kilowatt steam dynamo, together with a motor generator for regulation and for charging the batteries. The generating sets were supplied under the contract of the India-Rubber, Gutta-Percha and Tele-

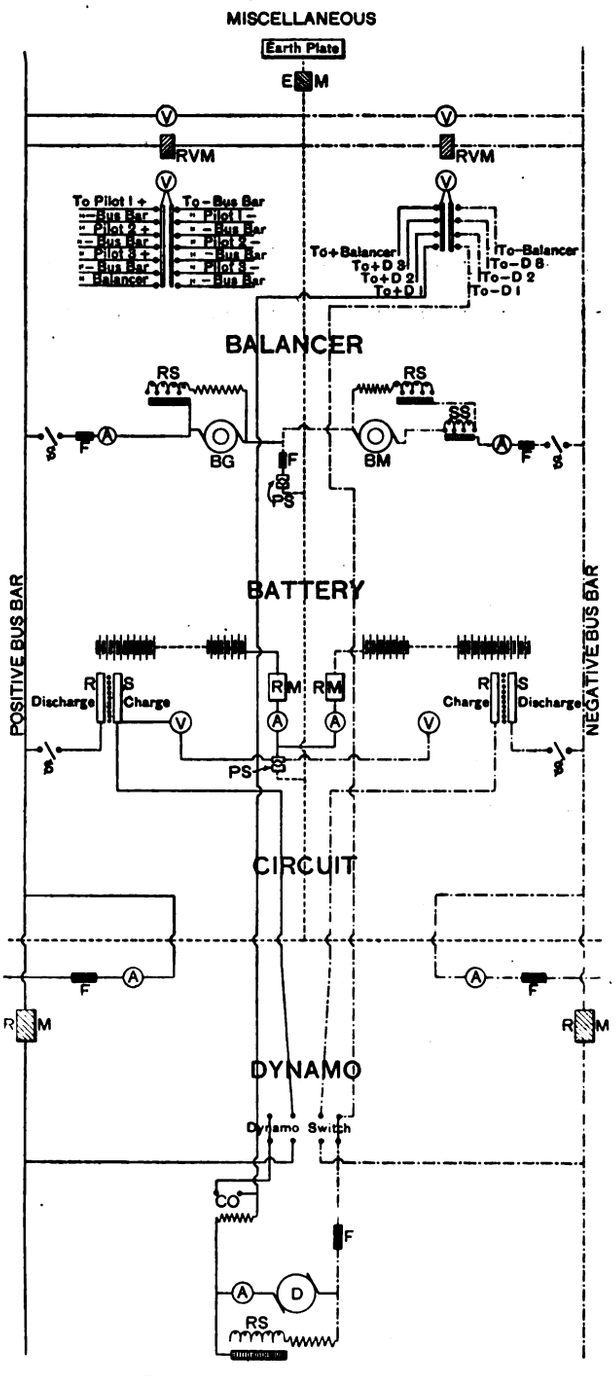

Diagram of Switchboard Connections.

D, Dynamo; F, Fuse; S, Switch; R S, Regulating Switch; A, Ammeter; B G, Balancer Generator; B M, Balancer Motor; P S, Plug Switch; V, Voltmeter; R V M, Recording Voltmeter; R M, Recording Meter; S S, Starting Switch; E M, Earth Meter; C O, Cut-out.

graph Works (Limited), and comprises two Belliss compound two-crank self-lubricating engines of their E. C. 7 standard pattern, each direct-coupled to a "Silvertown" S. D. 220 single horseshoe undertype dynamo with drum-bar armature, each set giving an output of 100 kilowatt at 440 to 500 volts when running at a speed of 450 revolutions per minute, and supplied with steam at 140lb. pressure, the engines being arranged to exhaust either into a condenser or to the atmosphere. There is also a third generating set composed of a Belliss E. C. 4-type engine coupled to a "Silvertown" single horseshoe undertype dynamo with Gramme-wound armature, and capable of giving an output of 50 kilowatt at 600 volts when running at a speed of 550 revolutions per minute. A balancer is provided consisting of two machines mounted on the same bedplate and coupled together, each armature being capable of carrying a current of 100 amperes and working at a voltage varying between 220 and 256 volts, so that it can transfer 25 kilowatt from one side of the three-wire system to the other. These machines are also single horseshoe undertype machines with drum-bar armature, and run at 1,000 revolutions per minute. A small motor has also been fitted for driving the scraper gear of the Green's economiser. Traversing the engine room, there is a small 25ft. span hand-traveller capable of lifting 5 tons, with a vertical lift of 18ft. This traveller was erected by the Sunderland Forge Co.

The switchboard in the engine room is very conveniently erected on a low platform facing the engine sets. It was constructed and equipped by Mr. James White, of Glasgow, and is built on a steel frame erected about 3ft. from the wall. It consists of 14 polished white marble panels screwed to the framework. The left panels serve as a dynamo section, the middle the balancing section, and the right panels a feeder section. The spaces between the panels are filled in with polished teak wood moulding, and surmounting the board is an ornamental frame carrying a self-winding clock, also the feeder and dynamo voltmeters. The back of the switchboard is enclosed, being reached through panel teak wood doors at the sides. Each dynamo panel is fitted with a Kelvin sector pattern ampere gauge, a maximum automatic cut-out and a double-pole change-over switch of the multiple contact knife pattern. Below each of the dynamo panels are the field regulators, the resistances in connection with which are fitted on the wall behind the board. At the top of the middle panel are fitted Kelvin recording voltmeters and two recording ammeters, while below these are the balancing ampere gauges and motor starting and field regulating switches. On the lower middle panel the voltmeter double-pole switches are fitted, while on each of the feeder panels there are mounted two Kelvin sector pattern ampere gauges, one on the positive and one on the negative section, the feeder fuses being mounted directly behind these.

The battery switchboard is mounted on a steel frame in a similar manner to the main board, and carries three polished marble panels. Two of these are provided with regulators for the 30 regulating cells of each of the two batteries, and on the top panel are mounted two Kelvin engine-room voltmeters connected between the middle of each of the "charge" bars of the battery. We may here say that the connections in the battery room from the regulating cells to the regulating board are of copper rod protected with anti-sulphuric enamel, the rods being carried on porcelain insulators fitted on wooden beams supported from the roof. A complete diagram of the switchboard connections for the main and battery switchboards is shown in one of the accompanying illustrations.

The battery room is reached from outside the building, and is a spacious apartment capable of holding considerably more cells than are at present erected. It now contains two batteries for the three-wire system, each battery consisting of 120 cells of 19 plates, in glass boxes, the output being 50 amperes for 10 hours, or 200 amperes for one hour. We may say that the batteries are of the usual type manufactured by Messrs. Pritchetts and Gold, by whom they were supplied for this station.

The feeders coming out from the station to the town are armoured triple concentric cables, manufactured by Messrs. W. T. Henley's Telegraph Works Co. (Limited). These are, of course, buried. The distributors are not triple concentric, but are of the three-core armoured pattern, and are also buried. They are insulated with impregnated fibrous material, lead covered and armoured with steel tape. A certain amount of earthenware conduit has been laid for future distributor extensions, but this at present is not in use. The arc cables consist of 7/16 single armoured cable, insulated with pure and vulcanised india-rubber, lead covered and protected by

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an armouring of steel tape. All the cables were supplied by Messrs. W. T. Henley's Telegraph Works Co.

For the street arc lighting there are altogether 48 arc lamps, erected on cast-iron pillars. The lamps along the front, 30 in number, as well as those on important crossings, are fixed in carriers so arranged that the lamp itself is immediately over the centre of the pole, a canopy being provided to protect it from the weather, and to give a good appearance. The remaining 18 lamps are all fixed along the kerb at the side of the road, and are suspended from overhanging brackets. Three of the pillars are also fitted with double incandescent brackets. The lamps are run in groups from the distributor network, at 440 volts. Each group consists of eight lamps in series. Each of the six circuits is provided with main fuses and a main switch, the switches being so grouped that the total number can be turned on or off from three columns, two controlling switches being placed in each column. The lamps themselves are of the well-known Crompton-Pochin type. They are for single carbons, to burn for 18 hours without re-trimming, and are fitted with opalescent globes. These lamps are similar to those used in Edinburgh and many other important towns. Each lamp is provided with an automatic cut-out, which, in the event of the lamp "hanging-up" from any cause, immediately short-circuits it, so that the other lamps in that particular circuit will not be extinguished, nor will any damage be done to the lamp itself. In the base of each lamp post is fixed an "isolating" switch, which, in the event of any attendant having to do anything to the lamp, can be turned off, thereby entirely disconnecting the lamp from the circuit and bridging the lamp mains to enable the current to pass on to the next post. This arrangement enables a man to examine, or retrim with safety, any particular lamp without disturbing the others. Access to the carbon holders for trimming is obtained by lowering the globes. In the case of the bracket lamps the globes are merely dropped until their weight is taken by a pair of chains, but in the case of the central carrier lamps a rod is provided down which the globe slides. The current for the lamps is 10 amperes, and the height of the arc from the ground level is 20ft. The lamps on the sea front are fixed at distances of about 50 yards apart, but those in the town are a little farther apart, and are so arranged as to distribute the light to the best advantage.

In conclusion we desire to acknowledge our indebtedness to Mr. A. H. Preece, the consulting engineer, and to Mr. H. Morton, the resident engineer, for their valuable assistance in the preparation of this article, and to convey to them our warmest thanks.

A COMBINATION ABSORPTION AND TRANSMISSION DYNAMOMETER FOR LABORATORY PURPOSES.*

BY J. J. FLATHER.

In this Paper Prof. Flather described some recent improvements in his hydraulic transmission dynamometer, the most notable feature being the employment of a water-cooled pulley and a perforated rim which permits the use of a brake band that can be used for absorbing the power furnished to the machine. The fixed pulley which is ordinarily used to connect the dynamometer to the machine to be driven has internal flanges for carrying the cooling water, and the rim is furnished with a number of brass bushings drilled through endwise, and provided with a regulating screw, by which the amount of water admitted to the brake is readily controlled. The brake band is a three-ply cotton belt, 7in. wide, connected through two sets of tension springs to the brake-regulating screw. The brake band may be quickly removed, thus converting the machine into a regular transmission dynamometer. In either case an automatic record is obtained on a roll of paper which is caused to pass with uniform motion under an indicator pencil that records variations of pressure. In addition to the force curve traced by the indicator pencil the zero or datum line is traced by another pencil which is adjustable in position and may be located at pleasure on a line parallel with the axis of the shaft. Thus one is enabled to measure the total power required to run a given machine or any subdivided part of it. The two cylinders through which the driving power is transmitted are each 10 square inches in area and are provided with bronze pistons actuated by plunger pins, which may be located in either of two positions—the inner for ordinary work and the outer for extra heavy work, say, when it is required to measure 20 H.P., or when the speed of rotation is very slow. It will be understood that springs of varying degrees of intensity may be used to transmit the pressure from shaft to indicator pencil. These springs are changed, as in any ordinary indicator. The work of friction of the plunger in the cylinder is practically eliminated, since the combined area of the plungers is so much greater than in the indicator piston, and, as the indicator motion multiplies the distance moved by the indicator piston five times, it will be seen that the motion of the plungers is exceedingly small. The more recent machines are provided with adjustable casters, which permit the weight of the dynamometer to be carried by wheels or to rest firmly on the floor, as desired.

* Abstract of Paper read before Section D of the American Association for the Advancement of Science.

NEW DYNAMOS OF MESSRS. P. R. JACKSON AND CO.

It is now the aim of all dynamo makers to produce a machine which not only has the advantage of sparkless collection—a *sine qua non* nowadays—but also possesses the property of sparkless running at all loads without a change in the position of the brushes being necessary. After a series of experiments, lasting two years, Messrs. P. R. Jackson and Co. have now put on the market machines embodying these features, and even (it is claimed) able to stand considerable overload without an adjustment of the brushes being needed. All the machines are wound on the Sayers system.

Fig. 1 on the opposite page is an illustration of a 150-k.w. Belliss-Jackson steam set. The dynamo is 4-polar. The outer ring, or yoke, of the magnets is of Messrs. Jackson's own special steel, as are also the magnets and pole-pieces. The ring is partially enclosed at the sides with gun metal gratings, which not only afford protection to the field-magnet coils and the armature, but facilitate the work of connecting the magnet coils, and afford considerable support to the pole-pieces. The whole of the pole-pieces are cast and machined together by a special patented method of Messrs. Jacksons, which secures solid metal at the pole tips, and obviates the necessity of annealing the steel. The core is built on a spider, and the shafts are removable. We are also informed that the commutator is built on an entirely new principle. The bearings are of the separator type, and are self-oiling, without loose rings or other such devices. The brush holders are adjustable lengthways on the brush spindle, and there is also screw feed and hold-off adjustment. The springs, which are all of stout flat steel are enclosed in the body of the holder, and can be adjusted to give any desired brush pressure. The brush leads are attached underneath the commutator to two circular collectors. These enable the leads to swing clear of everything to two terminals on the bottom side of the gun-metal gratings. The two main terminals are on the opposite grating, from which point they may be very conveniently connected to the underground or overhead cables.

Fig. 2 is a two-pole machine, with a capacity of 200 kilowatts at 450 revolutions per minute. Three of these dynamos are now running in a large works in Lancashire, where the current frequently varies throughout the full range of the machines. The brushes, which are of copper, are not only absolutely fixed in one position throughout the full variation of the load, but even when it is exceeded by 20 or 30 per cent. Notwithstanding this overload, the dynamos, it is said, run sparklessly and without trouble.

Surface-Box Explosion.—A slight explosion occurred at about 10:30 o'clock on Wednesday morning, at the Bow-street end of Wellington-street. The cover of a pavement surface-box belonging to the Metropolitan Electric Supply Co. was blown 2ft. or 3ft. in the air. No injury was done, and no disturbance to the supply took place, the station staff being in ignorance of the occurrence until word was brought them. The cables to the surface-box are run in lead-jointed iron pipes, and it has not transpired how the gas was fired. Sensational reports of the explosion were published in yesterday's papers, but these were quite inaccurate. Messrs. Callenders are making a trench for mains in close proximity to the spot, and it was no doubt the appearance of the roadway that caused the impression that the explosion had ripped up several feet of it.

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NEW DYNAMOS OF MESSRS. P. R. JACKSON & CO.

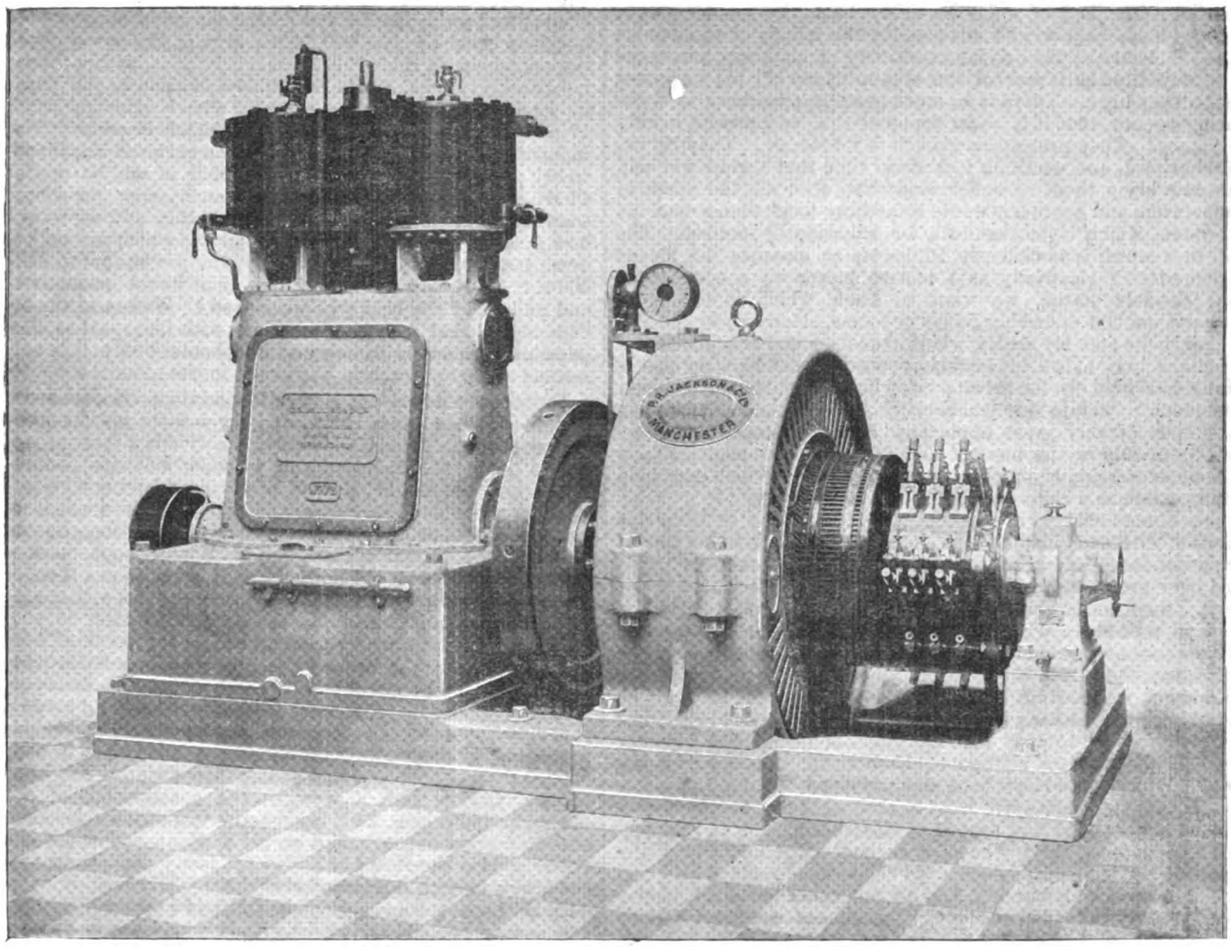

FIG. 1.—150-kilowatt Bellis-Jackson Steam Dynamo.

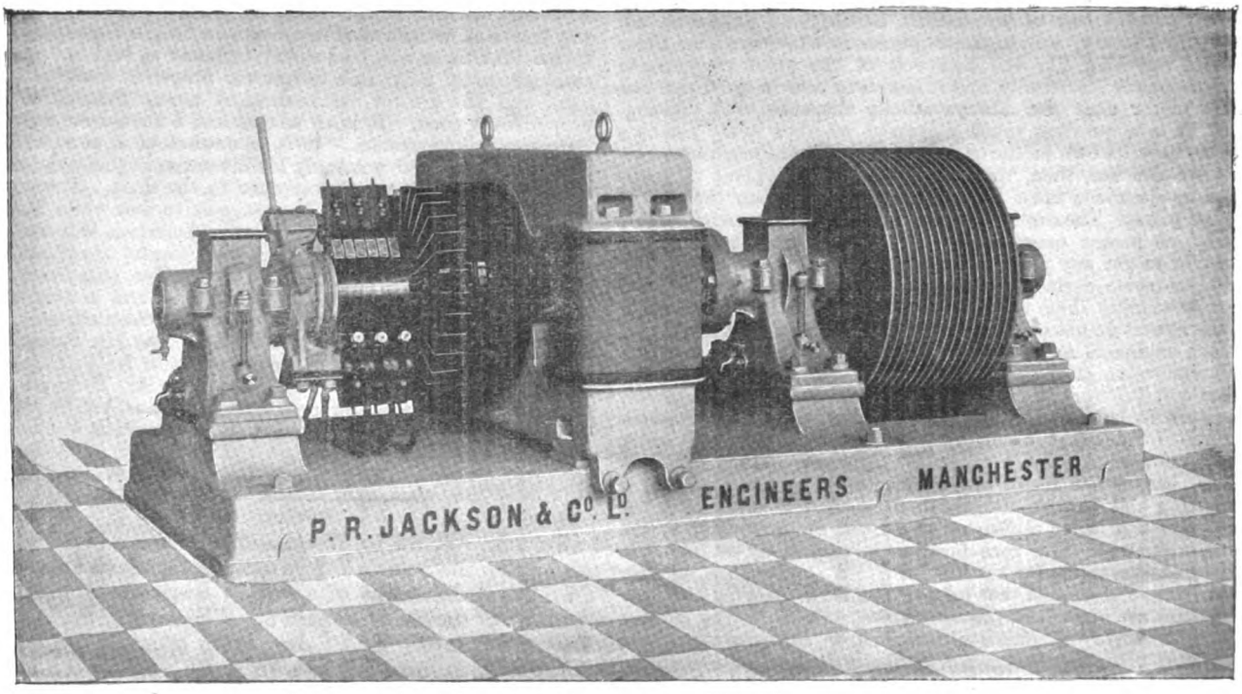

FIG. 2.—Two-pole 200-kilowatt Machine.

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ELECTRIC MOTORS.*

The advocates of electricity as a motive power are at once numerous and influential; perhaps more numerous, however, than influential. The lack of influence arises from the suspicion that those who write papers, and advocate in the course of discussions the use of electricity for driving machinery of all kinds, are more or less prejudiced in favour of the system whose all but universal adoption they urge. There is so much good in electricity as a distributing agency, that it is to be deplored that enthusiasts overdo its advocacy. They protest over much in its favour. They fly too far heavenward, and we think it is about time that a word was said which may bring them to understand that, after all, the world of manufacturers and engineers wants something more than a machine or a system which is mechanically or scientifically perfect. The world, in a word, is sufficiently Philistine to measure the merits and demerits of electricity as a motive power on a commercial basis. Crudely stated, we want to know which is the more economical method of driving lathes or looms, electricity or the old-fashioned belts and lay shafts. Unfortunately this is a species of information that exists in extremely small quantities, or else is carefully treasured up for private use. It is next to impossible at this moment to obtain any trustworthy and complete information on a subject of very great importance; and we confess that we write now mainly in the hope of eliciting some statement of facts and some expression of opinion from our readers which may help others to attain to a right conclusion on the question.

It goes almost without saying that we have nothing to do in this connection with such installations as that at Niagara. Our lack of information does not extend to cases where power has to be transmitted over great distances in order that a huge waterfall may be utilised. Such water plants as those in the United States must be limited in number. We are concerned with much smaller and much more numerous things. A mechanical engineer, for example, requires, say, 300 I.H.P. to drive his shops. They are new shops. Shall he put up shafting and use pulleys and belts, or shall he dispense with the shafting and drive his tools with electric motors? Either will do, and do well. He has only one question to consider—which is the cheaper method of distributing the power of the engine? What are the details of this problem? In the first place, it is clear that the engine will have to be bought and supplied with steam, no matter what the system of distributing the power may be. To begin with, the power must be had. The first cost of the engine will be, let us say, £500. To this must be added the cost of the dynamo or dynamos. We do not think we shall be far wrong if we say that the price of this portion of the plant will be at least equal to that of the engine; we could mention cases in which the dynamo has cost very much more than the engine, but we do not wish to raise difficulties. The cost, then, of engine and dynamo is, say, £1,000. Next we want the motors and the wiring and the switchboard, &c.; these things will cost at least another £500; that is to say, the ultimate first cost of the whole plant will be about equal to that of three steam-engines. On the other side, we must put the cost of lay shafting, belting, and pulleys saved. It will not be easy, we think, to pursuade engineers that these represent anything like the first cost of the plant required to distribute power electrically, and it is well to bear in mind that the electric motor does not always wholly dispense with belting. Indeed, it is a question much discussed whether every machine ought to have its own motor or only every group of machines. So far as we can see, then, the cost of the driving plant in shops worked by electricity must be very much greater than the cost of the usual plant. The capital invested is larger. How much larger, it is by no means easy to say. We have found it practically impossible to get any precise comparative figures. If our readers can adduce some derived from actual practice, they will do good service by sending them to us for publication. It is quite possible that the figures do not exist in an available form. But if they do not, then engineers must remain very much in the dark as to the commercial value of the new system of power distribution. For the first cost is a very important matter, which not only deserves, but is sure to have, the fullest consideration. It may be worth while here to add, that in one case which has come recently under our own knowledge, a leading firm of engineers, adding largely to its shops, has, as the result of a very careful inquiry, resolved to use shafting and belts in its new shops instead of electricity, the first cost of the latter appearing to be out of proportion to the advantage secured. Our own position is very easily stated. We are familiar with most of what has been said and written on electrical driving, and we feel that information is still lacking on many points which are vital. In the first place, writers on the subject are for the most part either electricians or enthusiasts, and in neither case competent to give a perfectly dispassionate opinion. In the second place, comparisons are constantly drawn in favour of electricity, which are based on inadequate or unfair data. Thus we are told that in such and such a shop, the power utilised in running the diverse machinery is not more than 30 per cent. of that given out by the engines, and that the substitution of electricity for shafts and belts has effected a great saving. This is, of course, what we should expect; but it remains to be proved that in modern shops fitted up in the best way, there must of necessity be a waste of 70 per cent., or even half 70 per cent. of the power developed on the engine crank shaft. Electrical driving is, within limits, a great mechanical success. It is mere waste of time in the present year to set about proving that it is. We have quite got beyond that. What we want to know now is how much it costs? We do not require to be told anything about the extreme handiness of electricity; of the convenience with which it can be used here, or there or anywhere. All this and much more we concede; but there must be something to pay for all this, and we want to know how much. Are there any data available which let us know how much less money will have to be spent per annum in distributing 500 H.P. electrically over a factory, than would be needed if belts and pulleys of the best type were used? We say of the best type, because we must compare like things with like; and as all the electrical plant must be in new and in splendid order, it is only fair to assume a like approach to perfection in the older installation.

Engineers who are not electrical specialists are disposed to think that electricians press their advocacy a little too far and without discrimination. The Heilmann locomotive is a case in point. We have a powerful locomotive with its boiler mounted complete on a frame, and the engine, instead of turning driving wheels, turns a dynamo which supplies current to certain motors which cause the rotation of the driving wheels. It is claimed that the steam can be generated on this system, and used with much more economy than is possible with the normal methods; but even if we conceded that the cost of fuel per horse-power hour was less with the Heilmann locomotive than it is with the ordinary locomotive, nothing would be gained, for the simple reason that the cost of working locomotives is never expressed in terms of pounds of coal per horse-power hour, but in terms of pound of coal per train mile. So far as our information extends, the Heilmann engine has entirely broken down in this direction, however successful it may be in other respects. The news of an extension of the Heilmann system comes to us from the United States. We are told that a Mr. Painton has interviewed Messrs. Cramp with a view to the construction of a torpedo destroyer 250ft. long, 24ft. beam and 1,000 tons displacement. She is to be a great improvement on the Turbinia. The defect of that vessel is, that she runs her screws too fast. Mr. Painton gets over the difficulty with the aid of electricity. His boat is to be fitted with De Laval turbines, which will drive 85 tons of dynamos, which will supply current to motors on six screw shafts, each carrying three screws, and making 2,500 revs. per minute. Whether the "85 tons of dynamos" includes the motors or not, we are unable to say. The weight of machinery and ordnance is put down as eight tons. There is no reference made to boilers, which will have to supply 10,000 H P. of steam. The guaranteed speed of the boat is 40 knots. According to a correspondent of the *Globe*, Mr. Edwin S. Cramp has said of Mr. Painton's boat:—"Is not only in every way feasible, but a decided improvement on the Turbinia. It seems to me that there will be decided economy in fuel and steam, the employment of a dynamo to run the propeller shafts is a decided gain, and the greater distribution of power through six sets of propellers is good. It is an adaptation, I should suppose, of the Parsons turbine system. It is somewhat of a wonder that Mr. Parsons himself did not apply his invention in this way instead of directing his turbine power at once to the shaft. There must be less vibratory movement." It is suggestive that while Mr. Cramp admits that he would like to see the American Government try some experiments for Mr. Painton, he is careful to explain that his own firm does nothing in that way. For ourselves, we are audacious enough to say that to use dynamos and motors simply to reduce the speed of the shaft of a steam turbine sufficiently to suit a screw propellor is absurd; and we hold that Mr. Parsons knows what is and is not right in marine propulsion far better than Mr. Painton. We do not wish to imply that Mr. Painton's scheme finds favour in the eyes of reponsible electricians, but we feel certain that an expression of their opinion on such matters would be some service just now.

* From The *Engineer*.

Students' Visits to Works.—The October number of the *Bulletin* of the Société Internationale des Electricians contains an illustrated account of a trip to Switzerland made by the students of the Ecole Supérieure d'Electricité during the last Easter holidays. Eight days were spent in Switzerland, during which time no less than 18 works were inspected. The report is compiled from notes collected by the students themselves.

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CORRESPONDENCE.

SHOREDITCH DUST DESTRUCTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am at a loss to understand Mr. T. W. Baker's attack upon the above scheme, especially when viewed in the light of the fact that Mr. Baker submitted a scheme to our Vestry for dust destruction, in conjunction with the electric light, in 1893; but the Vestry, with but few dissentients, rejected it. Is it a bid for cheap notoriety? Or is Mr. Baker's criticism the justification of his own scheme, for he states, "I do not infer, or wish to be understood, that all dust destructors are, or will be, financial failures?" Or is it the outcome of his chagrin that a more successful engineer should be in the happy position of being the first to successfully instal an electric light and dust destruction combined scheme?

Your contemporary *London*, having facts at their disposal, cleverly answers this attack in their last issue, for it must be known to you, Sir, that, as well as in your journal, Mr. Baker's letter appears simultaneously in *London*, the *Contract Journal*, the *Electrical Engineer*, *Lightning*, and the *Hackney Express* of this week, and no doubt there are more to follow; and I am put to the trouble, for the benefit of the many who are desirous of knowing the truth of our scheme, to reply to this attack.

As *London* points out, the basis of Mr. Baker's calculations of financial results falls to the ground in the face of the fact that he has taken our Vestry's financial reports, which only give accounts up to March this year, and is based upon a 12 months' expenditure with a nine months' income, the first quarter of which is invariably a heavy loss to any undertaking. Mr. Baker very ably connects the two schemes, the sale of electricity and the destruction of dust, and asks which is correct, the Vestry clerk's stated profit of £1,268. 17s. 9d., or Mr. Baker's supposed total loss of £1,522. 16s. 7d. Well, I emphatically state not Mr. Baker, and the Vestry clerk is correct so far as he goes, but from my point of view he does not go far enough. I will state here, and within the course of a few weeks justify my statement, as my committee's report on this matter will shortly be before the Vestry, and when it has passed that Board it can be made public. On our combined scheme we made a profit in the first year's working, after making all allowances, of £2,000 net.

This is as emphatic as I can put it, although probably Mr. Baker will again say "I note no amount for depreciation is allowed." I sincerely hope there never will be, because it must be remembered that we are paying back something like £5,000 per annum interest and capital on these undertakings, which means that in 30 years the dust destructor and electric lighting station will become a valuable freehold asset. That being so, where is the need of depreciation with the maintenance charges included in our estimates year by year. Further, I might add, as *London* reminds me, that the London County Council have practically verified the figures I have given you. Their valuer, in valuing us for assessment, went fully into these figures and based our assessment upon a profit of £1,800.

I cannot, without violating my position as Chairman of this Committee, give you details of the Scavenging Committee's figures, but they will all be included in the report I have mentioned, which I know is being anxiously awaited throughout the whole country, and which I venture again to say will give the satisfaction that this phenomenal scheme deserves.—Yours, &c.,

H. E. KERSHAW,
Chairman of Electric Lighting Committee.

Shoreditch Vestry, Oct. 24, 1898.

[We have also received a letter from Mr. H. Mansfield Robinson, the solicitor and clerk to the Shoreditch Vestry, covering to some extent the same ground as Mr. Kershaw's communication. He states, in addition:—"Mr. Baker's case consists of showing that the figures in my report (p. 2) do not harmonise with the surveyor's report and the electricity and destructor accounts. My statement that the 'destructor has also succeeded in destroying the whole of the dust in this parish, and *more besides*, up to a total of 18,842 tons *in nine months*' (p. 2) is not inconsistent, as Mr. Baker suggests, with the surveyor's statement at p. 188, that '*during the year*' 18,878 tons were collected by the scavenging department, as the latter figures refer only to the refuse of Shoreditch, whereas my figures expressly include 'more besides,' such as parish refuse from St. Luke's and trade refuse from the City sent to the destructor and not collected by the scavenging department at all. Again, my figures as to the coal burned were expressly stated to be for nine months, and were taken from the revenue account (p. 361), whereas the conflicting figures at pp. 350 and 323 of the accounts are headed in large type as 'accounts from March 25, 1897, to March 25, 1898,' and Mr. Baker, as an engineer, ought to know that it takes many weeks slow firing to prepare a destructor and make tests, &c., before steam raising can be attempted. He makes the same mistake in the dust destructor maintenance cost by comparing my figures for nine months with those for a year in the accounts. . . . The increase in the stokers' wages over the contractor's estimate is due to the Vestry adopting three shifts of eight hours each in place of the two shifts of 12 hours each, which were reckoned by the contractors." . . .—ED. *E.*]

LEGAL INTELLIGENCE.

The following causes are entered for trial at the Royal Courts of Justice during the present sittings:—

CHANCERY FINAL APPEALS.

Vestry of St. Mary, Battersea, v. *the County of London and Brush Provincial Electric Lighting Co.* (*Limited*).—Appeal of defendants from the order of Sir Francis Jeune, dated April 21, 1898.

Mica Insulator Co. v. *the Electrical Co.* (*Limited*).—Appeal of plaintiff Company from order of Mr. Justice Kekewich, dated June 30, 1898.

Castner-Kellner Alkali Co. (*Limited*) v. *the Commercial Development Corporation* (*Limited*).—Appeal of defendants from the order of Mr. Justice Bigham, dated Aug. 3, 1898.

QUEEN'S BENCH—FINAL APPEALS.

National Telephone Co. (*Limited*) v. *the Commissioners of Inland Revenue*.—Appeal of the Telephone Company from the judgment of Divisional Court, dated Dec. 14, 1897.

CROWN PAPER (Divisional Court).

Holliday v. *the National Telephone Co.*—Defendants' appeal from decision of Judge of the City of London Court.

CHANCERY DIVISION.

Before Mr. Justice North.—*Bristol Tramways Carriage Co.* (*Limited*) v. *the National Telephone Co.* (*Limited*). Cause for trial without witnesses.

Before Mr. Justice Stirling.—*National Co. for Distribution of Electricity, &c.*, v. *Gibbs*. Action and counter-claim with witnesses.

Before Mr. Justice Kekewich.—*Holophane* (*Limited*) v. *O. Bernd and Co.* (*Limited*). Witness action.

Holland v. *Chelsea Electricity Supply Co.* (*Limited*).—Action without pleadings.

Apostoloff v. *The Apostoloff Automatic Telephone, &c., Co.* (*Limited*).—Action with witnesses.

QUEEN'S BENCH DIVISION (Non-Juries).

Russell v. the London Electric Omnibus Co. (*Limited*).—Contract.

New Telephone Co. (*Limited*) *v. City of London Electric Lighting Co.* (*Limited*).—Contract.

Pearson v. Wilson Hartnell.

In the Leeds County Court, Mr. Reginald Hewitt Pearson sued Mr. Wilson Hartnell, electrical engineer, Leeds, under the Employers' Liability Act, to recover £210. 12s. damages and compensation for an accident alleged to have been due to negligence of defendant's foreman. It appeared that plaintiff was taken into defendant's service on Feb. 3, 1897, on the understanding that he was not to be bound apprentice, and that he was to receive no wages for the first three months, but 5s. a week after that period. On June 3, in this year, he was called upon by a foreman named Broughton to assist in removing an armature on to a trolley. In lifting the heavy piece of iron, the rope slipped at Broughton's end, and two of the plaintiff's fingers were crushed, one of them being permanently disabled. It was maintained by plaintiff that the lifting should have been done by means of the Goliath crane, which was adapted for heavy work. On plaintiff subsequently applying for compensation, he received a letter from the manager disputing liability on the ground that he "was not a member of the working class," that his position was not that of a serious workman, that he had had no premium to pay and had been employed as an improver, and certainly had not been retained for any useful service he had rendered. A statutory defence was set up to the effect that plaintiff had not given notice to the defendant of the accident within six weeks of the occurrence pursuant to the provisions of the Employers' Liability Act. His Honour held that sufficient notice had been given, and that if it had not been sufficient he had power to amend it. The further hearing was then adjourned.

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POLICE INTELLIGENCE.

At Bow-street (London) Police Court, on Monday, John Limbrey Higgs, of Delahay-street, Westminster, appeared to a summons charging him with committing perjury during an examination in respect to the affairs of the I.E.S. Accumulator Co.

Mr. Avory, for the prosecution, said defendant appeared during recent years to have been engaged in company promoting, and was now charged with having committed wilful and corrupt perjury in his examination in respect to the affairs of the I.E.S. Accumulator Co., in swearing that a mortgage deed, secured to a Mr. John Walton, for £1,200, dated May 9, 1894, had been paid off and satisfied prior to Aug., 1895. This mortgage related to a licence to work the Theryc-Oblasser accumulator patent. In Dec., 1893, defendant agreed to purchase this licence for £2,000, and in the following January promoted a company (the Universal Electrical Lighting Co.) to obtain the purchase money and work the patent. Only £1,200 was subscribed to this company, and defendant accordingly mortgaged the licence to Mr. Walton for a second £1,200. The licence was not assigned to the company, but in June, 1895, defendant entered into an agreement with Mr. Mann, as trustee for a new company, to buy this licence for £2,000. This company (the I.E.S. Accumulator Co.) was duly formed, with defendant and his father-in-law as two of the directors. The purchase of this patent did not appear on the prospectus, but at a board meeting in July, 1895, at which defendant was present, the directors agreed to acquire the patent, and to pay him £2,000 for it, and this sum was actually paid to him by cheques in 1896. In 1897 the company was in difficulties, and in Oct. called an extraordinary meeting to consider voluntary winding-up. Some of the shareholders opposed this motion, saying that certain practices had come to their knowledge which required fuller investigation, but the voting power of the directors was sufficient to get the motion carried. In March, 1898, however, an order was obtained for the examination of defendant and other directors of the company, and then defendant, being obliged to admit the mortgage of 1894, in order to justify his subsequent sale of the licence, swore that the mortgage was paid off before Aug., 1895. As a fact, the mortgage was not paid off until Oct., 1897, when defendant found the money because he was moving to have a receiving order against him rescinded, and to satisfy the registrar that he had paid all his debts he had to produce this mortgage and the receipt, dated Oct., 1897, so that he had made two conflicting statements.

At this stage the hearing was adjourned for a fortnight, Mr. Denniss, who represented the defendant, announcing that he should be prepared to prove that defendant had not received from the company the £2,000 purchase money for this patent.

At Exmouth on Wednesday Ernest James Thomas, *alias* Ward Thomas, described as an electrical engineer, of Laira, Plymouth, late of Exeter, was charged on remand with obtaining goods by false pretences from various firms, including the Telegraph Manufacturing Co., Helsby, and the Gandy Belt Manufacturing Co. Mr. Beale, who prosecuted, stated that the prisoner had sent out headed note paper to various firms wrongfully representing himself to be carrying on a genuine business. On the head of some of these letters he described his firm as the Western Counties Electrical Co., Barbican, Plymouth. Prisoner also wrote from Drayton House, Plymouth. In most of the letters the goods were asked to be sent on at earliest convenience. William Teglio said he was lessee of some stores on the Barbican, Plymouth, one of which was rented by the prisoner at a yearly sum of £10, but witness had not received his rent. William Furze, 3, Alderney-terrace, Plymouth, deposed to renting a store in Commercial-road, and directly over the one occupied by prisoner. The only business he ever saw carried on at prisoner's store was the cleaning of a dirty brass bracket. On the door was tacked a card bearing the words "Western Counties Electrical Company," and on another "All letters should be thrown over the door." Witness had seen prisoner frequently there, and had also seen railway vans bring a deal of goods, but they were never taken into the stores. Where they were taken to he did not know. Several witnesses proved the delivery of leather belting at the Exmouth Hotel in September, and subsequent delivery to prisoner. When apprehended at Laira, prisoner said: "Is that all; I can stand that like a man. I suppose it will be just the same as on the last occasion. I can plead under the Debtors' Act." Prisoner having been committed to the Assizes in respect to the charges in which the Gandy Belt Co. were concerned, evidence as to obtaining goods from two other firms was taken, and on both these charges the Bench committed prisoner to the Assizes. The remaining charges were heard yesterday (Thursday).

Lamp-holders for Meter-less Consumers.—In some districts small consumers whose quarterly bills for electrical energy could not support the burden of a meter rental are charged a fixed price per lamp per annum. The charge can take account of the possibility of exceedingly long burning-hours, but not of the honesty-factor of the consumers, the temptation to put in lamps of higher candle-power than those contracted for being very great. At Kingston, we believe, this difficulty was overcome by using locked holders, but a French firm of manufacturers has found a neater solution. The lamp-caps and holders are made on the bayonet principle, but with three pins and slots instead of two. These are placed in different relative positions for lamps of various candle-powers, so that only the lamp of the right size will fit the holder supplied for it.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. The Author hopes that, besides Telegraph and Telephone Engineers, it may, perhaps, also prove of service to those in charge of cables for the transmission of light and power. The localisation of faults has been very fully investigated, including the different degrees in which the various methods are affected by the presence of a second fault or of general leakage.—*Extract from Preface.* Demy 8vo, fully illustrated. 10s. 6d., post free; abroad 11s.

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d.

"The Students' Guide to Submarine Cable Testing."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition ready in November.*

"Practical Notes for Electrical Students."—By Messrs. A. E Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"Laboratory Notes and Forms."—With the above title we have ready the New Edition of a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves."—By Dr. O. J. Lodge, with many original illustrations. *Enlarged Edition*, 2s. 6d. net, 2s. 9d. post free.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"The Manufacture of Electric Light Carbons."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated. price 1s. 6d.; post free, 1s. 9d.

"The Bibliography of X-Ray Literature and Research, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. Prospectus on application.

"Electrical Engineering Formulæ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. A fine large paper edition with wide margins for notes can also be supplied. Price 12s. 6d.; post free, 13s.; abroad, 13s. 6d. *New Edition in the press.*

"The Alternate Current Transformer," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *New Edition.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"The Electrician" Primers.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth 2s. 9d. Single Primers, 3d. each, post free.

"Electromagnetic Theory."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s. *Nearly ready.*

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"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free; abroad 13s. 6d. Prospectus post free.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System o Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s. post free; abroad, 6s. 6d. Digest post free.

"ARMATURE WINDINGS OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"THE MANUFACTURE OF CARBONS FOR ALL ELECTRICAL PURPOSES."—By Francis Jehl. *In the Press.*

"THE ELECTRIC ARC."—By Mrs. Ayrton. *In the Press.*

"SECONDARY BATTERIES, THEIR DESIGN AND MANUFACTURE."—By E. J. Wade. *In the Press.*

"PRACTICAL TELEPHONY."—By Dane Sinclair and F. C. Raphael. *In the Press.*

"PRIMARY BATTERIES: THEIR CONSTRUCTION AND USE."—By W. R. Cooper. *In the Press.*

"'THE ELECTRICIAN' WIREMAN'S POCKET-BOOK."—*In the Press.*

"The Electrician" Electrical Trades' Directory and Handbook.—An important announcement in connection with the 1899 issue of the "Big Blue Book" will be found in an advertisement on another page of the present issue, to which our readers will please refer.

TENDERS INVITED.

The Electric Lighting committee of the *Salford* Corporation invite tenders for the supply and erection of the following: (1) boilers, (2) engines, (3) dynamos, (4) boiler feed-pumps, (5) mechanical stokers, (6) superheaters, (7) economisers, (8) condensers, &c., (9) steam and water pipes, (10) cranes and weighing machines, (11) tanks, &c., (12) switchboards, and (13) booster. Further particulars are given in an advertisement in another column, and specifications, forms of tender, &c., may be obtained from the borough electrical engineer (Mr. C. L. Turner), Walness-road, Broughton. Tenders, addressed to the chairman of the Electricity committee, must be delivered at the offices of the town clerk (Mr. Samuel Brown), Town Hall, Salford, by Dec. 1.

The Electric Lighting committee of the borough of *Middlesbro'* require tenders for the supply and erection of the following plant:—(*a*) Lancashire boilers and accessories, mechanical stokers, feed pumps, injector, economiser and electric motor; (*b*) slow speed steam dynamos and accessories; (*c*) condensing plant and pipe work; (*d*) overhead travelling crane; (*e*) switchboard and instruments; (*f*) accumulators; (*g*) trenching, cables, &c.; (*h*) meters. Further particulars are set out in an advertisement in another column. Specifications, &c., may be obtained at the offices of Mr. R. Hammond, consulting engineer to the Council, 64, Victoria-street, Westminster, S.W., after Nov. 2. Tenders to the town clerk (Mr. Geo. Bainbridge), Municipal Buildings, Middlesbro', by Tuesday, Nov. 29.

The *Redditch* District Council invite proposals for the wiring of premises on the hire-purchase or deferred-payment system. Further particulars are set out in our advertisement columns, and tenders are to be addressed to Mr. J. A. McMullen, M.I.E.E., consulting electrical engineer, Hornchurch, Essex.

The *Hornsey* District Council invite tenders for the supply and erection of electric lighting plant at the Council's central public library, Tottenham-lane, Hornsey. Specification, &c., can be obtained of Mr. E. J. Lovegrove, engineer to the Council. Further information is contained in an advertisement elsewhere, and tenders must be deposited with the clerk (Mr. F. D. Askey), Southwood-lane, Highgate, London, N., by 4 p.m. of Monday, Nov. 7.

The *Hornsey* District Council also invite tenders for the supply of 1,500 cast-iron telephone pipes and 30 telephone pit covers. Tenders to the clerk by Nov. 7.

The Corporation of *Barrow-in-Furness* invite tenders for the supply and erection of cast-iron lamp columns, arc and incandescent lamps, automatic switches and fittings. Some further particulars will be found in an advertisement elsewhere, and specifications, &c., can be obtained from the Municipal Offices, Barrow-in-Furness, or from Messrs. Kincaid, Waller and Manville, engineers to the Corporation, 29, Great George-street, Westminster, London. Tenders must be sent in to Mr. C. F. Preston, town clerk, Municipal Offices, Barrow-in-Furness, before noon of Monday, Nov. 14.

The *Belfast* Harbour Commissioners require tenders for the supply of nine iron lattice-built electric light masts, 70ft. high from the ground lines with suitable base. An advertisement on another page gives further particulars. Tenders must be sent in to Mr. W. A. Currie, secretary, Harbour Office, Belfast, not later than Monday, Nov. 14.

The *Edinburgh* Corporation invite tenders for the following plant for their electric lighting station in McDonald-road—(1) Marine type boilers and mechanical stokers, (2) engines and dynamos. The engines must be of the Willans or Belliss type. Tenders to the offices of the town clerk (Mr. Thomas Hunter), Town Hall, Edinburgh, by Nov. 14.

The *Sunderland* Corporation require tenders for an electric motor for pump driving. Tenders to the town clerk by 31st inst.

The *Leatherhead* District Council invite offers from engineers and others who are willing to take over their Electric Lighting Order (1898). Offers to Mr. W. J. Hodges, Council Offices, Leatherhead, by Nov. 21.

Tenders are invited for the supply and fixing of two engines and dynamos at the *Southampton* County Lunatic Asylum, Knowle, near Fareham. Tenders to Mr. John R. Wyatt, Knowle, by Nov. 16.

Tenders are required by the *Wimbledon* District Council for the supply, delivery and erection of transformers and accessories. Tenders to Mr. W. H. Whitfield, Wimbledon, by 5 p.m. Nov. 7.

The *East Indian Railway Co.*, Nicholas-lane, London, E.C., are about to introduce electrically-controlled block instruments on their system, and invite proposals for the supply of 18 instruments for nine blocks (for single line); 80 instruments for 41 stations (for double line), and six spare instruments. Tenders to the secretary by 1 p.m. of Nov. 23.

The Paving and Highways committee of the *Manchester* Corporation require tenders for the laying of a system of underground telephone pipes, &c. Tenders by 5 p.m. Nov. 8.

The Electricity committee of the *Nottingham* Corporation require tenders for the erection of a new electricity station. Tenders to town clerk by Nov. 4.

The *Harrogate* Corporation require tenders for supplying 18 cast-iron arc lamp-poles, with carriers. Tenders to the electrical engineer, Harrogate.

The Electric Lighting committee of the *Morecambe* District Council require tenders for supplying one Lancashire boiler, one 180 kilowatt continuous-current dynamo, three switch panels, two 40 kilowatt continuous-current transformers, long-range switches, short-circuiting switches, &c. Tenders to electricity works, Morecambe, by 31st inst.

The *Toronto* Board of Control require tenders for electric lighting plant, including (1) engine equipment, (2) countershafts and pulleys, (3) belting, (4) boilers, (5) feed pumps, (6) water and steam piping, (7) fuel economisers, (8) dynamos and station electrical apparatus, (9) arc lamps, (10) mast arms and lamp attachments, (11) poles and overhead circuits, and (12) conduits and cables. Plans, &c., from city engineer, and tenders to Board of Control, City Hall, Toronto, by noon of Nov. 9.

The *Spanish* Post and Telegraph authorities invite tenders for the concession to establish and work a telephone exchange in Cuenca. Tenders to La Direccion General de Correos y Telegrafos, Madrid, by Nov. 8.

Tenders are invited until Nov. 8 by the *Roumanian* Post and Telegraph authorities, Bucharest, for the supply of 16,000 porcelain insulators and 60 tons of 2mm. galvanised steel wire.

The *French* Post and Telegraph authorities invite tenders until Nov. 8 for the supply of four lots of telephone cable, and until Nov. 10 for 50 kilometres of paper insulated electric cable and 46 kilometres of gutta-percha-insulated cable. Tenders to le Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

TENDERS RECEIVED AND ACCEPTED.

The tender of Messrs. Victor Coates and Co. has been accepted by the *Belfast* Corporation for the supply of an additional mechanical stoker for the electricity supply works.

The *Bexhill-on-Sea* District Council have accepted the following tenders for the supply of electric lighting plant:—

R. Hornsby and Sons (water-tube boilers)	£1,748 10 0
W. H. Allen, Son and Co. (steam dynamo and balancer)	2,570 0 0
Chloride Electrical Storage Syndicate (storage battery)	1,020 0 0
British Insulated Wire Co. (underground cables and pipes)	5,958 0 0
British Insulated Wire Co. (arc lamps and posts)	665 15 6

The contract for the switchboard, for which eight tenders were submitted, has not yet been let. Twelve tenders in all were received for the boiler contract, 13 for the storage battery, 16 for the steam dynamo and balancer, seven for the cables, and eight for the arc lamps and posts.

The *Dewsbury* Town Council have accepted the tender of the Callender Co. for supplying an electric light cable at £1,396.

Tenders for wiring work usually display a remarkable difference between the highest and lowest amounts, but that this peculiarity is not confined to wiring tenders will be seen from the following:—The *Plymouth* Town Council have accepted the tender of the Newton Electrical Works for the supply of a 10 B.H.P. enclosed (ironclad) continuous-current motor, at £88. 15s. 6d. Sixteen tenders, varying from £88. 15s. 6d. to £205, were submitted.

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The Works committee of the *Hull* Corporation have accepted the following tenders for the electric tramways department :—

Westinghouse Electric Co. (45 motor cars, each to carry 51 passengers), at £582 per car.

Siemens Bros. and Co. (20 double-deck trail cars, to carry 52 passengers), at £195 and £210 per car.

Westinghouse Electric Co. (two sprinkling cars), at £336 per car.

J. Carrick and Sons (overhead crane), at £228.

The committee have selected the Brill truck ; 30 of the motor cars are to be fitted with chilled iron wheels, at a reduction of £10 ; and the car bodies are to be divided amongst the different makes specified, in the proportion of Brush 30, Milnes 10 and Brill 5. The accepted tender is at £522. 10s. for Brush bodies, £536 for Milnes bodies and £586 for Brill bodies, the motors in all cases being made by the Westinghouse Co. In the case of the trailer cars, the committee recommend that, if Messrs. Siemens Bros. and Co. do not object to supply trailer cars without motor cars, their tender be accepted for ten by the Electric Railway Carriage Co., and ten by Messrs. Milnes and Co. Failing this arrangement, they recommend that the Westinghouse Co.'s tender be accepted for 20 Milnes' cars. Messrs. Siemens Bros.' tender was at £195 for cars built by the Electric Railway Carriage Co. and £210 for Milnes' cars. The Westinghouse Co.'s tender was at £215. As to the tenders for five open trailer cars, none of the designs submitted seemed to meet the committee's requirements, and the acceptance of the tenders for these and for the traversing platforms has been deferred.

The *Gloucester* City Council have accepted the tender of Messrs. John Gurney and Son for the erection of electricity station buildings, at £5,750.

The Tramways committee of the *Bradford* Town Council have accepted the tender of the Westinghouse Electric Co. for the supply of eight new motor cars and that of the Brush Co. for the supply of four trailer cars at £238 each.

The *Dundee* Town Council have accepted the tender of the Callender Co. for the supply of feeder mains at £1,374.

The *Bolton* Corporation have accepted the following tenders for electric tramway and lighting purposes :—

Mather and Platt (two 1,000 H.P. engines, two 600-k.w. generators, and two 25-k.w. boosters)	£14,905	0
Mather and Platt (two 500 H.P. engines, two 200-k.w. generators, and two 12-k.w. boosters)	8,886	0
British Insulated Wire Co. (mains for lighting)	3,640	0
British Insulated Wire Co. (feeders for tramways)	16,980	0
British Thomson-Houston Co. (overhead equipment, bonding and switchboard)	32,821	0
British Thomson-Houston Co. (switchboard for lighting)	976	15
Musgrave and Co. (boiler)	795	0

APPOINTMENTS VACANT AND FILLED.

The London County Council invite applications for the position of chief officer of tramways. Salary £1,500 per annum. Applications to the clerk, County Hall, Spring-gardens, S.W., by 10 a.m., Nov. 14.

The Shoreditch Vestry require a clerk of works to supervise the erection of a new battery room, boiler house, &c., at their electricity supply works. Salary £3. 3s. per week. Applications to vestry clerk, Town Hall, Old-street, London, E.C.

The Salford Corporation require a switchboard attendant. Wages 34s. per week. Applications to the electrical engineer (Mr. C. L. Turner), electricity works, Walness-road, Salford. See advertisement.

Messrs. Thomas Richardson and Son, Hartlepool, require a wireman for general wiring and repairing work. See advertisement.

Agents are required by Messrs. W. M. Still and Co., of 24, Charles-street, Hatton Garden, London, E.C., for the sale of the "Still" incandescent electric lamp in all parts of England. See advertisement.

Agents in this country are required by M. A. Larnaude for the sale of incandescent lamps of his manufacture. See advertisement.

Mr. T. H. Harvey has been appointed London traveller for the Johnson and Phillips Electric Cable Works, in the place of Mr. McKrell, whose connection with the firm ceased on 31st ult.

Mr. C. H. Robinson, of Oldham, has been appointed assistant at the electricity station at Dewsbury.

BUSINESS NOTICES.

The partnership hitherto existing between Leslie Miller and Maurice W. Woods, trading as Miller and Woods, manufacturing electricians, 2, Gray's Inn-road, Holborn, London, has been dissolved by mutual consent. Mr. Woods continues to trade at the above address as Woods and Co. Mr. Miller has taken premises at 93, Hatton-garden, E.C. The circular announcing the dissolution states that all debts owing by the firm have been settled, and that the outstanding accounts can be paid to either of the parties.

Owing to increased demand for the company's manufacture of telephones, the General Electric Co. have found it necessary to extend their premises by the addition of No. 92, Queen Victoria-street, London, where a special telephone department has been created, and where a large stock of telephones and telephone accessories will be kept. A considerable addition has also been made to the works at Manchester. The company point out that, while they do not undertake the installation of telephones, clients will receive all possible assistance to enable them to tender for telephonic installation work.

Mr. Henry Lyon, lately with D. Stewart and Co. (Limited), has commenced business in partnership with Mr. J. B. T. Crosbie, as consulting electrical and refrigerating engineers, at 240, Hope-street, Glasgow.

The address of the English Varley Duplex Magnet Co. (Limited) has been changed from the Strand to Lodge-lane, Derby.

Mr. Henry Edmunds has removed his offices from 39, Victoria-street, to 2, Queen Anne's-gate, Westminster, London, S.W.

We are informed that Mr. Claude W. Hill has resigned his position as manager to the Phœnix Dynamo Co. of Bradford.

BANKRUPTCIES, LIQUIDATIONS, &c.

Mr. Serge Berditschewsky Apostoloff, electrical engineer, 5, Fenchurch-street, E.C., and 25, Coniger-road, Fulham, S.W., London, has executed a deed of arrangement, with liabilities amounting to £5,540. 1s. 6d., and assets estimated to produce £14,785. 4s. 7d. The trustee is Mr. W. B. Keene, 3, Church-court, Old Jewry, E.C.

The statement of the liquidation of the Morecambe Electric Light and Power Co. shows that the receipts since the meeting in Feb., 1896, amounted to £3,423, the principal item being £2,718 from the Council for plant and undertaking. Expenditure amounted to £3,422, leaving a balance of 17s. 9d. The holders of debenture bonds, "A" series, will be paid in full, absorbing £2,052 ; and "B" series 3s. 5½d. in the £. No assets are available for either unsecured creditors or ordinary shareholders.

Claims against the London Metallurgical Co. (Limited) must be in by Nov. 7. Mr. J. D. S. Bogle, 91-93, Palmerston-buildings, London, E.C., is liquidator.

Claims against Geo. F. Rogers, electrical engineer, 41, Maxilla-gardens, Notting Hill, W., and 9, Great Winchester-street, E.C., London, must be sent to the trustee (Mr. E. B. Lumb), 85, Grace-church-street, London, E.C., by Nov. 7.

Messrs. Donald Enock and Eric C. Enock, electrical and general engineers, Coombe Works, Dartmouth, have executed a deed of arrangement. The liabilities are returned at £1,759. 1s. 9d., assets £1,990. 6s. 3d. Mr. A. G. Davey, Torquay, is trustee.

At the London Bankruptcy Court the public examination of J. Condict, company promoter and director, Broad-street House, E.C., has been held. Liabilities £31,314, assets of uncertain value. For many years prior to 1890 debtor carried on business in the United States as an engineer and contractor, but in that year came to London with a capital of £20,000, and became engaged in the promotion of companies. He acquired an interest in the London Electric Omnibus Co. (Limited) and other companies. Creditors treated as partly secured held shares to the nominal value of £52,126 in the Omnibus Co. Failure attributed to heavy depreciation in the value of these and other shares. Examination concluded.

A meeting of the creditors of Charles Henry Kitching, 20, St. Hilda-street, and carrying on business at 172, Beverley-road, and 42, Chariot-street, Hull, as electrical engineer and plumber, was held on Friday, at the offices of the official receiver. Debtor returns his gross liabilities at £3,296. 19s. 4d., expected to rank £2,284. 17s., assets £1,365. 13s. 10d., leaving a deficiency of £919. 3s. 2d. Failure attributed to want of capital and bad debts. Commenced business, trading under his own name and also as the City Electric Lighting Works, in March, 1896, with £200 borrowed capital. A committee of inspection was appointed.

Sale by Tender.—Notice is given in an advertisement on another page by Mr. J. H. Thornton, the liquidator of the National Company for the Distribution of Electricity by Secondary Generators (Limited), of the sale by tender of certain patents for secondary generators belonging to the said company, particulars of which will be found in the advertisement. Tenders have to be sent in to Mr. Thornton, 2, Warwick-street, Regent-street, London, W., by 12 noon of Monday, Nov. 28.

Sale by Auction.—Messrs. Henry W. Figg and Son, of 37, Upper Thames-street, London, E.C., will sell by auction on the premises, 48, Commercial-street, Whitechapel, London, E., on Wednesday next, Nov. 2, at one o'clock, the stock in trade and electrical fittings of J. Goodman and Co. (in liquidation). Some further particulars will be found in an advertisement on another page.

Personal.—We are informed that Mr. Slater Lewis, engineer and general manager to Messrs. P. R. Jackson and Co., will shortly pre-

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sent a Paper on the subject of dynamo design to the Institution of Civil Engineers.

Instrument Catalogue.—Sig. C. Olivetti, of Ivrea (Italy), forwards a price list of electrical instruments. We notice two galvanometers on the moving coil principle of novel design, and a candle lantern for use with a celluloid transparent scale. Sig. Olivetti also supplies a Daniel cell with an arrangement for decantering off the acid when the battery is not in use, and makes a speciality of hot wire ammeters and voltmeters.

Insulated Wire and Cables Catalogue.—The past few years have witnessed a great improvement in the supply of textual matter in the price lists and catalogues of the leading makers of electrical plant, apparatus and materials, and the up-to-date manufacturer is no longer satisfied to leave the buyer of his goods in ignorance of the special features of his own particular make of electrical specialities. This feature is well shown in trade lists which have recently come under review in our columns, and a catalogue just to hand from Messrs. Connolly Bros. (Limited), of Blackley, Manchester, emphasises the point. The descriptive matter of the catalogue has been re-arranged and great care has been taken, in compiling the list, to give just the information required in as clear a form as possible for easy reference without any superfluous matter. Attention is called to the conspicuous success which has attended the placing on the market of "Blackley" tape, which, it is claimed, has earned a world-wide reputation. The information given covers the entire range of regular makes of electric wires and cables.

Machinery Catalogue.—The Southgate Enginering Co., of New Southgate, near London, forward a neatly-printed machinery catalogue, showing illustrations of lathes and other plant for turning and finishing projectiles. At a time when war is so much in the air the catalogue is opportune.

"Trades' Unionism Rampant."—Upon this subject we have received the following letter from Messrs. Calvert and Co., which must, so far as we are concerned, terminate the dispute :—

"TO THE EDITOR OF THE ELECTRICIAN.

"SIR: We cannot allow the letter of Mr. Sims in your last issue to remain unchallenged. Mr. Sims, in his former letter, said we were paying our men 22s. to 30s. per week, now he admits we are paying them the union rate of 9d. per hour, which means 39s. at 52 hours per week. This is Mr. Sims' first misstatement. Further Mr. Sims says that after certain of our men joined the union 'Messrs. Calvert refused to allow them to start because they were members, so that Messrs. Calvert have only themselves to blame for any delay that may occur.' This statement is absolutely false, and a man in Mr. Sims' responsible position ought to make it his duty to get at the facts of a case before making public misstatements, and causing unnecessary bad feeling all round.

"The facts are as follows: Mr. Rowbotham, the builder, was told by his bricklayers, &c., that they would strike unless Calvert's electrical workmen joined the union. We had no objection to our men joining the union, or to employ union men, having several in our employ at the present time; but we would not agree to bind ourselves to carry out the Bethnal Green contract under union tyranny (for reasons given below), and Mr. Rowbotham then shut our men out of the building.

"We again applied for admission, but were refused, and on leaving the works met some of our men, amongst others one named Fisher, who informed us that he and two others out of six skilled wiremen had joined the union. Our manager on the work (Mr. McInnes) informed him that unfortunately we were shut out, but he would try to find him another job. This is a very different tale to our refusing to allow the men to commence because they had joined the Union. This is Mr. Sims' second misstatement.

"Allow me [the writer is Mr. James Calvert] to take this opportunity of personally stating that I have always been a strong defender of Trade Unionism; but I hold that when it is demanded that I shall pay a fully skilled painter £2 a week to brush a little shellac on a piece of casing which can be quite as well done by a 15-year old boy getting 6s. a week, then Trades Unionism becomes gross tyranny."

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Oct. 19 to Oct. 25, with the ports of destination :—

Argentina—Buenos Ayres, £56. *Australasia*—Adelaide, £12; Albany, £121; Brisbane, £53 (telegraph wire); Melbourne, £296 (telegraph material); Otago, £51; Sydney, £50; Wellington, £2,710. *Belgium*—Ostend, £30. *Canada*—Santos (B.C.), £120. *Ceylon*—Colombo, £53. *China*—Shanghai, £314; Tientsin, £741 (telegraph material). *Denmark*—Copenhagen, £400. *Ecuador*—Limon, £12. *France*—Marseilles, £19. *Germany*—Bremen, £240; Hamburg, £654. *Holland*—Amsterdam, £10; Rotterdam, £4,498. *Hong Kong*, £1,025. *India*—Bombay, £105; Calcutta, £657; Madras, £19. *Japan*—Yokohama, £1,645 (telegraph material). *Madeira*—£122. *Russia*—Batoum, £50; Odessa, £70 (telegraph material); St. Petersburg, £175. *South Africa*—Cape Town, £176; Durban, £192; East London, £100. *Spain*—Malaga, £22. *Straits Settlements*—Singapore, £25. *Sweden*—Gothenburg, £256; Stockholm, £1,216 (including £792 telegraph material). *West Indies*—Trinidad, £36. Total £16,331, against £29,112 in the corresponding week last year (Oct. 20 to 26).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Amsterdam.—The Municipal Council have decided to undertake the working of the city tramways as from Jan. 1, 1900, the date of the expiry of the concession of the Amsterdam Omnibus Co., whose dividend for 1897 amounted to 9·8 per cent.

Birkenhead.—The Town Council's proposed tramway extension bill was under discussion on Wednesday, and approved. Power for adopting electric traction on the whole of the tramways is being sought.

Bognor.—Electric lighting powers are to be obtained by the District Council, who have retained Messrs. W. T. Chadwin and W. T. Pressland, as consulting engineers, at a fee of 30 guineas. The Council think that by adopting electric light a saving will be effected in the cost of public lighting. It is announced that a syndicate is endeavouring to obtain powers to construct a light (electric) railway between Bognor and Chichester, and it is possible that both schemes may be combined.

Bolton.—The Corporation have let contracts for the electrical equipment of the local tramways and for the extension of the electric lighting undertaking. The scheme is expected to cost nearly £250,000. The overhead trolley system has been decided upon, and 70 cars will be put on the lines, which will equal 30 miles of single track.

Bradford.—A special meeting of the Corporation will be held this (Friday) evening, when a report will be presented by the Gas and Electricity committee recommending that borrowing powers be sought to enable the electricity department to purchase and let on hire electric motors, fittings, &c., and also that two new 300 H.P. steam dynamos be ordered at an estimated cost of £4,000.

Brighton.—The Town Council last week upheld the decision of the General Purposes committee to oppose all schemes for the construction of electric tramways in the town. It was, however, stated that the Council would probably bring forward a scheme of their own next year.

Bristol.—The Constitutional Club, which has been undergoing decoration and repair, is now lighted electrically.

British Chamber of Commerce, Paris.—A lengthy report is just issued by this chamber covering the year 1897. Taking advantage of the occasion of the 25th anniversary of the foundation of the chamber a mass of comparative statistics of Anglo-French trade for the 25 years, 1872-1897, have been prepared and published. Those interested in the trade between France and England will study this volume of over 300 pages closely. There are 13 complete tables on trade, which have been specially drawn up for this report from documents supplied by the French customs.

Bury St. Edmunds.—It is reported that the Local Government Board have declined to receive the deputation recently appointed by the Town Council to urge the Board's sanction to their original electric lighting scheme.

Chelsea (London).—The Vestry are recommended by the Lighting committee to apply for a provisional order for the Kensal Town portion of the parish.

Cheltenham.—The Town Council decided on Monday to apply for a provisional order to extend the electric lighting area so as to include the whole of the borough.

Coatbridge.—Bailie Lavell, the convener of the Lighting committee, announces that he is prepared to propose to the Town Council the advisability of purchasing the undertaking of the Scottish House-to-House Electricity Co., as he believes that the works would be more successful in the hands of the Corporation.

County Council's Regulations as to Outside Lighting.—Last week, the Manufacturers' Section of the London Chamber of Commerce considered the proposed bye-laws of the London County Council for the regulation of lamps over structures overhanging the footway outside the City. It was stated that, if carried out, the regulations would involve considerable expense to shopkeepers and others, without any compensation, and would practically entail the total abolition of outside lighting, the impossibility of effectually displaying goods, increased risk of fire through interior lighting, and the refitting of windows and reconstruction of premises. It was unanimously resolved to call a meeting of the retail members of the Chamber to consider the whole matter, and take such action as was deemed necessary in opposing the Council's proposed bye-laws.

Darjeeling (India).—Complaints are made of what is described as excessive charges for electric current by the municipal authorities of Darjeeling. The cost per unit is said to be 12 annas.

Derby.—The Parliamentary committee have now arranged terms with the local Tramways Company for the purchase of the tram lines in the town. As soon as the undertaking is taken over by the Corporation it is probable that electric traction will be introduced.

Dewsbury.—The Town Council has decided to apply to the Local Government Board for sanction to borrow £9,060 for increasing

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the voltage of their system of electricity supply, for extending the mains into the residential part of the borough and putting down an additional steam dynamo, &c.

Dockyard Lighting.—The Grangemouth Dockyard Co. have decided to adopt electric lighting, and the contract has been placed with Messrs. T. Laurie and Co. About 300 lights, including 14 arcs for outside lighting, will be required.

Dudley.—The Town Council have sanctioned the British Electric Traction Co.'s application for leave to reconstruct the tramway from the depôt in Birmingham-road to the borough boundary at Hart's-hill for electric traction. The Company have practically completed the reconstruction of the line from Brierley-hill to Stourbridge.

Dumfries.—The Town Council resolved on Monday to obtain a provisional order.

Durban.—The directors of the tramways company have agreed to accept the offer of the Corporation for the purchase of the undertaking for £114,000. The Corporation has instructed the borough engineer and the borough electrical engineer (Mr. Hadfield) to proceed to England to investigate the question of electric traction and prepare specifications for converting the whole of the lines.

Ealing.—The equivalent number of 8 c.p. lamps connected to the Council's electric lighting mains is 18,276, and an additional 1,000 are awaiting connection. The capital expenditure to date is £57,803. There was a deficiency on last year's working of £498.

East Barnet.—The District Council have decided to obtain a provisional order.

Farnham.—The District Council have retained Mr. F. J. Warden-Stevens to advise them on the public electric lighting of the district.

Faversham.—The Town Council have decided to place the police station and the residences of the members of the fire brigade into telephonic communication.

Fleetwood.—The contract for the supply and laying of cables and mains for the Fleetwood and District Electric Light and Power Syndicate is being executed by Messrs. Johnson and Phillips. It is reported that the demand for current is satisfactory.

Forthcoming Books.—Our readers may be interested to learn that Messrs. Archibald Constable and Co. will publish early in November "The Life of the late Sir Charles Tilston Bright, C.E., M.P.," wherein is included the story of the first Atlantic cable, the first telegraph to India and the colonies, and the early land telegraphs of the United Kingdom. The book is written by Mr. E. B. Bright and Mr. Charles Bright, F.R.S.E., brother and son respectively of the subject of the memoir. The book, which contains many full page and text illustrations, as well as photogravure plates, maps, charts, &c., will be published in two volumes, demy 8vo. The price, which before publication will be £2. 2s. net, will be raised after the date of publication to £3. 3s. net.

Gateshead-on-Tyne.—The Parliamentary committee of the Corporation presented a report at Wednesday's meeting which stated that an interview had been held with a representative of the Electrical Power Distribution Co., with reference to the company's proposed application for a provisional order. The company were prepared to pay the cost of obtaining an order for the whole of the borough, and the Corporation would be entitled to purchase the undertaking on two years' notice at any time after 10 years at a value to be fixed by independent valuers. The company would be compelled to supply current for street lighting when required at 2d. per unit after the first hour at 7d. The price to private consumers would be 2½ per unit after the first hour at 7d. To consumers in artisans' dwellings or flats current would be supplied at the all-round inclusive price of 6½d. per unit, this price to cover free wiring and meter rent. Current for power purposes would be supplied at 2d. per unit after the first hour at 7d. The system of supply would be low-tension continuous current. The committee recommended the Council to sanction the company's application, and this was agreed to after discussion.

Gravesend-Northfleet Electric Tramways.—The proposals of the Drake and Gorham Electric Power and Traction Co. for the purchase of the local tramways, for the extension of the system, and for the introduction of electric traction, meets with much local favour. Already the Northfleet Council have conditionally approved the scheme, and it is more than probable that the Gravesend Council and other authorities interested will adopt a similar course.

Hampstead (London).—At the end of Sept. there was an equivalent of 71,367 8 c.p. lamps connected to the Vestry's electric lighting mains, an increase of 2,840 for the month.

Hawthorn (Victoria).—Some time ago the Municipal Council advertised for tenders for electric lighting plant, but as there was considerable opposition to the Council engaging in the business of electricity supply a poll of the ratepayers was taken upon the question. This poll has resulted in giving a majority to the opponents of municipalisation, and it is probable that the work will now be undertaken by a company.

Hereford.—The Electric Lighting committee are making investigations into the cost of putting down electric lighting plant. At present, the members seem to favour gas-driven plant, but no decision will be arrived at until reliable estimates for a steam power plant are obtained.

Hill of Howth Tramways.—At Dublin, on Tuesday, Mr. Ryan, C.E., arbitrator for the Board of Works, heard objections to his draft award in respect of the property taken by the Great Northern Railway Co. of Ireland under the powers obtained by them for constructing an electric tramway from Sutton to Howth. The sitting was occupied in hearing evidence on behalf of the objectors.

Hornsey (London).—The District Council have definitely decided not to entertain any proposal from a private company for the supply of electric current in the Hornsey district.

Hospital Lighting.—The electric light is to be installed at the North Eastern Hospital for Children, Goldsmith-row, Hackney-road, London, N.E. The cost of the work is being borne by Mr. C. G. J. Port.

Huddersfield.—There is an equivalent of nearly 50,000 8-c.p. lamps connected to the mains of this station.

Hull.—The Council have adopted the recommendation of the Works committee to oppose the proposal to construct an electric tramway from Hull to Hessle.

Institution of Engineers of the River Plate.—Some time ago Mr. E. Danvers, of Buenos Ayres, took a prominent part in the formulation of a scheme for the establishment of an institution of electrical and mechanical engineers of the River Plate, and on July 11 last a meeting was called for the purpose of drawing up a memorandum of association, rules, &c. It had originally been intended to confine the institution to electrical and mechanical engineers, but as several civil engineers had promised their support it was decided that all members of the engineering profession should be included in the title of the new society, which has therefore been established as the Institution of Engineers of the River Plate. At the meeting, Mr. Danvers submitted the rough draft rules, which were discussed and modified in accordance with the views of the gentlemen assembled, and ultimately Mr. Danvers was requested to submit the corrected rules and articles of association in order that copies might be supplied to the initiators of the movement for final signature. A meeting was held on Sept. 29 to confirm the rules and to elect a council. It is hoped that the institution will form a rallying ground for members of the engineering profession throughout the Plate, and doubtless the movements of the association will have a considerable interest for engineers in all parts of the world.

Islington (London).—A discussion arose at the meeting of the Vestry last week on the cost of public electric lighting. Mr. James thought the time had arrived when the electrical department should consider the question of reducing the cost of current for public lighting. The lamps cost £40 each per annum, which was in excess, he said, of the cost in any other metropolitan parish. Mr. Gordon, chairman of the Electric Lighting committee, said that as the whole question of price was about to be reconsidered, there would probably be a considerable reduction, and he denied that the price charged at Islington was greatly in excess of other parishes.

Kensington (London).—The Electric Lighting committee recommend the Vestry to apply for a provisional order.

Lectures.—A course of 28 lectures on "Elementary Metallurgy" will be given by Mr. W. J. Pope, at the Goldsmith's Institute, New Cross, S.E., on Wednesday evenings at 8.30. The fifth lecture will be given on Wednesday next, Nov. 2. The lectures will be illustrated by experiments, lantern slides, and diagrams.

Lewes.—The transfer of the Lewes provisional order is at present engaging the attention of a committee of the Town Council.

Light Railways.—The Light Railway Commissioners have sanctioned the application of the British Electric Traction Co. for powers to construct a light (electric) railway between Merthyr, Dowlais and Cefn.

The Middleton light (electric) railway scheme, recently sanctioned by the Light Railway Commissioners, came before Sir Courtenay Boyle and Sir Thomas Blomfield for confirmation last week. The promoters are the British Electric Traction Co., and the objectors were the Middleton, Oldham and Rochdale Corporations, who contended that the terms of purchase should be altered so as to approximate to those of the Tramways Act, 1870. In the order of the Light Railway Commissioners the projected lines cannot be bought out under 25 years, and then only on terms which are much less satisfactory from the point of view of the local authorities than those of the Tramways Act. Middleton, which is erecting an electric plant of its own, is desirous of supplying motive power to the new line, and Oldham, it was urged, ought not to be compelled to submit to a few hundreds of yards of line being put down within the borough. The decision of the Board of Trade was, however, reserved.

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London County Council.—At Tuesday's meeting, it was agreed to lend the Islington Vestry £22,500 for use in extending the electricity supply works at Eden-grove. The Finance Committee reported that the Shoreditch Vestry had applied for a loan of £20,539 to defray the cost of the acquisition of land and for the installation of the electric light in the parish, and the committee recommended that £8,200 be granted, and further that the Vestry be notified "that, as they have elected to spread the whole of the initial cost of the proposed additions and extensions of the electric light installation over 42 years, the Council will decline to give its sanction to the raising of any loan to replace any of the plant and machinery which may be necessary during the currency of the loan, and will expect the Vestry to provide for all replacements and renewals required during that period out of a sinking fund to be provided for that purpose or from maintenance account." This report was, however, withdrawn at the request of the chairman of the committee.

Earl Russell has been appointed on the Highways Committee, in the place of Mr. Baker, resigned.

Lye (Stourbridge).—Mr. F. J. Warden-Stevens has been retained to advise the District Council as to the establishment of electricity supply works.

Malakand (India).—Lieut. C. O. Halliday, R.E., has been deputed to consider and report upon the question of establishing electricity supply works on this frontier station.

Malta.—The revenue from the electric light works for 1897 amounted to £9,122 against £346 in 1896. The municipal installation came into operation in Dec., 1896, and the takings in 1897 included £6,947 paid by the Government for street lighting.

Manchester.—Major-Gen. H. D. Crozier held an inquiry on Monday into the application of the City Council to borrow £200,000 for electric light extension purposes. The deputy town clerk (Mr. Hudson) said that the electrical undertaking had been in existence a little over five years. At the present time there was an equivalent of 214,946 8 c.p. lamps connected, and 31,760 lamps waiting to be connected, which they would not be able to connect until plant, which had been authorised by the Local Government Board, and was now being constructed, had come into operation. The charges for electric current were 5d. per unit, or for large consumers 1½d. per unit, and £7 per annum per kilowatt. The Electricity committee had, up to March last, placed to reserve and renewal funds £34,245, and had handed over to the city fund £26,694, making £60,939, which for the period over which it extended was equal to a rate of rather more than a penny in the pound. This success had not resulted in any damage to the gas undertaking, which also belonged to the Corporation. In regard to water and gas supply and other matters there was a community of interest between the city and the surrounding urban districts, and there was a demand that Manchester should supply those districts with current for lighting and also for tram traction. The Corporation obtained parliamentary power in 1897 to meet that demand. In the same session several of the surrounding urban districts applied to the Board of Trade for and obtained provisional orders for supplying the districts with electricity. These districts were Denton, Droylsden, Levenshulme, Moss Side, Stretford and Withington, and all these orders were confirmed by one act. Failsworth, Heaton Norris, Gorton and Audenshaw were now seeking similar powers. The Manchester Corporation had made definite arrangements for supplying electric current to Levenshulme, Moss Side, Withington and Heaton Norris, but as the latter district had not yet got its order it was not possible to take action so far as that township was concerned. The main purpose of the present application had reference to the supply of electricity to Levenshulme, Moss Side and Withington. Negotiations were also pending in respect of other districts, and there was every probability that several of these would want to be supplied by Manchester. The price charged for current in the outside districts would be the same as in the city. The sum now sought to be borrowed was required for works that would be necessary to meet present and prospective demands. It was estimated that £116,558 would be required within the city, £52,332 in the Withington district, £16,002 in Moss side, and £9,400 in Levenshulme. The electrical engineer (Mr. C. H. Wordingham) had set aside a sum of £5,708 for contingencies. Of the £200,000 £7,000 was required for land, and they asked that the repayment of that should be extended over 50 years, and the remainder of the sum to be repaid in 25 years, the term granted in respect of previous applications. Mr. Alderman Lloyd Higginbottom, chairman of the Electricity committee, said that current was first supplied in July, 1893, and they had had extreme difficulty in meeting the demand for electric light and power within the city. Large extensions of plant had been made during the past two or three years, and the demand continued so great that further extensions were absolutely necessary. It was partly to meet these demands that the present borrowing powers were required. In accordance with the terms of the agreements entered into with Moss Side, Levenshulme and Withington, the compulsory streets mentioned in their orders had to be lighted by the Manchester Corporation within two years from Aug. 6, 1897, and, therefore, the necessary feeder and distributing mains and transformer stations should be at once proceeded with in these districts. The Council had instructed the committee to light up a large number of the principal thoroughfares in the city with arc lamps, if possible, during this winter. The expenditure on this item would be £11,500, and this was included in the application. The posts carrying the arc lamps would be about 43yds. apart, placed alternately on opposite sides of the streets. The Corporation, having obtained powers to work the tramways by electricity, had decided that these tramways should be equipped and ready for running in April, 1901, and it was probable that the overhead system of traction would be employed. The posts carrying the arc lamps would be prepared to receive the cross-span trolley wires for the tramcars, so that the work would not have to be done twice over. The provision of the transforming stations and transformers, for which borrowing powers were now sought, would also be applicable for the supply of electricity for the working of the tramcars. The capital expenditure incurred to the close of the financial year to March 31 last was £357,617. When the new 100 H.P. generator, now in course of erection, was completed there would be provision for 220,000 8 c.p. lamps. The following figures showed the extent to which the demand for the current had increased :—

	No. of consumers.	Equivalent 8 c.p. lamps.
December, 1893	289	32,716
December, 1894	624	60,298
December, 1895	1,016	93,290
December, 1896	1,466	133,504
December, 1897	1,869	171,396
October 20, 1898	2,281	214,946

When applicants now waiting for connection had been dealt with the total number of consumers would be 2,411, and the number of equivalent 8 c.p. lamps 246,706. It had been agreed by the committee to recommend the Council to abolish meter rents as from March next. The borough electrical engineer (Mr. C. H. Wordingham) gave full technical details of the propcsed extensions, and the inquiry closed.

At the special meeting of the City Council on Wednesday, the resolution referred to in our issue of Sept. 30, giving notice to the Manchester Carriage and Tramways Co., that the Council propose to acquire by purchase the undertaking of the company, was passed.

Marylebone (London).—Last evening the report of the Electric Lighting committee recommending "That the committee be empowered to enter into preliminary negotiations with the Metropolitan Electric Supply Co. for the purchase of their undertaking in this parish and to report to the Vestry" was discussed. Mr. Brooke Hitching, chairman of the committee, moved the adoption of this report, and said it was a recommendation upon which the committee were unanimously agreed. It was very desirable that the electric light monopoly should be broken, and the committee had done all it could to break that monopoly. The money they had spent in endeavouring to obtain a provisional order had not been lost, for they had wrung concessions from the Metropolitan Company that more than paid the ratepayers. The committee asked for the fight to be continued. Should they be unable to obtain powers for electric lighting, then they could do what other parishes had done, and buy out the company. He maintained that it would be to their advantage to purchase the company's undertaking. Mr. T.W. Baker seconded. Sir Edwin Galsworthy said he thought that Mr. Brooke Hitching was wrong in stating that concessions had been wrung from the company, because he saw that other parishes were to have similar concessions. He would ask the Vestry to mind what they were doing in giving the committee the powers they asked, or they would be landed into a great expense. He questioned whether this Vestry had the power to purchase the company's undertaking, or whether the company could sell to the Vestry. He moved an amendment that the committee be empowered to ascertain if the company is prepared to sell the whole or part of its undertaking to the Vestry, and, if so, on what terms. Mr. E. White seconded. Mr. Brooke Hitching said he hoped the Vestry would not delay. In regard to the powers of the Vestry to purchase, the Board of Trade reserved to itself the power of transferring on terms to vestries. The amendment was declared lost. Mr. Stringer moved another amendment that the question be postponed. Mr. Chick seconded, and said that no person who had a pecuniary interest in the company they were to negotiate with should be on the committee. Mr. Anglin said he would urge Mr. Brooke Hitching either to withdraw from the committee or sell out his shares in the company. Mr. Brooke Hitching said he had disposed of his shares in the company. The amendment was lost, and the committee's recommendation was agreed to.

Motherwell.—The Town Council have adopted the recommendation of Prof. A. B. W. Kennedy to establish electricity supply works at a cost of about £23,000. Current is to be supplied for both public and private lighting. The street lighting is to be effected by 30 arcs and 400 32 c.p. incandescents.

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Oldham.—The Town Council have resolved to promote a bill for powers to work the Oldham tramways and also the lines belonging to Royton, Crompton and Lees, and to adopt electric traction on the entire system.

Pembroke (Dublin).—The Town Council have fixed the charges for current for private lighting at 6d., and for power at 3d. per unit.

Provisional Order Notices.—The Corporations of Ludlow and Kidderminster give official notice of their intention to apply for provisional electric lighting orders.

Queenstown (Cork).—In the *Dublin Gazette* of the 18th, notice is given that the Township Commissioners have transferred their provisional order to the Cork Electric Tramways and Lighting Co. The Commissioners retain the right of purchase.

Rontgen Rays in War.—The ambulance section of the V.B. Royal Warwick regiment lately gave an interesting demonstration of Röntgen ray field practice recently at Ward End, Birmingham. A kind of field hospital was formed, and imaginary patients were manufactured. Bullet and bayonet wounds were assumed, and it was in connection with the former that the Röntgen ray demonstration was particularly successful. A complete portable set of apparatus was supplied by Henry W. Cox (Limited), and this was carried by four men upon a stretcher. Following this came two men, each carrying an accumulator. Two other men had charge of a collapsible developing tent, and the rear was brought up by two men with a box containing photographic films and chemicals for 150 exposures. Bullets were assumed to have struck various parts of the bodies of the "patients," and successful demonstration was made of the efficiency of the apparatus. It was agreed by those who took part in the performance that the application of Röntgen rays to military service had been demonstrated to be of great usefulness.

Runcorn.—Consistency is not the characteristic of the members of the Electric Lighting committee of this town. Some time ago it was decided to apply for a provisional order, but subsequently it was thought that the cost of obtaining the order was too great, and negotiations were opened up with a company which had given notice of its intention to apply for electric lighting powers. The committee have now reverted to the original proposal to themselves apply for an order.

Smoke Nuisance.—The Metropolitan Electric Supply Co. were summoned at Marylebone (London) on Friday by the Paddington Vestry for allowing dense black smoke to issue from the shaft at their Amberley-road station in such quantities as to be a nuisance. After a lengthy hearing Mr. Curtis Bennett inflicted a fine of £5 with £10. 10s. costs.

St. Annes (Lancs.).—This Council is in possession of a provisional order, and the Electric Lighting committee is considering the advisability of carrying out its terms. Three courses have been suggested: (1) To make arrangements with the Corporation of Blackpool to extend their mains to the district; (2) to transfer the order to a company; and (3) to put down an independent installation. It has, however, been decided to first of all consult an engineer.

Stourbridge.—The District Council have decided to apply for a provisional order, and a special committee has been formed to promote the application, with power to engage a consultant.

Telephone Municipalisation.—A deputation from the Manchester City Council, consisting of Alderman Southern, Mr. Brocklehurst, Mr. Copeland and the town clerk (Mr. W. H. Talbot), waited upon the Postmaster-General yesterday (Thursday) to discuss the present condition of the telephone service in Manchester.

At a meeting of the City of London Common Council last week it was resolved to urge upon the Government the extreme desirability of action being taken forthwith to give effect to the recommendations of the House of Commons committee on the telephone service.

The Lord Provost's committee, Edinburgh, has been instructed to report upon the question of obtaining powers to establish a telephone exchange.

The Telephone Users' Association, of Norwich, have sent the following note to the Press:—

"It is evident, from the fact that licences have been granted to Glasgow and Huddersfield, that the Government do not intend to take over the telephones, but to grant licences to municipalities, or to companies under their control, in accordance with the terms of the Treasury Minute of May, 1892. This will entail upon every Corporation anxious to have the control of the telephone exchange the trouble and inconvenience of obtaining a special act of Parliament for its own particular locality. What is wanted now is pressure to be brought upon the Government to bring in a general enabling act, whereby municipalities will be able to immediately take up the telephone business and work it in suitable areas, the extent of which ought to be at once under the consideration of every municipal authority. The chief point that requires the consideration of each town is, what extent of area suits the surrounding neighbourhood."

Telegraph Money Orders to Germany.—The Postmaster-General notifies that on Nov. 1 the telegraph money order system will be extended to Germany. No single order can be issued for more than £10. The sender of an order will be allowed, on paying for the additional words, to add to the official telegram of advice any short communication he may wish to send to the payee.

Wallasey.—In the Improvements bill which the District Council have decided to promote, power is sought to purchase and work the local tramways, and to introduce electric traction.

Weston-super-Mare.—The Lighting committee have practically arrived at an understanding with the Electrical Power Distribution Co. for leasing their provisional order for ten years, after which time the Council can acquire the undertaking on a valuation at twelve months' notice. The Company undertake to lay mains in the whole of the compulsory area and along the sea front within twelve months of the signing of the agreement. For private lighting the charge for current will be 8d. per unit for the first hour and 2d. afterwards, and for public lighting the price will be about 2½d. per unit.

Willesden.—The District Council decided at their last meeting to oppose the application of the Metropolitan Electric Supply Co. for a provisional order. The newly appointed electrical engineer (Mr. E. T. Ruthven Murray) will not be able to take up his duties before the end of December, but in the meantime the committee having charge of electric lighting matters is endeavouring to acquire a site for electricity supply works. The Council have also sent out circulars to builders pointing out the advisability of wiring new houses.

Workhouse Lighting.—The Croydon Guardians have authorised their Electric Lighting committee to consult an electrical engineer as to adopting electric lighting at the workhouse and institutions under the guardians' control.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom all information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

October 7, 1898.

21,125. H. MECHAN and D. MUIRHEAD. Glasgow. Improvements in and relating to the electrical communication of signals.
21,150. E. HUNGERBUHLER. London. Improvements in or connected with electric traction by means of underground conduits.
21,155. J. P. JUVENET. London. Improvements in electrically propelled vehicles. (E. M. de Siblas, France.)
21,165. C. D. ABEL. London. Method of and appliances for exciting alternating current dynamo machines whether acting as generators or as motors. (La Société Anonyme Pour La Transmission de la Force par L'electricité, France.)
21,169. R. HADDAN. London. Improvements in electric batteries. (Columbus Electrizitäts Gesellschaft (Limited Co.), Germany.)
21,171. J. H. BOLL and P. W. PETTER. London. A new or improved construction of electric motor with equational box or compensating differential gear combined.
21,172. C. O. BASTIAN and F. M. STAUNTON. London. A new or improved method and means of electrically operating apparatus such as valves, electrical switches or the like.

October 8, 1898.

21,216. L. LOMBARD-GERIN. Liverpool. An improved trolley for taking electric current applicable to the electric traction of vehicles, boats and the like.*
21,224. E. ROSE and G. VACOTTI. London. Improvements in or relating to electric clocks or watches.*
21,233. J. THORNTON and T. R. CANNING. London. Improvements in apparatus for coating metal articles by electro-deposition.
21,240. F. M. RICHTER. London. An improved telephone call counter.*
21,241. F. M. RICHTER. London. Improvements in telephone switchboards.*

October 10, 1898.

21,248. S. O. COWPER-COLES. London. Improvements in and connected with the electro-deposition of metals.
21,261. T. WARDELL Glasgow. Improvements in electrical ignition apparatus for internal combustion engines.
21,265. T. OXLEY. Manchester. Improvements in certain drums for holding electric cables.*
21,307. S. PITT. London. Improvements in the production of incandescent materials suitable for use in electric lighting. (The Pharmaceutisches Institut Ludwig Wilhelm Gans, Germany.)

October 11, 1898.

21,359. S. L. KILPIN. London. Improvements in and connected with shades or reflectors for electric lamps.
21,364. H. BLUMENBERG, JUN. London. Improvements in battery solutions.

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21,374. E. O. Raster. London. Improvements in rheostats or electric heaters.*
21,394. G. E. B. Eyre, W. H. Spottiswoode, C. A. Spottiswoode and E. J. Passingham. London. Improved press for moulding electrotype matrices.
21,407. A. F. Berry. London. Improvements in dynamo electric machines.
21,410. R. Hutchinson. London. Improvements in controlling switches and apparatus for electric motors.*

October 12, 1898.

21,467. Veritys (Limited) and L. J. Steele. Birmingham. An improved form of alternating-current transformer or economy coil.
21,480. C. A. W. Huttman. London. Improvements in or relating to channels, tubes and wells for underground electric conductors and the like.
21,492. W. S. Simpson. London. Apparatus for generating and utilising electric energy.
21,501. W. L. Wise. London. Improvements in coin-freed electrical apparatus. (E. G. Lochmann and Cie., Germany.)

October 13, 1898.

21,505. F. Roberts. Keighley. Improved device for use in connection with apparatus for the electric haulage of vehicles.
21,524. H. A. Wollaston (of W. Pope and Son) and R. Kennedy. Leeds. Improvements in electro-magnetic variable speed and clutch gearing.
21,550. W. B. Potter. London. Improvements in systems of control for electric motors and railway trains. (Date applied for under Patents, &c., Act, 1883, Sec. 103, March 17, 1898, being date of application in United States.)*
21,551. E. W. Rice, Jun. London. Improvements in controlling electric motors and electrically propelled railway trains. (Date applied for under Patents, &c., Act, 1883, Sec. 103, March 26, 1898, being date of application in United States.)
21,573. C. W. Thompson. London. Improvements in dynamo-electric generators, motors and transformers.

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1897.

17,316. Garcia. Electric accumulators.
24,155. Hatton and W. T. Henley's Telegraph Works Co. (Limited). Joint box for electric cables.
24,156. Hatton and W. T. Henley's Telegraph Works Co. (Limited). Joint box for coupling underground and aerial electrical cables.
24,157. Nichols and W. T. Henley's Telegraph Works Co. (Limited). Clamp connection for electrical conductors.
25,246. Von der Linde. Process for the electrolytic separation of metals.
28,382. Lake (Compagnie de l'Industrie Electrique). Commutator brush carries for electric machines.

1898.

5,068. Wood. Carbon feeding mechanism of electric arc lamps.
13,210. Lundell. Electric heaters.
13,399. Déri. Method of combined application of continuous and alternating currents for exciting magnetic fields and combination apparatus for producing by this method electrical energy and mechanical power.
14,090. Royce and Claremont. Means of lowering the load of cranes or hoists driven by electromotors.
14,732. Déri. Method for obtaining combined alternating and continuous currents and distributing the same for the electrical transmission of power, particularly for electrical traction.
15,222. Lake (Burns). Electric accumulators.
16,155. English Industrials (Limited) and Heyl-Dia. Globes of electric incandescent and similar lamps and lamp shades or chimneys.
16,875. Schattner. Electricity meters.
17,280. Bergmann. Electrically driven fans or ventilating devices.

COMPANIES' MEETINGS AND REPORTS.

Eastern Extension, Australasia and China Telegraph Co. (Limited).

The fiftieth half-yearly ordinary general meeting of this Company was held on Wednesday, the 26th inst., at Winchester House, Old Broad-street, London, the Most Hon. the Marquis of Tweeddale, K.T., presiding.

The MANAGER and SECRETARY (Mr. F. E. Hesse) read the notice calling the meeting, together with the minutes of the forty-ninth half-yearly ordinary general meeting, which were confirmed and signed by the Chairman.

The CHAIRMAN: Gentlemen, before asking you to approve of the motion—

"*That the report and accounts of the directors, now submitted, be received and adopted,*"

I will trouble you with a few observations on the proceedings of the half-year which ended last June. The gross revenue for that period amounted to £277,282, being a decrease of £13,467 as compared with that for the corresponding period of 1897. This will not be regarded, I think, as unsatisfactory when it is borne in mind that the past half-year compares with a period when the China, Japan, and other tariffs were considerably higher and that the political disturbances and cutting of our cables between Hong Kong and Manila and Manila and Panay seriously affected our traffic with the Philippines. From these causes a much larger decrease might have been anticipated, but happily the growth of traffic in other directions has very nearly made up the deficiency (hear, hear). The working and other expenses have amounted to £102,873, being an increase as compared with those for the corresponding period of 1897 of £3,448, which is accounted for by the repairs to cables having been heavier during the past half-year than in the same period of 1897, and also by the opening of the several stations in the Philippine Islands, under an arrangement with the Spanish Government, which was reported at length at our last meeting. The usual interim dividends at the rate of 5 per cent. per annum have been paid for the past half-year, amounting to £62,500, and after transferring £50,000 to the general reserve fund, the sum of £10,723 is carried forward to the next account. During the half-year under review the policy of strengthening the weak portions of the Company's system has been steadily pursued, with the result that the Penang-Sumatra cable has been entirely renewed, the Java-Port Darwin duplicate cable has been renewed to the extent of 135 nautical miles, and 207 nautical miles have been added to the Hong Kong-Manila cable. The cost of this work has been £46,709, the whole of which, as you will have, no doubt, observed from the accounts, has been debited to the general reserve fund. When I last had the pleasure of addressing you, I referred to the dangers and privations to which our staff was exposed in the Philippine Islands, owing, in the first instance, to the native rebellion, and afterwards to the hostilities which broke out between Spain and the United States. This latter event rendered the position of our staff, as you may easily imagine, a very delicate one, and this dangerous condition of things lasted for several months; but I am happy to say that although much damage was done to the property, both public and private, connected with our establishments there, no lives were lost, and I do not think that any personal injury was sustained beyond the great privation which was suffered by our employés. When the peace preliminaries were concluded we were able to make a very satisfactory arrangement with the two Governments under which both the Hong Kong-Manila and the Manila-Panay cables were reopened on a neutral basis, so that the Company are now working at Manila direct with the public, instead of through the medium of the Spanish officials, as heretofore. (Hear, hear.) Unfortunately, the political situation is still unsettled, and further fighting was reported a few days ago in the neighbourhood of our Tuburan station, in the island of Cebu. I may mention that the courage and devotion to duty displayed by the Company's staff during the earlier troubles at Cape Bolinao have been specially recognised by the Spanish Government by the granting of suitable decorations to the officers concerned (cheers); and I cannot myself personally refrain from expressing my admiration of the conduct of Mr. Herbert Jones, our superintendent, and his subordinates during the extremely trying times through which they have passed (applause). The time will, I hope, come when we shall be able to recognise from this side of the table the services they have rendered during this period (hear, hear). The Company's claim against the Government of the United States of America for compensation in respect of the loss and damage sustained through the cutting of the Manila cables has not yet been admitted, and the Government appears to be under the impression that the repair of the Hong Kong cable was effected by their own officials. This, however, was not the case, as the repair was temporarily made by the Company's staff with the assistance of an American tug boat, but it was permanently effected within a few days afterwards by our own steamer, the "Recorder." I have on more than one occasion referred to the probability of the establishment of cable communication in the Pacific. The occupation of the Philippines by the United States has undoubtedly given a stimulus to efforts having this object in view. As far, however, as we know, nothing definite has yet been arranged, and all I can say with respect to this matter is that we are carefully watching developments in that direction, and I think you may rely upon it that we are taking steps to protect your interests in every possible way (applause). With these observations I beg to ask you to adopt the report and accounts now submitted.

Mr. FRANCIS AUGUSTUS BEVAN seconded the resolution, which was carried unanimously.

Mr. JOHN NEWTON afterwards proposed a vote of thanks to the chairman and directors, and remarked that the way in which the Company had been managed in the past should give the shareholders confidence with reference to the future.

A SHAREHOLDER seconded the motion, which was carried unanimously.

The CHAIRMAN acknowledged the vote and the proceedings then terminated.

Brazilian Submarine Telegraph Co. (Limited).

The fiftieth ordinary general meeting of this Company was held at Winchester House, Old Broad-street, London, on Wednesday, under the presidency of Mr. J. Denison Pender.

The SECRETARY (Mr. E. Steer Hodson) read the notice convening the meeting, and the report of the directors was taken as read.

The CHAIRMAN said: Gentlemen, the income for the half-year ended June 30, 1898, amounted to £103,689; for the previous half-year it was £100,300, showing an increase of £3,389 resulting from the following increases:—£1,964 in message receipts, £1,420 in dividends onshares in other telegraph companies, and the small sum of £5 from bank interest, &c. Taking the expenditure side of the account, we find that the total expenditure for the half-year is £21,474, and that for the previous half-year was £26,166. There is, therefore, a decrease of £4,692; but this decrease, as I have often explained to you,

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gentlemen, is entirely a question of repairs or no repairs to cables. In the previous half-year there was a sum of £5,725 spent on repairs of cables, but in the half-year ended June last we were fortunately free from any such expense. Increases are apparent in the following expenditures:—In London of £351 and at stations of £834, making a total of £1,185, but there is a small decrease under other items amounting to £152. Therefore a net increase is left of £1,033, which, deducted from the £5,725 I have referred to, leaves the net decrease in the half-year £4,692, as I have previously mentioned. I have before me the details of the increases and decreases, but I think I need not go further into them unless you wish it. After payment of £3,200 for debenture interest and sinking fund, and providing for the payment of income tax, there is a credit balance on the half-year's business of £77,301. To this is added £8,662, the balance brought forward from December 31st, making together £85,963. The usual interim dividend for the March quarter, amounting to £19,500, has been paid, and £25,000 transferred to the reserve fund. The directors now recommend the declaration of a final dividend of 3s. per share making, with the interim dividends, a total dividend of 6 per cent. for the year, and also the payment of a bonus of 2s. per share, both free of income tax, which together will amount to £32,500, leaving a balance of £8,963 to be carried forward. With respect to the condition of the cables, the Lisbon-Madeira No. 1 cable previously referred to as faulty continues to work satisfactorily, therefore no attempt to remove the fault will be made so long as the cable performs its work. The Madeira-St. Vincent No. 2 cable is falling in capacity, and it seems probable that at an early date steps will have to be taken to have the fault removed. That will be an expensive matter, because the cable is lying in deep water—very likely, considerably over 2,000 fathoms; and although we constantly see in the papers that these depths can be easily dealt with and the cables easily handled, our experience is that, although they can be repaired as a certainty, it is very often a very long and costly job to do. Gentlemen, this deals really with the Brazilian Submarine Company's accounts as the Brazilian Submarine Company pure and simple for the last time, because next half-year we shall also be taking into consideration the results of the working of the Western and Brazilian Company, in conformity with the arrangement which has been carried out. Therefore what I have said deals with the past, and I will now just say a few words on what has taken place since we last met. You will remember that the last meeting we had was in August—August 11th—for confirming the carrying out of the arrangement entered into with the Western and Brazilian Company. The Western and Brazilian shareholders have sent in their assents to a very much larger amount than was required for the legal majority to carry the arrangement which was entered into by the two Boards; and the result is, gentlemen, you now see, I am glad to say, sitting on the Board of the Brazilian Submarine Co. the directors of the Western and Brazilian Co., Mr. Andrews, Lord Richard H. Browne, Mr. Coppen and Mr. Goodsall, whom I have the pleasure of introducing to you. I may also say, personally, that I am taking the chair here for the last time. The Board considered—and very rightly, too—that Mr. Andrews, who has been for very many years associated with the telegraph world, being the chairman of the Western and Brazilian Co., and very closely associated with the Indo-European Co.—they considered that his seniority as a telegraph director entitled him to take the chair of the joint Board; and I need hardly say that I myself most thoroughly concur with the rest of the directors in that opinion. There is also another reason why it will certainly be to the advantage of the Company that Mr. Andrews should be chairman. Mr. Andrews, as presiding over the Western and Brazilian Co., has naturally had a good deal of intercourse with the Brazilian Government. The cables of the Western Company are laid along the shores of that country, and call in at many of the ports, whereas we only run to Pernambuco. In the arrangement entered into between the two Boards it is very natural that the Brazilian Government might consider, without knowing the facts, that the combination might be disadvantageous to themselves and the public, and, after all, it is their duty to see to such a matter. They might think that it was a combination for the raising of the rates, but I am perfectly certain that directly they see that the gentleman who has been Chairman of the Company closely associated with them has become Chairman of the joint Board, any suspicion—if I may use that word—if there is any, will at once be allayed. I ask you to support Mr. Andrews as Chairman of this Company in the same way that you have always supported whoever has presided at these meetings—a fact which has rendered our meetings a pleasure for the Board to attend and meet the shareholders. Now, with respect to the staff, of course, in the arrangements which have had to be made between the two Companies, the old servants who have grown up in the employment of both, have had to be taken into consideration, and into careful consideration; but the appointments which affect you, the shareholders, perhaps more than any others, are those of the Manager and Secretary. You see in the report that Mr. Axworthy, who has been here since the Brazilian Submarine Company first commenced business, as traffic accountant and general accountant, has been appointed Manager, and it is with very great pleasure that the Directors have placed him in that position. On the other hand, Mr. Hodson, who has been brought up in a very good school (he began in the Eastern, then went to the Brazilian Submarine, and then to the Western and Brazilian, and has spent the whole of his commercial life in the telegraph service), has been appointed, I am glad to say, Secretary to the Company. But in carrying out these arrangements, especially with the Secretary, there is one name which all those shareholders who have watched the progress and have read the reports of the Brazilian Submarine Company will notice as being omitted from the outside sheet of our report on this occasion—I refer to the late Secretary, Mr. Collett. Mr. Collett has been for nearly 26 years the Secretary of the Brazilian Submarine Company, and he has been anxious to retire for the last two or three years. By the directors' desire, however, he remained with the Company to see what would become of the negotiations which were then on the *tapis*, and which since then have been so successfully carried through. Directly that took place Mr. Collett retired from the secretaryship of the Company, and I am sure that there is not a shareholder in the Company who will not endorse the action of the directors in giving Mr. Collett, as they have done, a pension of £500 a year for his honourable and most faithful service to the Company during 26 years. Now I think I have given you a good deal of detail, and you must not forget that this is the fourth meeting we have held during the last six months. The first one was the usual half-yearly meeting; the second was the meeting at which the agreements were brought forward; the third was the meeting to confirm those agreements, and make them legal; and the fourth we are present at to-day. I therefore think that the shareholders and directors who have attended these meetings have at any rate done their duty towards the Company. I will now propose the resolution, but will anyone who has any question to put, or who wishes for further information, ask me now? After a pause, and no shareholder rising to address the meeting, he continued: Gentlemen, there appear to be no questions to ask, and I will therefore now move the following resolution:—

"*That the report of the directors and the accounts to June 30, 1898, now submitted, be approved and adopted, and that a dividend be now declared of 3s. a share, making with the interim dividends already paid a total dividend of 6 per cent. for the year, and also a bonus of 2s. a share, making in the aggregate a distribution of 7 per cent. in respect of the profits for the year ended June 30, 1898, the said dividend and bonus to be respectively free of income tax.*"

Mr. FREDERICK YOULE seconded the motion, which was carried unanimously.

The retiring auditors were afterwards re-elected.

The Rev. WILLIAM HICKMAN then proposed a vote of thanks to the chairman and directors for their able and efficient management in the past six months.

Mr. CHARLES H. HOBBS seconded the motion, which was carried unanimously.

The CHAIRMAN briefly acknowledged the vote, and the proceedings then terminated.

NEW COMPANIES, STATUTORY RETURNS, &c.

ELECTRO-SMELTING CO. (LIMITED).—This company was registered on Oct. 22, with a capital of £10,000, in £50 shares, to acquire, sell, dispose of and deal with mines, minerals, mining rights, &c., and to win, reduce and refine ore and mineral substances and precious stones.

GENERAL WATER POWER (LIMITED).—This company was registered on Oct. 22 with a capital of £21,500, in £1 shares (of which 1,500 are Deferred), to produce electricity by means of water power or otherwise, and to carry on the business of electricians and suppliers of electricity. The first subscribers, with one share each, are: P. H. Sainsbury, P. G. Tovey, C. Boyle, H. P. Cousins, C. F. A. Spashett, J. H. McCashen and P. H. Hetherington. The first directors are: Montagu F. Armstrong, John S. Bergheim and the Hon. William Vernon.

NATIONAL CONDUIT AND CABLE CO. (LIMITED).—This company was registered on Oct. 21 with a capital of £1,000, in £1 shares, to construct, lay down, fix and complete, any conduits, cables, wires, lines, accumulators, and works in connection with electric telegraphs, telephones, electric lighting, &c., and to carry on the business of manufacturers of cables and wires for electrical purposes, electrical engineers and contractors, suppliers of electricity, manufacturers of electrical apparatus, &c. The first subscribers (each with one share) are: C. T. C. Price, H. G. Carvall, N. G. Newington, G. J. Jackson, C. W. Barrett, J. H. Bodell and A. Benwell.

TELEPHONIC BELL PUSH SYNDICATE (LIMITED).—This company was registered on Oct. 20 with a capital of £2,000, in £1 shares, to acquire, develop, work and deal with an invention for improvements in telephonic bell pushes, and to enter into an agreement with G. L. Anders and A. J. Wilson, jun. The first subscribers (each with five shares) are: A. J. Wilson, jun., G. L. Anders (electrician), F. M. Robertson, J. King, J. F. Jamieson, L. W. Stanley and F. O. Jerram.

SUNBEAM LAMP CO. (LIMITED).—The annual return to Aug. 19 has been filed. The capital is £25,000, in £10 shares, of which 1,765 shares have been taken up. 857 have been issued as fully paid, and the full amount has been called and paid on the remainder.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Oct. 13, 1898). **Price of silver** 27$\frac{1}{16}$d. **per oz.** (Oct. 27). **Consols** (2$\frac{3}{4}$ **per cent.**) 108$\frac{7}{8}$—109$\frac{1}{8}$ **for money,** 108$\frac{7}{8}$—109$\frac{1}{8}$ **for account; 2$\frac{1}{2}$ per cent.** 103$\frac{1}{2}$—104 (Oct. 27). **Stock Exchange Settling Days: Consols, Nov. 4; Stocks and Shares Continuation Days,** Nov. 9 and 28; **Ticket Days,** Nov. 10 and 29; **Pay Days,** Nov. 11 and 30; **Mining Share Carry-over Days,** Nov. 8 and 26.

AKKUMULATOREN FABRIK AKTIEN-GESELLSCHAFT (BERLIN).—This company has declared a dividend of 10 per cent. for the past year (same rate as in 1896-97).

BARROW-IN-FURNESS TRAMWAYS CO. (LIMITED).—A provisional agreement has been entered into for the sale of this company's under

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taking to the British Electric Traction Co. (Limited), at £22,750, the Corporation of Barrow having, however, the right of refusal to buy at the same price.

CALLENDER'S CABLE AND CONSTRUCTION CO. (LIMITED).—The directors of this company have declared an interim dividend of 5s. on the Ordinary shares (at the rate of 10 per cent. per annum).

CITY OF LONDON ELECTRIC LIGHTING CO. (LIMITED).—The revenue return of this company for supply of electricity only for the quarter ended Sept. 30 is as follows: Gross revenue from sale of current for public lighting £3,196, against £3,146 in the corresponding period of last year; private lighting, &c. (less allowances to customers) £23,705, compared with £21,978; making a total of £26,901, against £25,124, an increase of £1,777. On Sept. 28 there was an equivalent of 334,573 8-c.p. lamps connected, being an increase of 12,873 during the quarter, against an increase of 7,264 in the corresponding quarter of 1897. In the corresponding quarter last year the charges were under the old scale.

FORT WILLIAM ELECTRIC LIGHTING CO. (LIMITED).—A meeting of this company was held recently at Fort William, when the directors recommended a dividend of 2½ per cent. for the year from April 30, 1897, on the original capital of £7,000, and a like dividend on the increased capital of £2,000 from Feb. 1. A balance (£110. 17s.) was carried forward. The managing director (Mr. R. F. Yorke) stated that the plant and mains were in good condition; the number of consumers had considerably increased; the result of the past 18 months' work was considered satisfactory, and better results were anticipated.

MONTEVIDEO TELEPHONE CO. (LIMITED).—The report of the directors of this company for the year ended July 31 states that the accounts show a net profit for the period of £6,827, after providing for all working expenses in Montevideo and London, and writing off amounts for bad debts, depreciation of stock of materials at Montevideo and office furniture. £976 is brought forward, leaving an available balance of £7,803. The value of subscriptions has continued to increase. The expense of removals and repairs of instruments has been considerable during the past year, which accounts for an increase in working expenses at Montevideo. The plant has been kept in efficient repair at the cost of revenue. The directors recommend the payment of the full 5 per cent. on the Preference share capital, absorbing £4,200, and leaving, after placing £1,000 to reserve fund, the sum of £2,603 to be carried forward, sufficient to provide for a dividend upon the Ordinary shares after the promissory notes have been cancelled.

NEW ZEALAND ELECTRICAL SYNDICATE (LIMITED).—The petition to further reduce the capital of this company, which was before the Courts last sittings, has been restored to the list for hearing on next petition day.

NORTH STAFFORDSHIRE TRAMWAYS CO. (LIMITED).—At a meeting of this Company last week, the Chairman (Ald. E. J. Hammersley, J.P.) said that the negotiations with the British Electric Traction Co. for the purchase of their undertaking would be completed in a few days. He was informed that a new company had been registered, and was in process of flotation, for amalgamating the powers which the North Staffordshire Tramways Co. possess, and the powers obtained by the Potteries Extension Co.

ORIENTAL TELEPHONE AND ELECTRIC CO. (LIMITED).—An interim dividend of 4d. per share, free of income-tax, is declared.

STOCK EXCHANGE NOTICE.—The Stock Exchange Committee has ordered the further issue of 7,500 £5 fully paid Ordinary shares (Nos. 22,501 to 30,000) and 7,500 £5 fully paid Six per Cent. Cumulative Preference shares (Nos. 52,501 to 60,000) of Willans and Robinson (Limited) to be quoted in the Official List. The Committee has also been requested to allow the £4,000,000 Ordinary stock of the Eastern Telegraph Co. (Limited) to be quoted in the Official List in lieu of the Ordinary shares now quoted.

TELEGRAPH TO DAWSON CITY.—Mr. J. M. Catton writes to a contemporary that he holds a charter, which received the Royal assent in June last, intituled "An Act to Incorporate the Dawson City and Victoria Telegraph Company." The charter confers the right to lay cable lines from Victoria and to complete the telegraph to Dawson City by land lines. The authorised capital, including debentures, is £525,000, and estimates for construction have already been passed, and the work will be taken in hand and construction commenced immediately.

UNION ELEKTRICITATS GESELLSCHAFT (BERLIN).—At the forthcoming meeting the shareholders will be asked to sanction a proposal to increase the capital from 3 million to 18 million marks (£150,000 to £900,000). The new shares have been entirely taken up by the Ludwig Loewe Co. at 110 per cent. This company offers £150,000 to the old shareholders of the Union Company at 110, and £375,000 to its own shareholders at 135 per cent. The remaining £225,000 will be kept by the Loewe Company, which then will have an interest in the Union Company to the extent of about £275,000.

WESTERN AND BRAZILIAN TELEGRAPH CO. (LIMITED).—This company's traffic receipts for the week ended Oct. 21 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Co., Limited) were £3,404.

WIRELESS TELEGRAPH AND SIGNAL CO. (LIMITED).—An extraordinary general meeting of this company was held at the offices, 28, Mark-lane, London, E.C., on Monday, under the presidency of Mr. H. Jameson Davis, to confirm the resolutions passed at the meeting on the 7th inst., for increasing the capital of the company to £200,000 and for amending the articles of association by giving one vote for every share held, no member to be "entitled to vote in respect of any shares held by him in excess of two-fifths of the issued capital for the time being of the company." The chairman proposed the resolutions, both of which were carried. The chairman, in answer to Mr. Ashton, stated that the offer of the 25,000 new shares would be made to the shareholders who were on the register on Nov. 15. No fractions would be issued. Any shareholder who had odd numbers of shares, and was not entitled to a full complement of the new shares, must buy other shares, or if he had one or two too many, he must sell them. They had been advised that they could not deal in fractions.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
*Birmingham Tramways.	Oct. 22	3,978	+ 300	...	...	...
Blackpool Corporation...	,, 20	202	+ 23	29	14,900	+ 2,178
Blackpool and Fleetwood Co.	,, 22	242	...	15	12,681	...
*Bristol Trams & Carriage	,, 21	2,566	- 47	16	51,055	+ 7,030
City & South London Ry.	,, 23	1,024	+ 54	17	16,277	+ 756
Dover Corporation	,, 22	184	+ 60	29	5,633	...
Dublin United (Southern)	,, 21	648	+ 154	16	16,907	+ 5,172
Liverpool Overhead Rly.	,, 23	1,376	+ 41	17	27,386	+ 2,661
*Sheffield Tramways.....	,, 23	1,088	+ 75	...	...	...
*South Staffs. Trams.....	,, 21	639	- 26	42	26,560	- 289

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price Oct. 19.		Price Wednesday, Oct. 26.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Oct. 26	
			ELECTRICITY SUPPLY COMPANIES.					£ s. d.		Highest	Lowest
6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	10	10⅜	10	10⅞	—	—	..	—
6,000	10	6/3⅞	Do. 4½ per Cent. Cumulative Pref.	10⅜	11⅛	10⅜	11⅛	..	..	..	—
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp. ..	11½	12⅛	11½	12⅛	2 16 0	February & August	..	—
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6¼	6	6½	3 9 3	,, ,,	6 1/16	—
£34,000	5	2/6	Chelsea Electricity Supply Ordinary	8½	9½	8	9	3 6 8	March	8⅜	8⅛
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	113	115	113	115	3 18 3	June and December	—	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red)	103	105	103	105	4 15 3	..	..	..
50,000	10	5/0	City of London Elec. Lighting Ord. 40,001 to 90,000	23	24	23	24	5 4 2	February & August	23⅛	22
10,000	10	1/9	Do. Ordinary 90,001 to 100,000	22½	23½	22½	23½	..	..	22⅝	..
40,000	10	6%	Do. 6% Cumulative Pref.	16	17	15½	16½	3 12 9	January and July ..	16½	15⅞
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	127	132	127	131	3 16 1	June and December	131	130½
30,000	10	..	County of London & Brush Prov. Ord. (fully paid)	12½	13½	12½	13½	—	—	..	..
10,000	10	..	Do. (£8 paid)	10	11	10	11	..	..	10⅝	..
20,000	10	6/0	Do. 6% Cumulative Preference	14½	15½	14½	15½	4 0 0	March & September	—	..
15,660	5	2/6	House-to-House Electric Lighting Supply Ord.	9	10	9	9½	2 7 4	..	9¼	—
12,000	5	3/6	Do. 7 per Cent. Preference	9½	10½	9½	10½	3 6 8	March & September	..	—
15,000	5	10%	Kensington and Knightsbridge Ord.	13½	14½	13	14	3 18 7	..	..	—
10,000	5	6%	Do. 6% 1st Pref.	8	8½	7⅞	8⅛	3 12 9	January and July ..	..	—
111,000	3	..	London Electric Supply Ordinary	3⅝	3⅞	3⅛	3⅜	—	—	—	—
50,000	5	..	Do. Preference	6½	6⅝	6½	6⅝	—	—	..	—
62,400	10	5/0	Metropolitan Electric Supply Ordinary	15	16	15	16	3 2 6	April and October ..	16	15⅝
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	121	117	121	3 14 9	June and December	—	—
6,452	10	6/0	Notting Hill Electric Ordinary	15½	16½	15	16	3 15 0	March	15 1/16	15⅛
275,000	1	..	Rand Electric	⅞	1⅛	⅞	1⅛	—	—	—	—
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb	83	93	88	93	5 8 1	—	—	..
150,000	$100	$2	Royal Electric Company of Montreal Shares ..	155	160	155	160	5 0 0	—	..	—
130,900	100	4½%	* Do. 4½% 1st Mort. Debs.	104	106	104	106	4 5 0	April and October ..	104½	..
31,980	5	5/0	St. James and Pall Mall Electric Ordinary	16½	17½	15½	16½	4 17 0	February & August	16	—
20,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	,, ,,	..	—
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.)	104	107	104	107	3 15 6	June and December	—	—
65,000	5	..	South London Electric Supply Ordinary (£3 paid)	2⅞	3⅛	2⅞	3⅛	..	..	..	..
79,900	5	5/0	Westminster Electric Supply Ordinary	14½	15½	14½	15½	4 3 10	March & September	15½	14½
18,848	5	5%	Yorkshire House-to-House	7⅞	8	7⅞	8	3 2 6	February and July ..	—	—
18,626	5	5%	Do. (£4 paid)	5⅞	6⅛	5⅞	6⅛	3 18 5	February and July ..	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Oct. 19.	Price Wednesday, Oct. 26.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Oct. 26. Highest	Lowest
			TELEGRAPHS			£ s. d.			
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	100 104	100 104	3 17 4	January and July	..	..
25,000	10	..	Amazon Telegraph	6 7	6 7	..	..	..	..
£125,000	100	5%	Do. 5 per Cent. Debentures	92 95	92 95	5 5 3	..	..	..
£905,560	Stock	15/0	Anglo-American	63 66	61 64	4 13 9	Feb., May, Aug., Nov.	..	..
£3,047,220	Stock	30/0	Do. Preferred	113½ 114½	111 112	5 7 2	" "	114½	111
£3,047,220	Stock	..	Do. Deferred	15⅝ 16⅝	13⅜ 14½	..	..	14 15/16	13⅝
180,000	10	3/0	Brazilian Submarine	15½ 16½	15½ 16½	4 6 2	Mar., June, Oct., Dec.	16 1/16	..
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	111 115	111 115	4 8 0	June and December	..	..
10,000,000	$100	$12½	Commercial Cable Capital Stock	180 190	180 190	4 4 3	Jan., Apr., July, Oct.	..	..
£918,297	Stock	4%	* Do. 4 per Cent. Debenture Stock	104 106	104 106	3 15 6	..	105½	..
16,000	10	..	Cuba Submarine Ordinary (Deferred)	8½ 9½	8½ 9½	..	February and August	..	..
6,000	10	..	Do. Preference 10 per Cent.	15½ 16½	15½ 16½	..	..	..	..
12,981	5	2/0	Direct Spanish (Ordinary)	4 5	4 5	4 8 11	April and October	..	..
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10 11	10 11	4 12 10	" "	..	..
£30,000	50	4½%	Do. 4½ per Cent. Debentures	103⅞ 106⅞	104⅞ 107⅞	4 4 8	January and July	..	..
60,710	20	3/0	Direct United States Cable	11½ 12	11½ 11⅝	5 10 8	Jan., Apr., July, Oct.	11 11/16	11⅝
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	101 104	101 104	4 7 5	..	..	..
400,000	10	2/6	Eastern	17⅞ 18½	17½ 17⅞	3 18 11	Jan., Apr., July, Oct.	17⅞	17⅝
£1,295,000	Stock	17/6	Do. 3½ per Cent. Pref. Stock	104 107	104 107	3 5 5	" "	106	104⅛
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	126 130	126 130	3 2 3	May and November	128½	..
£89,900	100	5%	* Do. 5 per Cent. Debentures, 1899	100 103	100 103	4 17 1	February & August	..	..
£500,000	Stock	8/9	Do. Provisional Certificates 50% paid	..	52 55	..	..	..	..
250,000	10	2/6	Eastern Extension	17½ 18	17½ 17⅞	3 18 11	Jan., Apr., July, Oct.	17⅞	17½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125 129	125 129	3 2 4	February & August	..	..
£16,200	100	5%	* Do. 5 p. c. (Austln.Gov. Sub.) Debs. 1900 (reg.)	100 104	100 104	4 16 10	January and July	..	..
£64,400	100	5%	Do. (Bearer)	101 104	101 104	4 16 10	" "	..	..
£35,100	100	5%	*Eastern and S. African 5 p. c. Mor. Deb., 1900 (reg.)	100 104	100 104	4 16 10	" "	..	..
£46,500	100	5%	Do. (Bearer)	101 104	101 104	4 16 10	" "	..	..
£800,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102 105	102 105	3 16 4	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	104⅞ 107⅞	104⅞ 107⅞	3 15 4	May and November	..	..
180,227	10	4/8	Globe Telegraph and Trust	12 12½	12 12½	4 3 8	Jan., Apr., July, Oct.	12½	12½
180,042	10	6%	Do. 6 per Cent. Preference	16⅞ 17½	16⅞ 17½	3 9 7	" "	..	..
150,000	10	5/0	Great Northern of Copenhagen	28½ 29½	28½ 29½	3 7 10	January, April, July	29½	29⅛
£150,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B"	101 104	100 103	4 17 10	March & September	..	..
£97,800	100	4½%	Halifax and Bermuda Cable 4½% 1st Mort. Deb. (red)	101 104	101 104	4 7 0	June and December	..	..
17,000	25	37/6	Indo-European	52 55	52 55	4 10 11	May and November	54½	..
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	109 112	109 112	5 7 7	March & September	..	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red)	105 108	105 108	3 14 3	June and December	..	..
11,889	8	4/0	Reuter's	8 9	7½ 8½	4 14 1	April and October	..	..
3,881	£100 Cert.	6%	Submarine Cables Trust	133 138	133 138	4 6 11	" "	..	..
15,609	10	..	West African Telegraph	3½ 4½	3½ 4½	..	..	..	..
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99 102	99 102	4 18 0	March & September	..	..
30,008	2½	..	West Coast of America	⅛ ⅜	⅛ ⅜	..	..	..	..
£150,000	100	4%	* Do. 4 per Cent. Debentures	104 107	104 107	3 15 2	June and December	..	..
88,321	10	0/6	West India and Panama	1 1½	1½ 1⅝	..	May and November	1 5/16	1⅛
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½ 9⅞	9½ 9⅞	6 3 1	" "	9⅞	9½
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7 9	7 9	6 13 4	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures	106 109	106 109	4 12 10	January and July	..	..
64,269	15	6/9	Western and Brazilian Ordinary	12½ 12⅝	12½ 12⅝	3 16 6	May and November	..	..
33,129	7½	6/0	Do. 5 per Cent. Preferred Ordinary	8 8½	8 8½	4 8 2	" "	..	..
33,129	7½	0/9	Do. Deferred Ordinary	4 4½	4 4½	..	" "	4	..
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	107 110	107 110	3 13 1	June and December	107	..
1,168,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	105 110	105 110	6 7 10	Feb., May, Aug., Nov.	..	..
£158,100	100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	93 103	98 103	5 16 6	March & September	..	..
			TELEPHONES.						
44,000	£5	4/0	Chili Telephone (fully paid)	2⅜ 3⅛	2⅜ 3⅛	6 8 1	August	..	..
224,850	10/0	1½d.	Consolidated Telephone Const. & Manufacturing	1/16 1/8	1/16 1/8	6 7 0	July	..	..
28,000	5	4/0	Monte Video Telephone 6 per Cent. Preference	2½ 2¾	..	7 5 6	October	..	..
484,597	5	3/0	National	5½ 5⅝	5⅝ 5⅝	5 11 7	February & August	5⅛	5⅛
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	12 14	12 14	4 5 9	" "	..	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	12 14	12 14	4 5 9	" "	13½	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	5½ 5½	5½ 5⅝	4 13 0	" "	5½	5⅛
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	100 105	100 105	3 6 8	June and December	101½	..
171,504	1	0/8	Oriental	⅜ ½	⅜ ½	6 13 4	April and October	..	..
58,000	5	6/0	United River Plate	4½ 4¾	4½ 4¾	6 6 5	July	..	..
£151,788	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103 106	103 106	4 14 4	June and December	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
90,000	2	1/2½	Brush Electrical Engineering	1⅝ 2	1⅝ 1⅞	3 4 0	..	1⅞	1⅝
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2½ 2⅝	2 2½	5 6 8	..	2½	2
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	109 113	109 113	4 0 4	February & August	..	..
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	103 106	103 106	4 6 2	June and December	104⅜	..
£20,000	5	8/6	Callender's Cable Construction	10 11	10 11	5 13 8	" "	10⅜	10 3/16
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	110 113	110 113	4 0 6	November and May	..	..
300,000	1	9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛ 1⅜	1⅛ 1⅜	5 16 5	..	..	..
50,000	1	..	Chadburn's Ship Telegraph Ordinary	1⅛ 1⅜	1⅛ 1⅜	..	..	..	..
50,000	1	7⅛	Do. 6 per Cent. Cumulative Pref.	⅞ 1⅛	⅞ 1⅛	5 6 8	..	..	..
32,098	3	..	Crompton and Co. (Nos. 1 to 32,098)	1½ 2	1½ 2	..	..	1½	..
£82,850	100	5%	* Do. 5% First Mort. Deb. (red.)	91 96	91 96	5 5 10	January and July	..	..
99,261	5	2/1½	Edison and Swan United ("A" Shares) (£3 paid)	2½ 2⅝	2½ 2⅝	6 10 5	February & August	2½	..
17,189	5	3/1⅛	Do. (£5 paid)	4 5	4 5	6 0 0	..	..	..
£194,023	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	101 103	105 107	3 15 8	June and December	..	..
17,400	5	5%	Edmundson's Electric Corporation Ord (fully paid)	5 5½	5 5⅛	4 10 11	Half-yearly	5 3/16	5⅛
110,000	2	1/2⅜	Electric Construction Co. (Limited)	2⅛ 2⅜	2⅛ 2⅜	4 16 10	February & August	1⅛	..
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Pref.	2⅜ 3⅛	2⅜ 3⅛	4 6 2	August	..	..
£111,100	Stock	4%	Do. 4% First Mortgage Deb. (red.)	105 107	105 107	3 16 2	..	106½	..
91,196	1	..	Elmore's Patent Copper Depositing	⅝ ¾	⅝ ¾	..	..	..	..
12,500	10	8/0	Henley's Telegraph Works Ordinary	20½ 21½	20⅝ 21½	6 0 11	February & August	21⅝	..
3,000	10	7/0	Do. 7 per Cent. Preference	18 19	18 19	3 13 8	" "	..	..
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110 115	110 115	3 18 3	" "	..	..
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	22½ 23½	22 25	4 0 0	" "	22	..
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	102 106	102 106	3 15 6	March & September	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	39 43	37 41	4 6 2	March and July	40	39
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	100 103	104 107	4 14 9	January and July	..	..
£50,000	5	4/0	Willans and Robinson Ordinary	7⅜ 8½	7⅜ 8½	4 17 0	April and October	8	..
£30,000	5	3/0	Do. 6% Cumulative Preference	6⅜ 7½	6⅜ 7½	4 2 9	..	7⅜	..
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	107 109	108 110	3 18 8	May and November	..	..
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	..	Blackpool and Fleetwood Tramways	14½ 15½	15½ 16½	..	..	16½	15⅜
25,000	10	6%	Bristol Tramways and Carriage	21½ 22	21⅜ 22	2 14 7	..	..	..
25,000	10	6%	Do. (£7. 10s. paid)	18⅜ 18⅞	18⅜ 18⅞	1 14 1	..	..	..
£90,410	Stock	4%	Do. 4% Debenture	121 123	121 123	3 5 1	..	..	..
80,000	10	..	British Electric Traction Ordinary	16⅜ 17½	16 17	..	..	17 1/16	16⅜
10,000	10	2/4 1/16	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm.pd.)	13 14	13 14	4 5 9	..	13⅜	..
34,440	10	..	Calcutta Tramways	5 6	5 6	..	..	..	..
£35,250	10	3/0	Central London Ordinary	10 10½	9⅜ 10½	2 18 6	June and December	10⅜	10
178 303	10	1/9⅜	Do. (£6 paid)	6 6½	5⅜ 6½	2 16 6	" "	..	..
£630,000	Stock	2½%	City and South London Railway Con. Ordy.	70 72	70 72	2 15 7	January and July	72	70½
22,500	10	..	Do. Ordinary (£3 paid)	2⅜ 3½	2⅜ 3½	..	..	..	..
9,251	10	5%	Do. 5% Perpetual Preference	14½ 15⅜	14⅜ 15⅜	3 4 6	January and July	15 5/16	..
£137,701	Stock	4%	Do. 4% Perpetual Debenture	136 138	136 138	2 18 0	May and November	..	..
20,000	10	6%	Imperial Tramways Ordinary (old £6 shares)	16½ 16⅝	16½ 16⅝	2 3 9	March & September	..	..
10,000	10	6%	Do. 6% Preference	15 15½	15 15½	3 18 8	" "	..	..
37,500	10	3%	Liverpool Overhead Railway Ordinary	10 1/16 10 1/16	10 1/16 10 3/16	3 1 6	February & August	..	..
10,000	10	5%	Do. 5% Preference	15½ 16	15⅜ 16	3 2 6	" "	..	..
125 000	Stock	4%	Do. 4% Debenture	107 109	107 109	3 13 5	January and July	..	..
20,000	5	3/3½	New General Traction 6% Cumulative Pref	4⅜ 5½	4⅜ 5½	..	..	..	..
£540,000	Stock	3%	Waterloo and City Ordinary	113 118	106 111	2 15 1	June and December	115⅜	107⅜

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

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CONTENTS OF THE CURRENT NUMBER.

NOTES	29	Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe	45
Meetings of Scientific Societies.	32	The State and the Telephones	45
Obituary	33	A New Pattern of Preece-Trotter Photometer. Illus.	48
Hull Municipal Electric Supply Works. Illustrated	34	Mr. W. H. Preece's Presidential Address to the Institution of Civil Engineers	49
The "Anderson" Closed-Conduit System of Electric Traction. Illustrated	38	Physical Society	51
Notes on the Turin International Exhibition. Illus. Continued	39	Electricity in Morocco	52
The International Magnetic Conference	41	Correspondence	52
Electricity Works Accounts	42	Legal Intelligence	54
ELECTRICITY IN CIVIL ENGINEERING	44	Trade Notes and Notices	55
		Companies' Meetings & Reports	60
		City Notes	63

NOTES.

FROM the POSTMASTER-GENERAL'S reply to a deputation of the Manchester Corporation on Monday, it appears that the next move towards the settlement of the telephone question will be to take the opinion of the House of Commons on the subject of the Select Committee's report. By the time the law has been amended so as to enable local authorities to erect public telephone exchanges it is doubtful whether many will find it worth while to avail themselves of the opportunity. Ratepayers who favour telephone competition in the abstract may yet oppose the borrowing of money for such an undertaking when they realise that the sum would have to be redeemed in twelve years' time. It is significant that the Manchester Corporation want to make a cat's-paw of the New Mutual Telephone Co., in the same way as the Select Committee suggest that local authorities may serve as a cat's-paw of the Post Office.

THE article, entitled "Telephones and the State," which will be found in another part of our present issue, is intended to assist the general reader in some measure to form a correct opinion of the recent Parliamentary Committee's proceedings, and to estimate the true value of its recommendations. In view of the changes of policy, and even of administration, which the report seems to foreshadow, this matter is of some considerable importance just now.

WE publish this week an abstract of the Report of the Permanent Committee on Terrestrial Magnetism and Atmospheric Electricity to the International Meteorological Conference, a document which, although principally framed in the interests of an important branch of pure science, is not devoid of interest for practical engineers. The proceedings of the International Magnetic Conference during the British Association week, at Bristol, have been duly notified in our columns, and a list of the Papers read appeared in *The Electrician*, Vol. XLI., p. 686. In the abstract we give of the Report there is evidence that the Conference was made use of by the permanent committee of experts to frame a valuable set of recommendations to the International Meteorological Conference.

SUCH of these recommendations as relate to purely scientific matters call for little comment. They have regard to the equipment and working of magnetic observatories, to the best designs of instruments for the purposes of observation and research, and to the desirability of extending the field of observation by the establishment of new observatories in various parts of the globe. With the scientific motive for these recommendations we are in entire sympathy; and it is to be hoped that no commercial consideration will be permitted to prejudice the just rights of a branch of physical science, the full importance of which to posterity cannot be foreseen at the present time.

SEVERAL recommendations embodied in the report bear upon the disturbance of the work of magnetic observatories arising from electric tramways and other electric plant. It is evident that no observatory can of itself be shielded from such disturbance, since it is the essential business of the observatory to detect and record identically the same phenomena as are produced, on an exaggerated scale, by the electric traction plant. The remedy, if it is to be carried into effect, must be applied to the traction equipment, preventing it from affecting the normal terrestrial magnetic condition in the neighbourhood of the observatory. Appended to the report, as well as to our abstract, is the text of the clause introduced into the Bill authorising the construction of the electric tramway in the neighbourhood of Kew Observatory.

"WHY not gas trams?" asks an influential London newspaper, *apropos* of the proposal to adopt mechanical traction on the metropolitan tramways. *Why* gas trams?—is the obvious retort. Wherein has gas power shown its superiority over electric traction? Certainly not in point of numbers of lines, mileage of track, commercial success, or popular approval.

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We do not deny that gas trams will work, after a fashion; nor even that in certain circumstances they can be made to pay; but in no respect can they be regarded seriously as a possible competitor of the electric car. On the continent, the gas interests have exploited one or two lines, not without a degree of success; and between Blackpool, Lytham and St. Anne's there runs a service of gas-driven cars, the performance of which affords an instructive contrast with that of the two electric tramways in and around Blackpool. We are content to let gas tramway traction have its full trial, fearing nothing as to the possibility of its staying the advance of electric traction throughout this country.

We publish two letters this week on the question of the breakdown at Brighton, chronicled in our last issue. One of these suggests as an explanation of the back current an interruption of the field circuit of the disabled machine causing a momentary increase of E.M.F. in that machine. We believe there is no reason to expect that the shunt circuit of the machine was interrupted before the cut-outs acted; but, even if that had been the case, we cannot conceive that the consequent increase of E.M.F. due to self-induction would have been sufficient by itself to neutralise the thousands of amperes which were flowing from the remaining machines. Our other correspondent favours the explanation we offered, but objects to the temporary replacement of the minimum cut-outs by heavy excess cut-outs, and states that to tie up the former would not in this case have saved the station from shutting down. He prefers our other suggestions of separate excitation and non-return cut-outs. It has also been suggested to us in conversation that the defect lay in the minimum cut-outs themselves, and that the current through them never did diminish to a minimum, but we are not inclined to support this view, if only for the reason that all the apparatus acted simultaneously.

The Electrical Engineers, R.E. (Volunteers).—The enrolment of men into this corps has now begun again. The headquarters are open between 7 and 8 p.m. on Mondays and Thursdays.

German Safety Regulations.—The regulations issued by the Verband Deutscher Elektrotechniker, to ensure safety in high and low pressure electrical installations, have been officially recognised by the German Government.

Institution of Junior Engineers.—Arrangements have been made for the members of this Institution to visit the King William-street station of the City and South London Railway extension works on Saturday, November 12th, at 3 p.m.

Cable Interruptions.—	Date of Interruption.
Bissao—Bolama	Aug. 3, 1898
St. Louis and Noronha	Oct. 17, 1898
Gibraltar—Tangier	Oct. 18, 1898
Pernambuco—Ceara	Oct. 19, 1898

A New Cuban Land-Line.—Capt. Brady, of the United States Signal Service, has been ordered to begin the construction of an overland telegraph line from Guantanamo *viâ* Santiago de Cuba to Manzanillo, Cuba. The line is to be used principally for the transmission of Government despatches, although commercial messages will be accepted.

Some Amusing Errors.—Our contemporary, the *Revue Pratique d'Electricité*, makes a sad series of blunders in an article on the Bristol B.A. meeting. Sir *Henry* Crookes is stated, in his presidential address, to have affirmed that *M. Olivier Ladger* and not M. Branly was the inventor of the coherer. We are sure that Sir William Crookes never disputed the claim of Branly to his invention, nor did Dr. Oliver Lodge—if that is the gentleman to whom our contemporary wishes to allude. M. Olivier Ladger is twice mentioned in the article, however, and M. Mascart is persistently printed Massart. Dr. Rucker we are also informed is professor of physics at the University of London.

The Maritime Electrical Association.—A new electrical association, bearing this name, and formed by electrical engineers in the maritime provinces of Canada, held its first regular convention in Halifax, N.S., on September 27th last. After the president, Mr. F. A. Bowman, had delivered his address, a Paper was read by Mr. F. A. Hamilton on "Electric Gong Buoys." The Paper described a system of buoys, devised by the author, in which electric bells, placed on the buoys and connected by cable with the land, were constantly kept ringing. Mr. Hamilton read a letter from Mr. Preece approving of the system, but suggesting the use of alternating currents instead of springs in the bell mechanism.

Electrical Machinery in Prussia.—Some interesting statistics are published in the *Reichsanzeiger* of Sept. 30th. Up to the beginning of 1898 there were no less than 2,490 machines in Prussia used for driving dynamos, while 815 were partially used for that purpose. These are tabulated as follows:—

Uses.	No. of Machines.	Horse-power.
1. For lighting purposes	2,873	154,772
2. For driving motors	61	10,785
3. For other purposes	25	7,278
4. For several purposes at the same time—		
(a) For lighting and transmitting power	325	84,216
(b) For other purposes	21	1,675
Totals	3,305	258,725

These figures include all State and private undertakings in Prussia, with the exception of those under the War Office and Admiralty.

Electrical Supply in Paris.—*L'Industrie Electrique* publishes some interesting figures giving details of the capacities and lamp connections of the central stations supplying Paris with electric light and power. There are in all six companies and one small municipal network, and the following table gives totals for all the districts:—

Plant Capacity.	
Dynamos	24,396 k.w.
Accumulators	3,243 „
Lighting.	
Number of arc lamps	11,028
Number of incandescent lamps	701,524
Total number of lamps reduced to equivalent of 10 c.p.	922,603
Total power necessary	36,906 k.w.
Motors.	
Number of motors for lifts	753
Power required	2,141 k.w.
Number of motors for miscellaneous purposes	841
Power required	1,731 k.w.
Total power required for working motors	3,872 „
Heating.	
Number of apparatus	130
Power consumed	127 k.w.
Total power consumed	40,905 „

New Electric Supply Works at Folkestone.—Electric supply at Folkestone was "inaugurated" on Wednesday last, although the works have been supplying light to private consumers for some months past. The central station is now practically complete, however, and on Wednesday the public arc lamps were switched on for the first time. The works of the Folkestone Electricity Supply Co. are situated at a considerable distance from the town, and the three-wire system at 420 volts is employed, the arc lamps being connected across the outers in series of eight. At present the equivalent of about 9,000 8 c.p. lamps and 24 arcs are connected to the mains, there being 75 consumers. The capacity of the station is about 300 kilowatts. An amusing feature of the inauguration ceremony was that the directors of the local gas company had been invited. At the luncheon which followed, the toast of the electricity supply company was proposed by one of these gentlemen, who informed the guests, amid much laughter, that, if he had not withheld his casting vote in the Town Council on a particular occasion,

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there would have been no need for the ceremony which had just taken place. We reserve a full description of the works for an early issue.

Dublin Sub-station Attendants not "Boys."—*Apropos* of the statement in our leading article last week that "at Dublin it has been found possible to leave the sub-stations in the charge of boys," Mr. E. Bolton, who describes himself as "one of the unfortunate boys in question," writes to protest that what we had mistaken for boys are really men; "their faces," he says, "belie them." As Mr. Bolton appears to think an injustice has been done, and as we are far from desirous of causing harm by our remarks on the subject, we give below the leading points in his letter:—

"In your leader on polyphase traction, special attention is drawn to the erroneous idea that boys are employed to take charge of the sub-stations in Dublin. As such is not the case it should be contradicted, as it is very unfair to those who are in charge of the sub-stations in question. The leader implies that the stations are so simple that even a boy can be left in charge; also it implies that they are, therefore, paid at a boy's rate of wages; neither, I can honestly say, are true. . . . A rotary converter or a motor generator may require but very little attention, but certainly not less than any other type of dynamo. However, until about seven or eight months ago there were in charge of the sub-stations two men of over 27 years of age and two of 20 years. The latter two, I presume, have been taken for boys, as probably their faces belie them. Since that time there has been one man of 23 and three of 21 years of age in charge of the stations. Being, as I imagine, one of the unfortunate boys in question, I write to protest at being called such, for reasons already given, and I hope you will not consider it mere vanity. I consider that being called a boy, or at least doing a boy's work, would prove to be a barrier to me bettering my position in the near future, as I should like to do."

Bennis Stoker at Belfast Electricity Works.—Some further particulars of the Bennis automatic stoker erected at Belfast may serve as an interesting supplement to our descriptive article recently. The stoker, as erected at the Belfast station, is of the new pattern, and comprises the machine stoker and a new self-cleaning compressed air furnace. This enables the consumption of coal per square foot of grate per hour to be varied at will in a few minutes from a few pounds to as much as 40lb. or 50lb. The results obtained over a series of tests which the makers have been carrying out during the last fortnight at the station have been most satisfactory, and are roughly as follows:—A test on Oct. 12, when the machine was pushed as hard as possible all the time, gave an average evaporation of 12,580lb. per hour, the maximum evaporation being 13,900lb. in one hour. On Oct. 18 a trial was made with Welsh coal on the "Bennis" stoker and compressed air furnace, giving the following results:—

Average evaporation per hour from temp. of feed 50°F. 7,257lb.
Water evaporated per pound of coal from and at 212°F. 11·59lb.

The machine, it may be stated, was shut down for a considerable period, for the steam produced would have been more than necessary for the load. The hand-firing trial made with the same coal, on October 14th, gave an hourly evaporation (average), from temperature of feed 54°F., of 7,025lb., and the water evaporated per pound of coal from and at 212°F. was 10·6lb.

The Manchester Corporation and the Telephones.—The Postmaster-General (the Duke of Norfolk) on Monday received a Deputation, representing the Manchester Corporation, who desired to lay before him the views of their city with reference to the administration of the local telephone service. Mr. Alderman Southern acted as spokesman for the deputation, and said that the Manchester City Council had decided to support the petition of the New Mutual Telephone Co. (Limited) for a licence. Over £80,000 of the company's capital had, it was said, been subscribed. The present action had been taken largely because the Corporation would have to obtain a special Act of Parliament to enable them to establish a Municipal system. On behalf of the Corporation, he asked (1) whether the Post Office was considering the advisability of establishing a competitive service; (2) whether a licence would be granted to the New Mutual Telephone Co., provided they entered into a contract not to sell their undertaking to anyone save the Manchester Corporation; and (3), in the event of a negative answer to questions (1) and (2), to what extent the Postmaster-General intended to give effect to the recommendations contained in the Select Committee's report, especially under the following heads:—(a) By introducing a public bill for enabling the Postmaster-General to grant provisional orders to enable the local authority to lay down and work telephones in its own district and the districts of other authorities within a specified area; (b) to enter into an agreement that the Post Office will purchase the land, buildings and plant of the new undertaking in 1911; (c) toassist the Corporation to obtain a suspension of the sinking fund and allow payment of interest out of capital for, say, three years, in order to avoid an undue burden upon the rates; (d) definition of area to be of sufficient extent and to embrace the large towns near Manchester. The Duke of Norfolk promised to send full written replies to the two questions. In the meantime he said that it had been definitely decided not to grant any further licences to private companies. At present he did not feel justified in saying anything as to the future policy which the Post Office proposed to adopt. The Report of the Select Committee on Telephones was presented too late in the recent session for any expression of opinion to be taken from the House, and until that had been done he did not wish to say anything which could be construed into even a quasi pledge.

Motor-Car Trials in Paris.—In the competition of motor-cars for heavy loads, which took place in Paris from October 6th to 12th, the electrically propelled cars did not gain any distinction. Of the four electric cars competing, only one went through all the six journeys precribed as tests. These journeys were, however, of such a nature as to be particularly trying to electrical automobiles, being on three routes—26, 29 and 41 miles long respectively—with one minute's rest after each kilometre traversed. It is intended, according to the *Engineer*, to choose a special route for the electric cars next year, to fulfil as much as possible the conditions of town and suburban goods transport. The Jenatzy van of the Compagnie Général des Transports Automobiles is of the same system as the cab which took part in the recent Paris trials, except that it has no change-speed gear. The gross weight was 4,500 kg., including 1,500 kg. of dead weight and four passengers. The batteries of Fulmen accumulators weigh 1,200 kg., and the inventor claims that with these the van can run 120 km. With a discharge of 28 to 30 amperes the vehicle ran 12 to 13 km. an hour on the level, and on the up grades the discharge was 70 amperes and the speed 7km. an hour. The average voltage was 82. The van accomplished all six routes without incident. The Société des Electromobiles presented a van upon the Bersey system with a battery of Fulmen accumulators. It completed five out of the six journeys. The Krieger van was not ready before Monday, so that it was only able to cover the three routes once. As with nearly all the French electric cars, the energy was stored in batteries of Fulmen accumulators. The weight of the vehicle was 2,500kg., including 600kg. of dead weight. On the A route the average rate of discharge was 24 amperes at 85 and 86 volts, and the consumption was 6 kilowatt hours. The carriage work of the Mildé-Mondos van is, says our contemporary, of the highest class description, and is fitted with a duplex motor, the power being transmitted by chain from a very small pinion on the countershaft to the rear driving wheel. There were two batteries, one containing Mildé accumulators and the other Fulmen; moreover, one of the batteries was old and the other new. To make matters worse, the accumulators polarised through bad charging. and for most of the time the van was in the tent undergoing repairs. The only time it finished a route it was followed by a portable engine with a dynamo, and this precaution was a wise one, for the batteries had to be re-charged on the road to enable the van to return to Versailles. The greatest interest was taken in the trials by delegates from local bodies all over the country, and the Minister of War ordered a large number of officers to follow them with a view to ascertaining whether motor cars could be profitably employed for military purposes.

Automatic Pressure Regulation on a Three-Phase System.—An interesting method of regulating the voltage at the terminals of the rotary transformers, which furnish power to the shops of the General Electric Co. at Schenectady, is described in the *Electrical World* of Oct. 1. The three-phase current is transmitted from Mechanicville as described in an

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article in our issue of Oct. 7, and is transformed to continuous current by means of stationary step-down and rotary transformers. The transmission line has considerable self-induction, and the rotaries are compound wound, the series winding being heavy, and the shunt-winding being, at no load, insufficient to generate at synchronous speed a back E.M.F. sufficient to choke back the impressed alternating-current waves. The result is that wattless currents lagging behind the impressed E.M.F. enter the rotary armature and automatically increase the field excitation to a proper value. These lagging currents react upon the self-induction of the line, causing a drop considerably greater than that due to its resistance alone, and—the direct-current voltage being practically proportional to the impressed alternating voltage at the rotary rings—the reduction of the latter by means of the increased line drop prevents too great a pressure being delivered from the direct-current end on no load. As the load rises, however, the action of the series fields of the rotaries begins to assert itself, and the wattless currents in the armature necessary to maintain the field excitation fall off, until at a point about three-quarter-load the power factor of the incoming current approaches unity. As the load further increases the line drop is diminished, and the leading current and line inductance may even be sufficient to boost up the volts to a greater value than at the receiving end. This arrangement alone would be sufficient to obtain proper voltage regulation but for the interference of the load taken by the synchronous motors driving the generators of the testing department. Any increase of the load in this department increases the current in the line, consequently increases the ohmic or resistance drop without the proper compensating effect in the wattless currents taken by the rotary. To make the rotaries take leading or lagging currents which shall balance out the disturbing effects of the synchronous machines the following system has been devised. The rotary shunt fields are excited from a separate direct-current 'bus bar which is fed with current from the main 'bus through an auxiliary exciter. This auxiliary exciter serves to raise the voltage across the rotary fields, and is driven by an alternating-current synchronous motor of the same number of poles, thus keeping its armature in step with the alternating system. It has no field exciting winding, but its armature is fitted with three collecting rings, into which alternating current may be introduced from the secondaries of three small series transformers, the primaries of which are inserted in the lines feeding the synchronous motors. The armature of the auxiliary exciter is coupled to the synchronous motor at such an angle that the currents introduced from these series transformers, when the load passing through their primaries is of unity power factor, tend to set up a field of force in the magnetic circuit of the auxiliary exciter, and build up a direct-current voltage across its brushes; thus, the greater the load on the motors in the testing department the greater is the boosting action of the auxiliary exciter.

The Utilisation of Blast-Furnace Gases.—In the course of an interesting article on this subject in the October number of *Cassier's Magazine*, Mr. H. Savage, of the Société John Cockerill, details some experiments made at that company's works at Seraing. Some of these results have already been given in a Paper read before the Iron and Steel Institute by M. A. Greiner. Trials lasting over two years were made at Seraing by MM. Bailly and Kraft. The first machine experimented with was a small 8 H.P. "Simplex" gas engine of the type patented by Messrs. Delamarre-Debouteville. This engine ran for a period of 18 months, but developed only 4 effective horse-power. Later on, after modification of a few details, the full 8 H.P. were attained. The gas consumption was certainly high, but with the engines working at full load there was no doubt it could be materially reduced, and it was expected that a consumption of 105 cubic feet per hour per indicated horse-power would not be exceeded in a large 200 H.P. engine recently started. This engine was designed by M. Delamarre and constructed in the Company's shops. The supply of gas is taken from the blast-furnace mains and led through three pairs of coke scrubbers, in which it is thoroughly washed by being brought into contact with water driven into the scrubbers in the form of spray by Körting injectors. After washing, the gas may be sent direct to the engine, although a gasometer exists to serve the purposes of a regulator and reservoir. The engine has one working cylinder, 800 millimetres (31 $\frac{1}{2}$in.) in diameter, with a stroke of one metre (39·37in.). It is of the usual four-stroke, or Beau de Rochas, cycle type, each explosion corresponding to two forward and two backward strokes of the piston. The working speed is 100 revolutions per minute, and to insure regularity the engine is fitted with a heavy fly-wheel, weighing about 15 tons, and a counterbalanced crank, besides which a pendulum governor, acting on the gas inlet valve, restrains any tendency towards excessive speed. The initial compression in the cylinder reaches about 115lb. per square inch. The gas is ignited electrically. Trials of this engine, conducted by the well-known expert, M. Aimé Witz, have given the most satisfactory results. During a continuous run of 24 hours an almost constant power of 180 I.H.P. was maintained, on a remarkably low consumption of gas, equivalent to about 115 cubic feet per hour and indicated horse power. The conditions of the trial were those of ordinary work, no attempt being made to drive the engine to the extreme limit of its power. A second 200 H.P. engine at present building at Seraing is to be adapted to electric driving. The present one drives an air-compressor. The objection based on the presence of dust in the gas was one to which Mr. Lürmann gave great prominence at a recent meeting of the German iron and steel makers at Düsseldorf, and one which is by no means minimised by the nature of the gas given off by the Seraing furnaces, in which purple ore is very largely used. It was found, however, that the small 8 H.P. engine was able to run for four months continuously without cleaning, and the new large engines are supplied with far better means of getting rid of the dust. Gas absolutely free from dust is, says Mr. Savage, no more a necessity with gas engines than distilled water is in the case of steam engines. No inconvenience was experienced from corrosion of internal parts. Finally, the irregularity in the composition of the gas, which was expected to be the great drawback, loses much of its apparent gravity in the light of practical experiment. Gas so poor in combustible ingredients as to be practically useless for heating boilers still gives fairly satisfactory results with a new motor, which seems to adapt itself readily to considerable differences in the quality of its fuel. At Wishaw, in this country, gas from furnaces burning raw coal is utilised for driving an electric lighting plant, after the separation of the tar and ammoniacal waters, and Mr. B. M. Thwaite, the designer of this plant, is said to have been equally successful with gases from blast furnaces using coke. The Westinghouse Co., in the United States, have also had on trial a 750 I.H.P. gas engine for some time past.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

MONDAY, November 7th.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

SOCIETY OF ENGINEERS.

7:30 p.m. Ordinary Meeting at the Royal United Service Institution, Whitehall.

TUESDAY, November 8th.

LONDON INSTITUTION.

5 p.m. Lecture at Finsbury-circus on "Fire and Fire Extinction," by Prof. Vivian B. Lewes.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read and discussed: "The Extraction of Nickel from its Ores by the Mond Process," by Prof. W. C. Roberts-Austen, F.R.S.

THURSDAY, November 10th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting, when Prof. Silvanus P. Thompson, F.R.S., will read a Paper on "Rotatory Converters."

FRIDAY, November 11th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Agenda:—(1) Discussion on Mr. A. Campbell's Paper on "The Magnetic Fluxes in Meters and other Electrical Instruments"; (2) "On the Propagation of Damped Electrical Oscillations along Parallel Wires," by Prof. W. B. Morton; (3) "On the Properties of Liquid Mixtures," by R. A. Lehfeldt.

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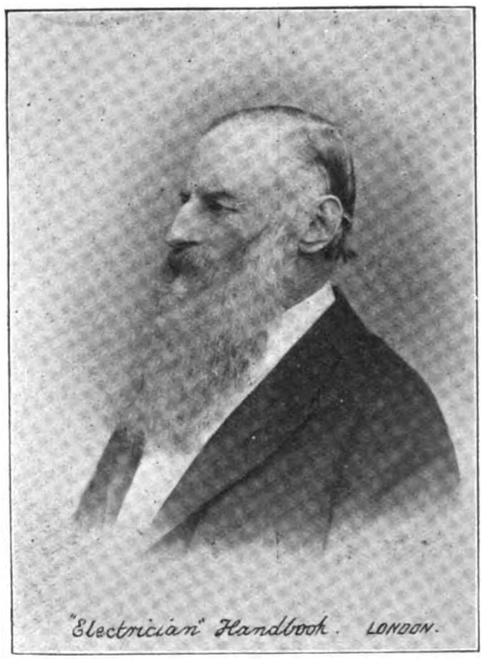
OBITUARY.

LATIMER CLARK.

It is with profound regret that we announce the death of Mr. Latimer Clark, C.E., F.R.S., which took place quite suddenly at his residence at Twickenham, on Sunday morning last at about 7:30. The announcement of Mr. Latimer Clark's death will be read with sorrow by a very wide circle of our readers, and we desire to take this opportunity respectfully to tender our sympathy with his family and the numerous friends who mourn his loss.

Latimer Clark was born at Great Marlow on March 10, 1822, and attained, therefore, the ripe age of 76 years. Although principally known to the world at large in connection with his prominent association with submarine telegraphic enterprise and the construction of submarine cables, Mr. Clark was at first connected with the chemical manufacturing industry, after which he commenced railway surveying in 1847, and was appointed assistant engineer for the construction of the Britannia tubular bridge across the Menai Strait, the resident engineer being his brother, Mr. Edwin Clark. It was on this occasion that he applied electricity for the purpose of firing a time gun every evening at eight o'clock, which attracted the attention of the chairman of the Electric Telegraph Co., who, in 1850, appointed Mr. Clark to the post of assistant engineer to that company, under his brother. Later on he became their chief engineer and consulting engineer. It was thus that he entered upon his association with telegraphic enterprise, in which he has played such a conspicuous and useful part. Connected in the first instance with land telegraphy, Mr. Clark introduced many improvements in the telegraph system, and in 1860 a report by him on the subject of underground telegraph wires was prepared and was embodied in the Government report on the subject in 1861. It was he who first detected the retardation of signals owing to induction in submarine and underground lines, a discovery which led him to investigate the question of the transmission of signals, and to demonstrate that electric currents of low voltage travel at the same speed as those of high voltage. As an instance of one of the details of the numerous improvements in the construction of overhead telegraphy which Mr. Clark introduced, we may mention the double-cup insulator which he invented and patented, and which is now extensively employed all over the world. To him also we owe the invention, in 1854, of the now largely used system of transmitting messages through tubes pneumatically. In 1858 he applied to practical use the experiments which he had been making in the protection of submarine cables by a compound well known as "Clark's compound." The subject of submarine telegraphy was at about this date one of national interest, and in 1860 Mr. Clark was nominated a member of the committee jointly appointed by the Government and the Atlantic Cable Telegraph Co. to inquire into the whole subject of submarine telegraph cables; and in this capacity he rendered very great assistance to the cause of submarine telegraphy; for, in addition to the help he gave as a member of the Committee, he drew up and submitted a valuable report on technical matters connected with submarine signalling, and embodied the researches and experiments that had been made up to that date. About this time—*i.e.*, 1860—Mr. Latimer Clark went into partnership with Sir Charles Bright, and for 10 years carried on under this partnership extensive work in the construction and laying of submarine cables. In conjunction with his partner he read a Paper before the British Association at Manchester, in September, 1861, putting forward a definite system of electrical measurement in ohms, volts and farads, the heterogeneous and unscientific systems of measurement until then in vogue being thereafter gradually displaced by the system these electricians propounded, which practically forms the basis of modern electrical scientific measurement. In fact it was this Paper which led to the formation of the British Association Committee on Electrical Units, which since that date has done so much useful work. In foreign work, Mr. Clark was for many years engineer to the Indian Government cable lines in the Persian Gulf; and his researches during this period on the effect of temperature on the insulation of gutta-percha cables, made in conjunction with his partner, Sir Charles Bright, in 1863, proved of great value for practical telegraphic use. Their table embodying these researches is, indeed, still in daily use. It should not be forgotten that Mr. Clark was the inventor of the well-known and most extensively used standard cell which bears his name, a standard which is equally of service in heavy electrical engineering as in telegraphic practice. We may here mention that in addition to scientific and practical work, Mr. Latimer Clark was the author of several important contributions to scientific literature. His "Elementary Treatise of Electrical Measurements," which appeared in 1868, has from that date been a standard work on the subject. A few years later, in conjunction with Mr. Sabine, he published his work on "Electrical Tables and Formulæ." He is also the author of several astronomical works.



LATIMER CLARK, C.E., F.R.S.

As head of the well-known firm of consulting engineers, Messrs. Clark, Forde and Taylor, Mr. Latimer Clark has been connected with the submergence of some 100,000 miles of submarine cables in all parts of the globe. For a number of years he was also a partner in the engineering firm of Clark and Standfield, and in the late firm of Latimer Clark, Muirhead and Co., in which he brought out many important improvements in various branches of engineering. Up to the time of his death Mr. Latimer Clark remained head of the firm of Messrs. Clark and Standfield, the well-known dock engineers.

In recognition of his services to engineering and scientific advancement, as well as to the community at large, he had numerous honours bestowed upon him. He was a Chevalier of the Legion d'Honneur, a Fellow of the Royal Society and Past-President of the Society of Telegraph-Engineers and Electricians, having held the office of President in the year 1875, before the change of name.

Mr. Latimer Clark was at his office in Victoria-street, Westminster, on Friday, last week, apparently in his usual health. He complained in the night of Saturday of indigestion, and took a slight stimulant to ward off the attack. As above stated, later (at 7:30 a.m.) he was found to have expired in his bed.

Mr. Clark was buried yesterday (Thursday) at the Kensington Parochial Cemetery, near Hanwell, Middlesex. Several members of the Council and other members of the Institution of Electrical Engineers were among the mourners present at the grave.

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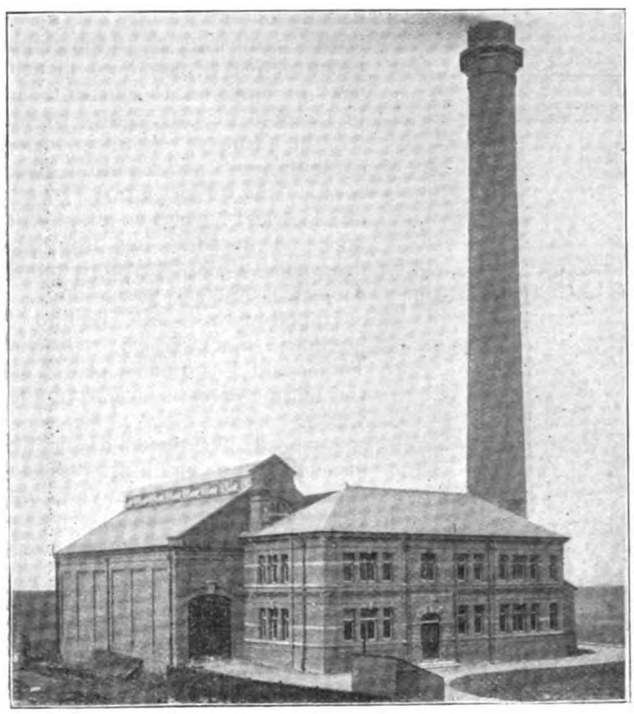
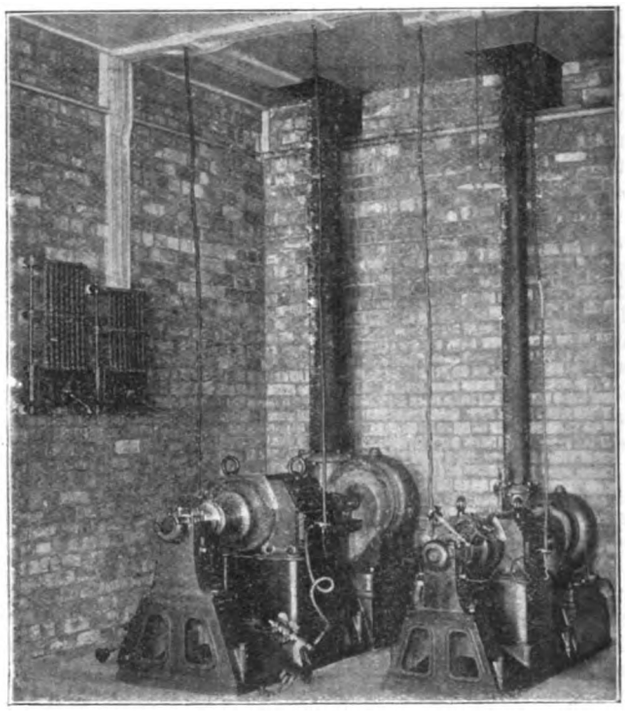
HULL MUNICIPAL ELECTRIC SUPPLY WORKS.

As announced in our issue last week, the electric supply works of the Hull Corporation have recently undergone considerable extension, in the opening of a new generating station, at Sculcoates-lane. The history of the electric light undertaking in Hull is, briefly, as follows:—In 1887 an electric lighting committee of the Corporation was formed, and on August 4th of the following year an electric lighting order was obtained. Mr. R. E. Crompton was engaged to report on a scheme, and recommended, in 1891, a low-pressure scheme at an estimated cost of £16,000. This was followed by the appointment of Mr. F. Harman Lewis as borough electrical engineer, the Crompton scheme being immediately proceeded with. This scheme included a generating station in Dagger-lane, with engines aggregating 560 H.P., built by Messrs. Willans and Robinson, direct-coupled to Siemens dynamos of 300 kilowatts capacity. The boilers of this station were supplied by Messrs. Davey, Paxman and Co., and the original plant included accumulators of the Crompton-Howell type, and about 2¼ miles of mains laid on the Crompton system. On June 16, 1893, these works were opened, and have since run continuously with complete success. There were 83 consumers connected at the time of the inauguration, and an equivalent of 600 lamps. During this year Mr. Harman Lewis was appointed to the post of Corporation electrical engineer at Wolverhampton, and was succeeded, at Hull, by Mr. A. H. Gibbings, now of Bradford. Also during this year considerable extensions of mains took place, about three miles of mains on the Callender-Webber system being laid. In the following year the plant at the Dagger-lane station was extended by the installation of a 300 H.P. Willans engine and a 180 kilowatt dynamo by Messrs. J. H. Holmes and Co., and in the next year a similar extension of plant took place. In October, 1895, Mr. Gibbings left, and Mr. A. S. Barnard was appointed in his stead, a post Mr. Barnard still retains.

Owing to the rapidly increasing demand for current, it became necessary, in June, 1896, to consider a scheme for very extensive additions to the electrical supply system, this scheme being estimated to cost £42,000. Unfortunately, it was twice rejected by the Town Council, but in December of the following year Mr. Hammond's report on the scheme was submitted for a third time, and finally accepted by the Council, with the addition of £10,000 to the estimate for the district of East Hull. At this time, the number of consumers connected was 520 and the capacity of the plant 26,817 lamps. No less than 340,339 units were sold during the year 1896, a profit of £1,970 being made on the year's working. The new works were pushed on with, but owing to some delay in starting them and to the increased number of applications for current, temporary works had to be laid down in 1897, these commencing supply in conjunction with the Dagger-lane station. The temporary works ran from Nov. 5th until March 5th following, when the capacity of the Dagger-lane station was increased to 1,160 H.P. in engines and 660 kilowatts in dynamos. The present capacity of the new station in Sculcoates-lane, together with the sub-stations at Argyll-street and Albion-street, is 760 H.P. in engines and 456 kilowatts in dynamos, but there are 750 H.P. in engines at present under order together with 450 kilowatts in dynamos. At the present date, there are 863 consumers connected to the mains and lamp connections aggregate 67,900, while no less than 16½ miles of mains have been laid, including the 3¼ miles now actually being laid. The customers include a great variety of consumers, there being, in addition to the ordinary lighting consumers, a fairly large motor load for printing and other work. We will now proceed briefly to describe the equipment of the new station and the sub-stations which have been recently erected.



Hull Municipal Electric Supply Works. Sculcoates-lane Station.



Motor-driven Centrifugal Pumps at Sculcoates-lane Station.

Boiler Room.—In the boiler room there are at present erected two Lancashire boilers by Messrs. Tinkers (Limited), of Hyde, each being 30ft. in length and 8ft. in diameter, together with a Babcock-Wilcox boiler of 150 H.P. The last-named boiler has 1,218 sq. ft. of heating space, composed of six sections, each section having nine tubes 4in. diameter and 18ft. long. The headers are made of wrought steel, and the drums are 36in. diameter and 23ft. 7in. long. The boilers work at 150lb. pressure. All the boilers are at present hand fired with the best South Yorkshire steam coal. In conjunction with the boiler plant there is a Green's economiser, composed of 192 tubes, arranged in two groups, coupled together by expansion elbows, and tested to 350lb. pressure. The feed pumps are of the direct-acting vertical type, with the pump underneath. They throw their supply from a tank filled with softened water, a water softener of the Pemberton type being used, together with a clarifying or filtering tank and apparatus for thoroughly mixing the re-agent solution with the water to

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be softened. The feed supply is arranged on the duplicate ring main system, similar to that employed for the steam ranges, and arranged so that any pump can supply any boiler either with cold or hot water. In addition to the feed pumps there is also an independent injector feeding gear, which can be used either in conjunction with the pumps or otherwise. The water for the feed, as well as for the condensing plant, is pumped out of an adjacent drain by means of two centrifugal pumps 5in. and 7in. in diameter, and is discharged into a large overhead tank of 29,120 gallons capacity. Each pump is driven independently by an electric motor by Thomas Parker (Limited). From this tank the water is supplied to the two ejector condensers through a 12in. pipe. The exhaust from the engines can be turned either into the condensers or into an atmosphere pipe of 15in. diameter which runs along under the floor and is carried upwards outside the building. The steam ring consists of two parallel lines of 8in. wrought iron solid drawn pipe, with welded flanges resting on cast-iron chairs behind and above the boilers and connected at the ends with copper U bends of the same size as the pipe. Into this ring each boiler feeds by a separate copper pipe bent into an S shape so as to avoid strains due to expansion. The standpipes are each provided with a complete set of valves enabling each boiler to be used independently, an arrangement which is also applied to the engines running off the ring mains. The plane of the ring is inclined downwards towards the boilers, and it is drained at two points by steam traps. Messrs. Thomas Parker (Limited) have erected one 30 B.H.P., and one 14 B.H.P. shunt motor, coupled to centrifugal pumps for condensing purposes; also one 2 B.H.P. shunt motor for driving the economiser scrapers, all the motors running off the 220 volt circuit.

Machinery Room.—In the machinery room there is erected high and low-pressure continuous-current plant, having an aggregate capacity at present of 456 kilowatts. The low-pressure plant consists of two Willans engines of the G.G.S. type, each indicating 100 H.P. under 140lb. steam pressure. These engines run at 450 revolutions, and are coupled direct to two-pole dynamos by Messrs. Thomas Parker (Limited), each dynamo giving 130 amperes at 300 volts. These machines are for the supply of local consumers; also for the pump and economiser motors on the works. The motor generator is also installed in the building, and is used for balancing purposes or for supplying light loads in conjunction with the battery. The high-pressure plant consists of two Willans engines of the I.I.I.S. type, capable of developing 360 H.P. at the same pressure when running at 350 revolutions per minute. These are coupled direct to two-pole dynamos, by Messrs. Thomas Parker (Limited), each giving 90 amperes at 2,250 volts. These generators are separately excited from a 225 volt circuit. The armatures of these machines are wound on the Eickemeyer principle. All the engines are fitted with Messrs. Willans and Robinson's automatic expansion gear, and a separate condenser is provided for each engine, the condensers being of the Körting injector pattern, and arrangements are made so that each set can be run either condensing or non-condensing, as required. A 10 ton hand-power travelling crane spans the engine room.

Switchboards.—The switchboard equipment consists of two separate switchboards for the high and low-pressure plant respectively. These have been made as nearly as possible fireproof, being composed of 1½in. slate slabs mounted on iron frameworks. The low-tension board contains two dynamo panels, one battery panel, two feeder panels, one Board of Trade panel, one motor-generator panel, and one works distribution panel. Each dynamo panel is fitted with a Weston ammeter and voltmeter, a D.P. switch with maximum and minimum control, a throw-over main switch and field regulating switches. The battery is placed on one side of the three-wire system and 18 regulating cells are connected to the switchboard. All motors, lights, &c., on the works are connected to throw-over switches on the works distribution panel, so as to enable them to be run from either side of the system. Thomson-Houston wattmeters are installed in the low-tension feeders both here and at the sub-stations, so that all current delivered to the distributing mains is metered.

The high-tension switchboard contains two dynamo panels, one Board of Trade panel and six feeder panels, and four spare panels for extensions are provided. Each dynamo panel contains a Weston ammeter, a Kelvin voltmeter, a D.P. switch with maximum and minimum control, and field regulating switches. The dynamos are connected by the D.P. switches to the high-tension 'bus bars, from which the feeders are tapped. The feeder panels each contain a Weston ammeter and voltmeter, a D.P. switch with maximum cut-out, and transformer starting and regulating switches. The voltmeters on the feeder panels are connected to the feeding points on the low-tension mains, and the pilot wires are connected to them *viâ* the shunt coil of a long range switch on each transformer. By short-circuiting the voltmeter about 5 amperes is made to pass through this coil, and the long range switch is actuated, connecting a transformer to that particular feeding point. A repetition of the process throws the switch into the "off" position.

Battery Room.—The battery room at the main station contains 126 Pritchett and Gold 11-plate cells in glass boxes. The capacity of this battery is 300 ampere-hours at 225 volts.

Sub-Stations.—There are at present two sub-stations, one at Albion-street and one Argyle-street. The building at Albion-street was specially designed for the purpose, and contains two 90 kilowatt rotatory transformers and a motor generator. Room for an extension of the plant is provided. At Argyle-street four railway arches have been utilised, two of which are used as stores for the outdoor department, one as a battery room and one as a transformer chamber. In the battery arch there are 240 Pritchett and Gold cells similar to those at the generating works. These are charged in three sets of 80 cells off the distributing mains, and are discharged in two sets of 120 cells. The switchboard is situated in the transformer arch, where there are two 90 kilowatt and two 45 kilowatt machines with the necessary switches, &c. The 90 kilowatt transformers are wound for a step-down from 2,250 to 450 volts, and the two smaller transformers are wound for 2,250 to 225 volts. The 90 kilowatt transformers at Albion-street supply a portion of the old network and are wound for 2,250 to 225 volts, the motor generator forming a connecting link between the old 220 volt three-wire and the new 440 volt three-wire networks. The transformer armatures are of Messrs. Parker's usual type with high and low-tension winding on the same core and with a commutator at each end. They are "Eickemeyer" wound, with an earthed metallic shield between high and low-tension windings. The lubrication is effected by a force pump on each bearing, and the machines can be run for long periods without attention.

Mains.—The mains extensions have been carried out by Messrs. Siemens Bros. and Co., and consist of six high-tension circuits running from the generating station in Sculcoates-lane to the two sub-stations, and low-tension feeders running from the generating station and these sub-stations to various points in an extensive network of distributing mains. The high-tension feeders, pilot and telephone wires are drawn into Doulton's stoneware conduits. These conduits are made in 3ft. lengths, and are jointed together by means of stoneware cradles with Portland cement; no less than 45,000 yards of 2¼in. by 2¼in. duct has been used, spare ways being provided for future extensions. Draw-boxes built of 9in. brickwork on concrete foundations are provided at all corners and bends and where otherwise necessary, and they are provided with cast-iron frames and covers, and are ventilated by means of a stoneware pipe connected to a small ventilator frame. The high tension feeders (of which about 17,000 yards have been laid) are 0·06 sq. in. and 0·03 sq. in. sectional area, concentric, insulated with impregnated fibrous material, lead-covered and externally taped and compounded. The low-tension feeders consist of about 4,600 yards of 0·5 sq. in. concentric lead-covered cable, armoured with two layers of 0·05in. hoop-iron, and is laid direct in the ground. Three nine and 12-core pilot wires are laid alongside the feeders, and a four conductor "dry-core" (air-space) telephone cable permits of communication between the generating and sub-stations.

About 24,000 yards of distributors have been laid of the triple core, impregnated fibre insulated lead-covered and armoured

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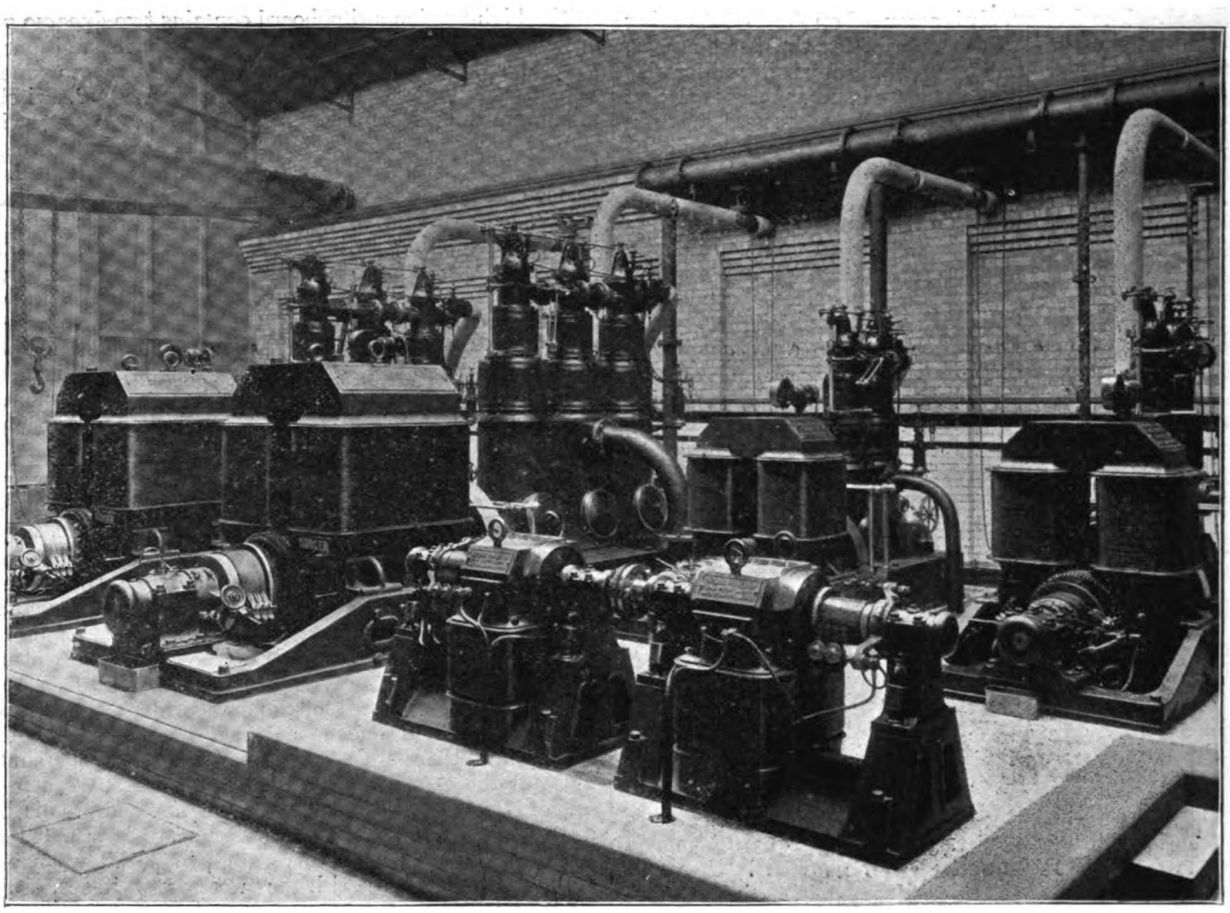
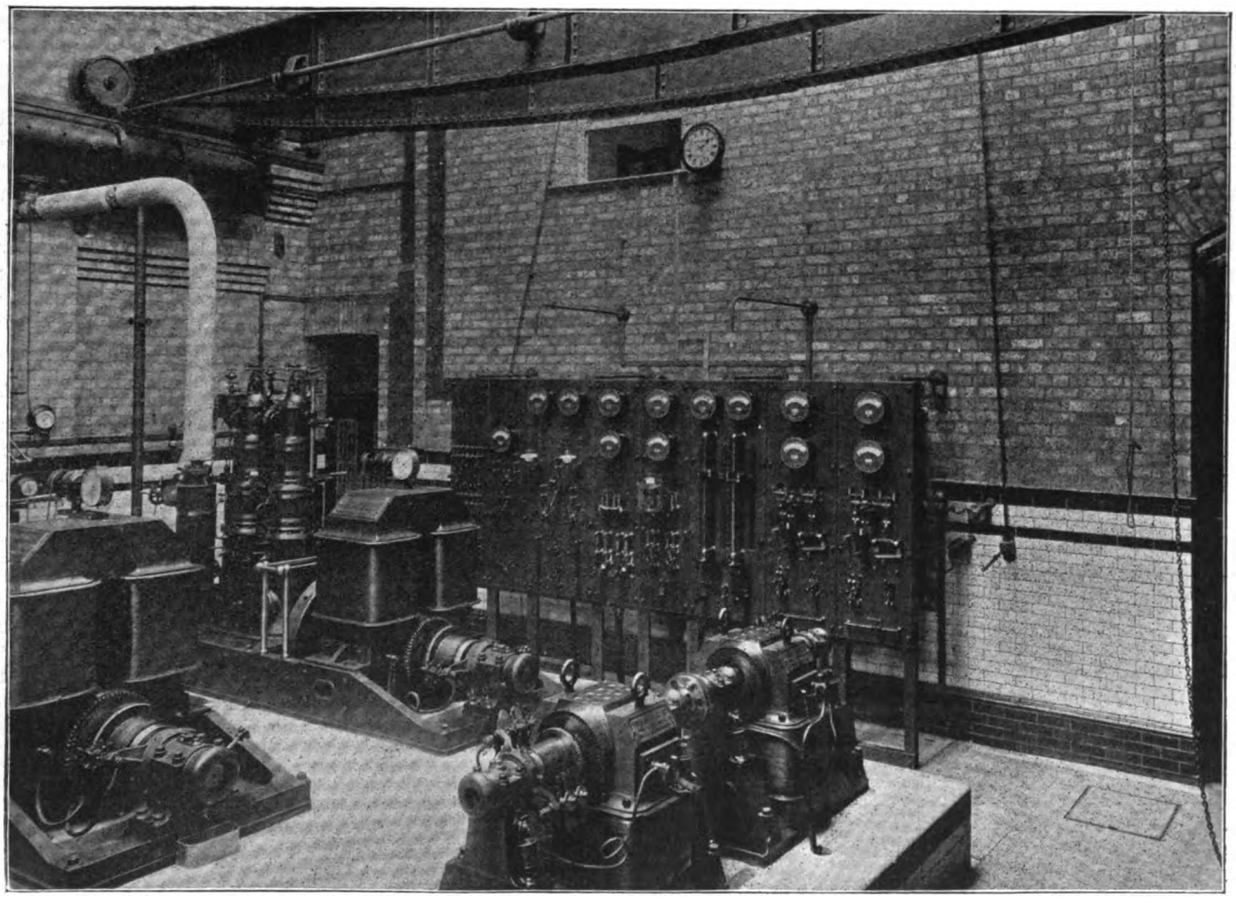


Hull Municipal Electric Supply Works. Interior of Machinery Room at Sculcoates-lane Station.



Interior of Machinery Room, showing Low-pressure Generators, Motor-Generator and Low-pressure Switchboard.

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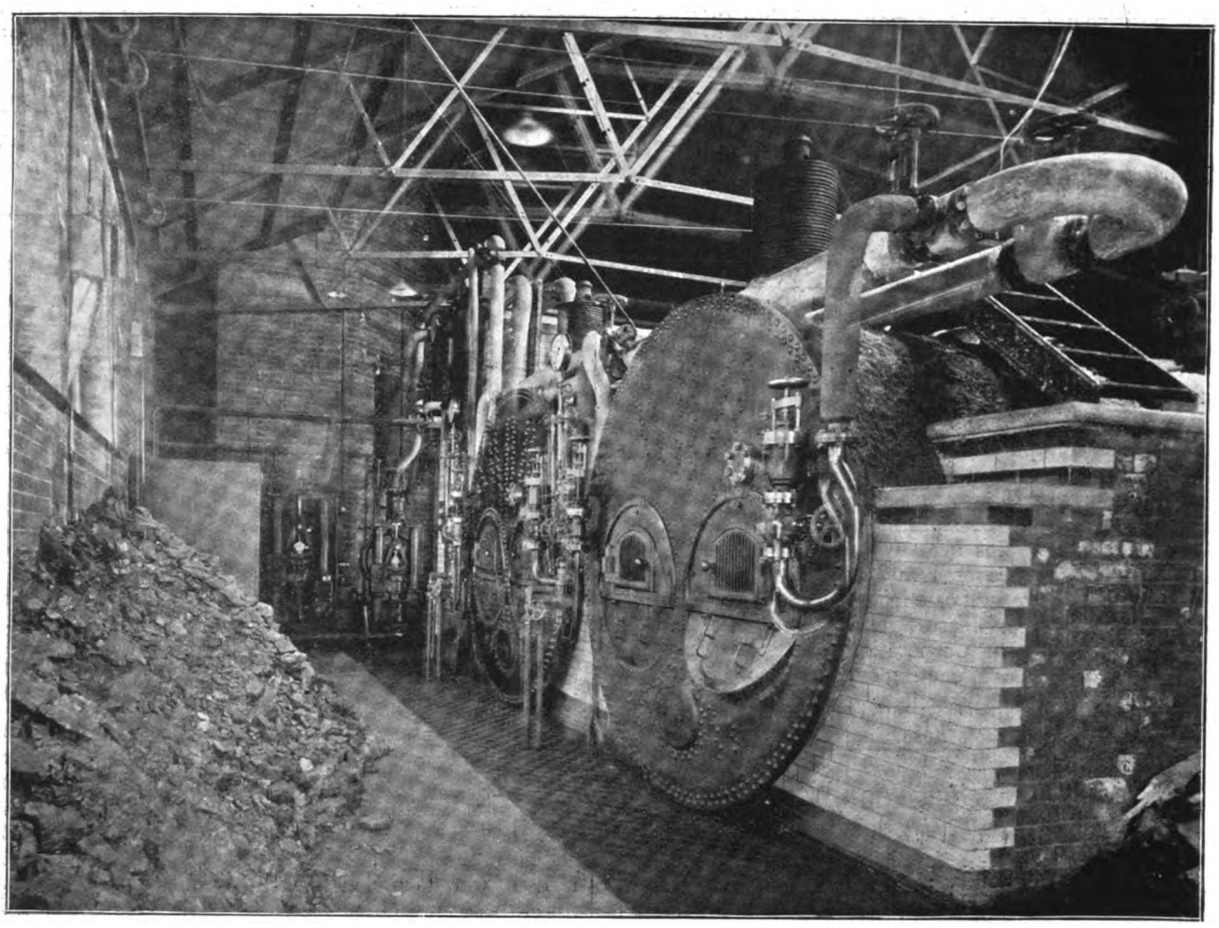
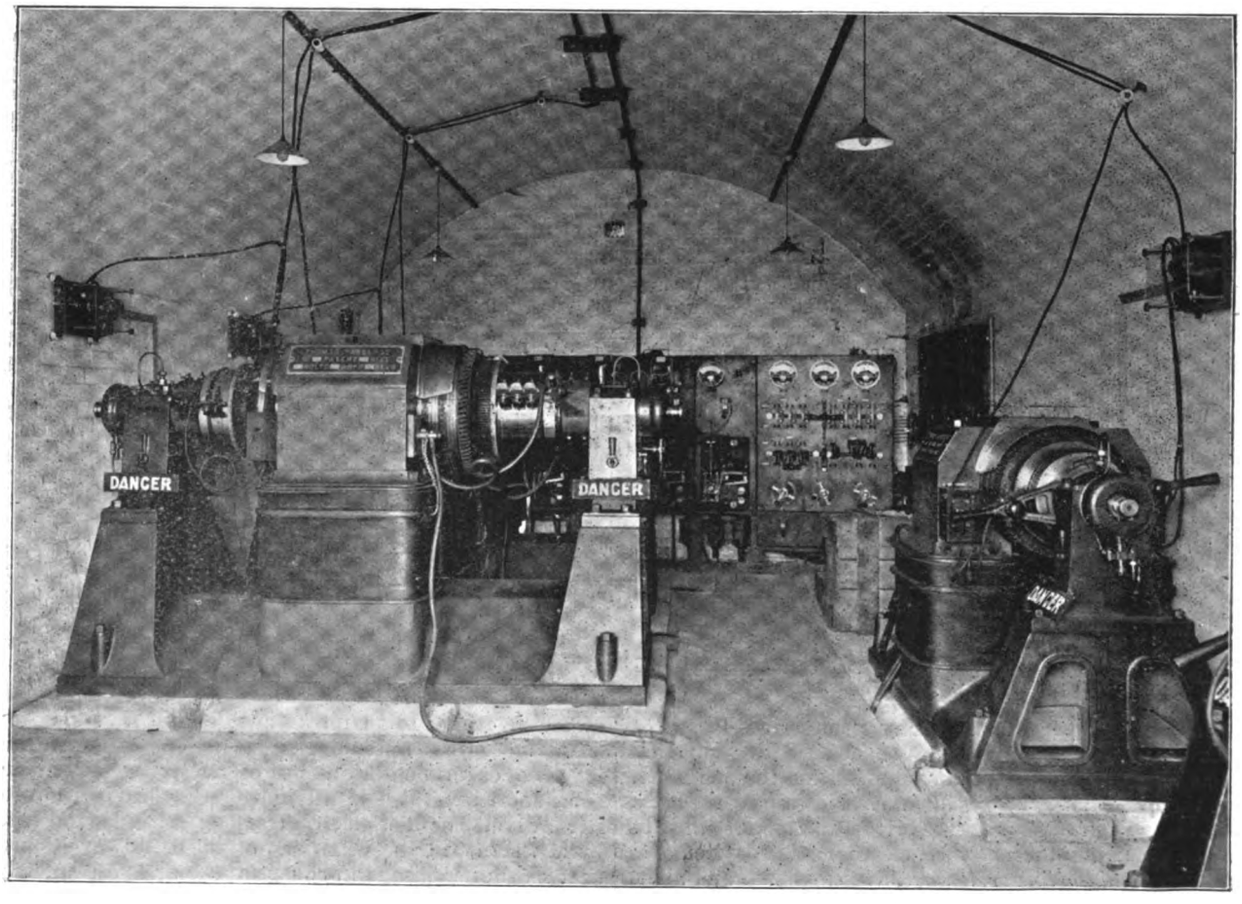


Interior of Boiler Room.



Argyle-street Sub-station Machinery Arch.

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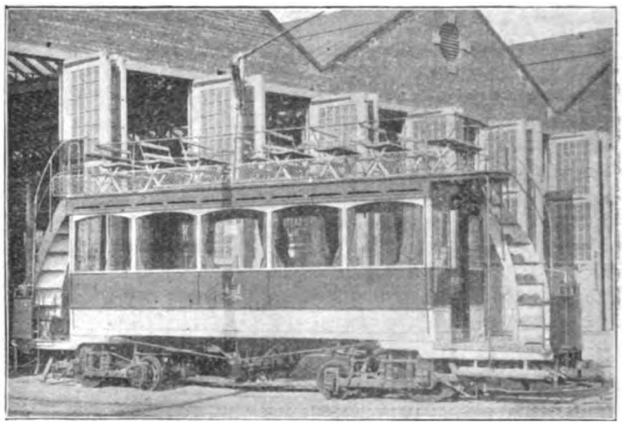
type, the positive and negative conductors being 0·15 sq. in. section. The advantages of this class of distributing main for three-wire systems are now universally recognised. It combines flexibility with facility of jointing, the service and other boxes employed being of a much simpler construction than those for triple concentric mains. It was first made by Messrs. Siemens for the Bolton Corporation some years ago, and has since been advantageously adopted by many Corporations.

All the cables, before and after laying, have been subjected to exhaustive tests with satisfactory results. The straight joints are made in cast-iron boxes in two halves bolted together. The internal fittings consist of copper sleeves and sockets for sweating the conductors into, and are embedded in the hard-setting insulating compound with which the boxes are filled. About 60 disconnecting boxes, both of three-way and four-way patterns, have been inserted in the network, and allow of any section of the distributor being rapidly cut out or disconnected for testing purposes. The internal fittings of these boxes are so arranged that either disconnecting copper links or fuses can be used. They are set in brick pits, with manhole frames and covers of similar construction to the draw boxes. The service cables are of the twin pattern, india-rubber insulated, lead covered and armoured, and are connected to the mains through cast-iron T boxes.

In conclusion, we have pleasure in tendering our best thanks to Mr. A. S. Barnard, the Corporation electrical engineer at Hull, and to the several contracting engineers, for much of the information embodied in this article.

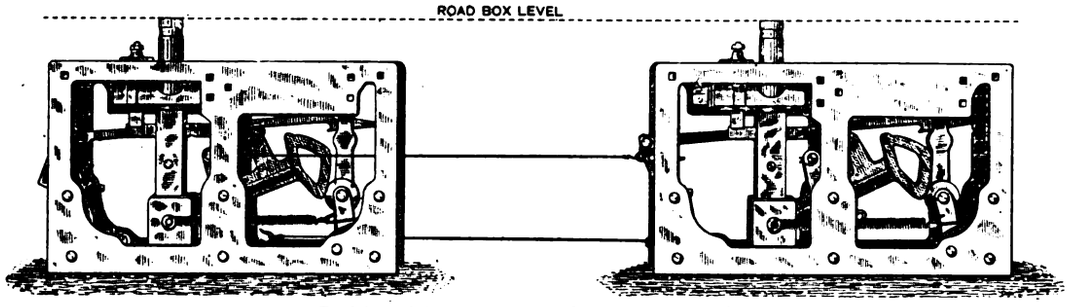
THE "ANDERSON" CLOSED-CONDUIT SYSTEM OF ELECTRIC TRACTION.

The closed-conduit system invented by Mr. Christopher Anderson, and now being tried upon a short length of experimental tramway at Leeds, represents another and somewhat older attempt than the one we described last week to discover a satisfactory system of electric traction that should avoid unsightly overhead equipment, on the one hand, and, on the other hand, open slots or cavities in the roadway. This system, which we purpose briefly to describe in this article, differs from the class of closed-conduit systems to which belong the Thomson-Walker, Westinghouse and allied systems, in that the surface contact pieces on the roadway are not fixed, but are capable of no less than 4in. of vertical motion. When no electric car is over any one such contact piece it is, in the ordinary course, in its lowest position and out of the way of ordinary vehicular or pedestrian traffic; it should, therefore, in this circumstance, possess no element of danger. When an electric car glides over the contact piece the latter is automatically raised above the ground level and projects sufficiently to come into contact with a collector

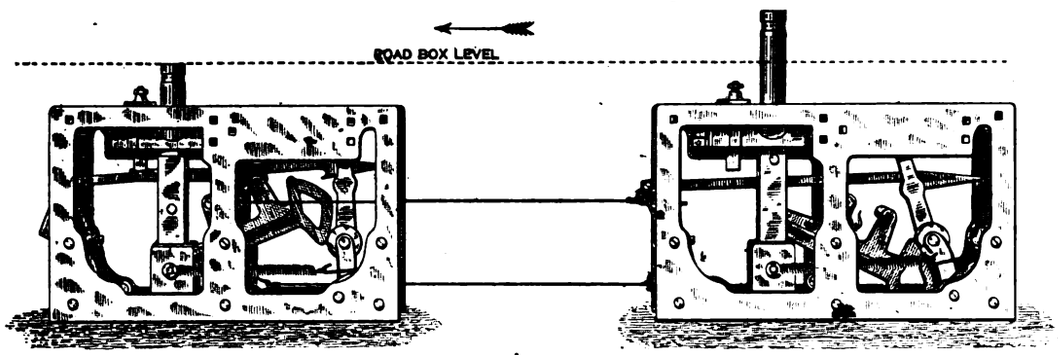


Trolley Car equipped for working on the "Anderson" Closed-conduit System as well as on the Overhead Trolley System, at Leeds.

carried on the car at a much greater clearance than usual. Simultaneously with the elevation of the contact rod it is made electrically alive, it being in all other positions inert. On the passage of a car beyond the elevated rod the rod is arranged, in the ordinary course, to fall into the position of safety; but it will be evident that failure of it to do so would expose upon the roadway a metal rod projecting 4in. above the surface, and in a dangerous condition of electrification. Consequently, the essential feature of the system in regard to guarantee of safety must be to ensure that such an occurrence would be impossible. Although the short length of experimental line has been working satisfactorily for some short time, it is rightly felt by the authorities interested in the development of electric traction in Leeds, and especially by Mr. Hannam, the Chairman of the Tramways Committee, that a definite opinion in favour of the system cannot be pronounced until it has been tried for a lengthy period in all sorts and conditions of weather. It is of the utmost importance to



Position of Contact Pieces when not in operation.



Position of Contact Pieces when actuating car.

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determine whether frost or wear-and-tear can interfere with the falling of a plug into the safe position when a car has passed from over it. Nevertheless, the system possesses many points of novelty, and exhibits great ingenuity in its design and construction. The cost of the surface-contact boxes, we are informed by the inventor, is £600 for the half-mile of experimental line; but it is expected that this figure will be considerably reduced when the boxes are turned out by machinery in large quantities.

NOTES ON THE TURIN INTERNATIONAL EXHIBITION.

(BY OUR OWN CORRESPONDENT.)

(*Continued from page 751.*)

Messrs. Siemens and Halske, of Berlin, who have erected electric lighting plants in many Italian towns, have naturally a fairly large exhibit, but so far as dynamos and motors are concerned there is very little of real novelty. Among their machines I may mention two large continuous-current dynamos, working at 480 volts and 400 amperes, directly coupled to the engines. These machines are of the old type, with internal field magnets and external armatures and commutators. This firm also exhibits some other dynamos, a transformer, a car motor, and three-phase motors of smaller sizes. There are also many interesting measuring instruments, which will be referred to later on.

Some well-designed machines, although not comprising any particular novelty, are exhibited by Messrs. Guzzi and Ravizza, of Milan. These include a series of three-phase motors and a large 300 H.P. 3,000-volt alternator, with its exciter. This firm also exhibits a model of an oscillometer adopted by the Italian navy for measuring the oscillations of a ship. Fig. 4 shows the instrument in section, elevation and plan. The armature of an electric motor is suspended by a balanced suspension, and rotates at a very high speed. The armature is weighted by a heavy brass ring, which acts as a gyroscope, and, its centre of gravity being placed in the centre of the suspension, its position does not change when the ship rocks. Attached to the motor are two pointers, H_1 and H_2, moving along graduated scales, F_1 and F_2. These scales are fixed to the two axes of suspension of the apparatus, and when the ship is still, one of them lies in the vertical plane passing through the axis of the ship, while the other is at right angles to it, and the two pointers are at the zeros of the scales. When the ship oscillates, the two scales oscillate with her and the amplitudes of the oscillations are shown on the scales.

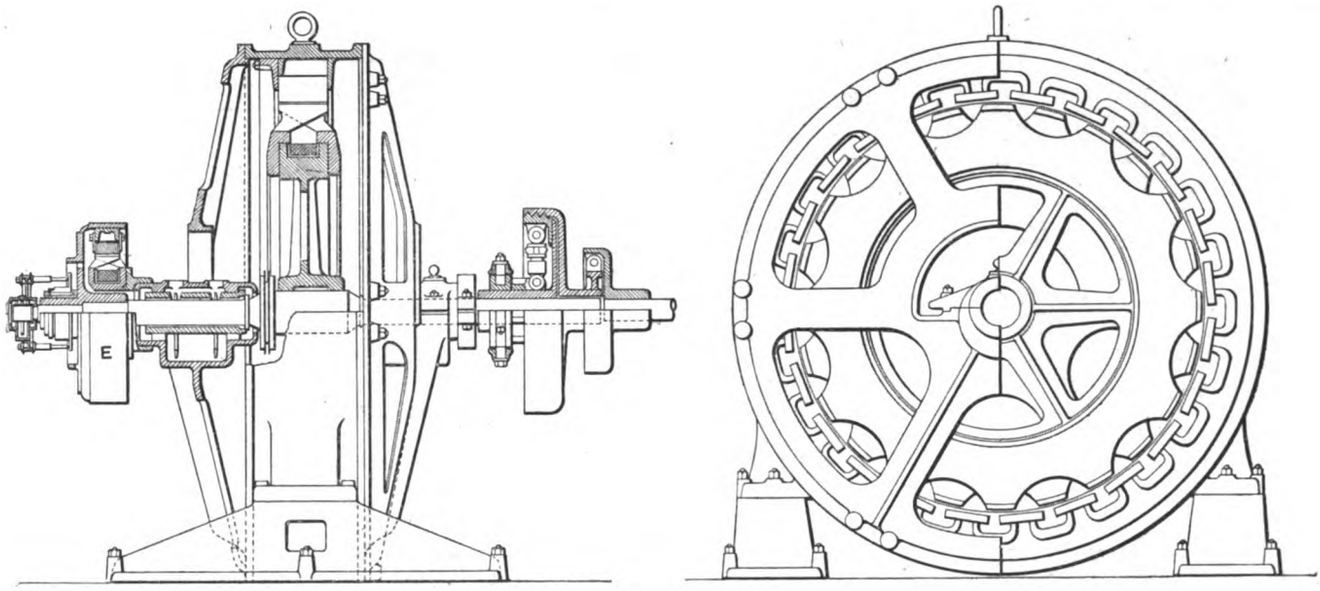

FIG. 5.—Caramagna and Ambrosetti's Alternator.

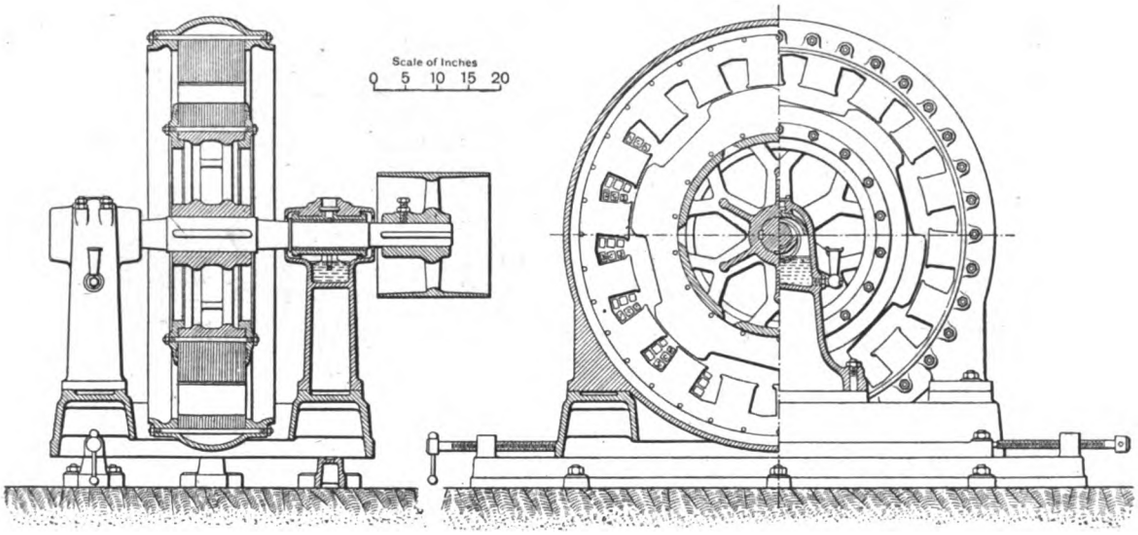

FIG. 6.—150-H.P. Three-phase Alternator constructed by Messrs. Brioschi, Finzi and Co., of Milan.

Messrs. Caramagna and Ambrosetti, of Torino, only exhibit one machine, but of an entirely new design. It is a 250 H.P. two-phase alternator, working at 4,000 volts, and is connected directly to a shaft by means of a friction clutch. The machine is shown in Fig. 5. The field magnets rotate, and as can be seen in the drawing, there are two crowns of 24 poles, between which the winding lies. Although each north pole lies

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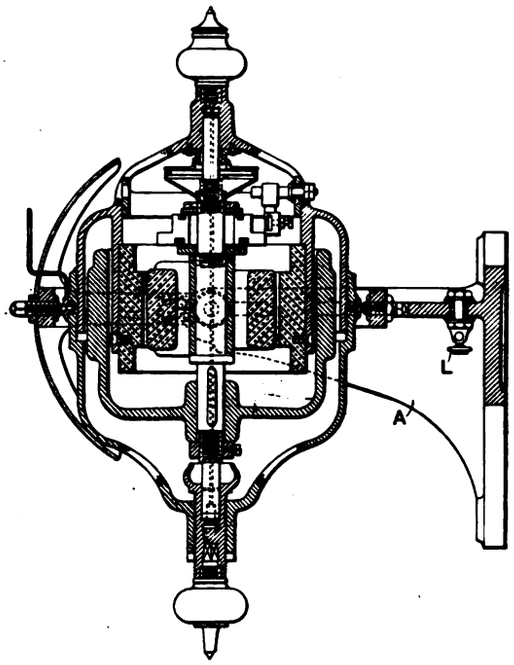
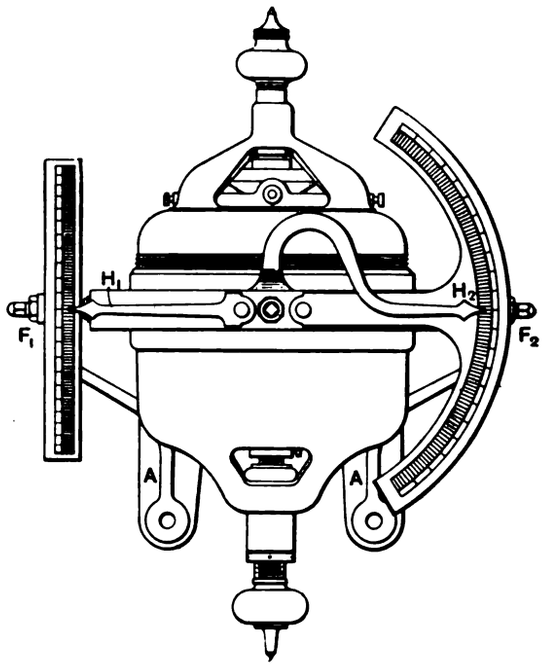
between two south poles, their shape is such that all the poles present the same outside surface. The annular armature has 24 laminated cores, and the exciter E, which is built on the same shaft, has four field magnet poles very similar to those of the alternator. But in this case the annular armature is keyed to the shaft and revolves, while the internal field magnets are stationary. Incidentally, I may mention the switch used for controlling this machine. The moving parts form a parallelogram, of which one link is a long glass bar and takes the place of the usual hand lever.

Messrs. Finzi, Brioschi and Co., of Milan, have a number of entirely new designs. Their largest piece of machinery is the 150 H.P. three-phase inductor alternator, shown in Fig. 6, which works at 900 volts. As seen in the drawing, the stationary part has 18 pole-pieces projecting inwards. Each of these poles holds two armature coils, and the field coils are sandwiched between them. The inductor has six poles. The lavish use of soft iron in the design of this machine is especially noticeable. Broadly speaking, it may be said that the entire magnetic circuit is of this material, cast iron





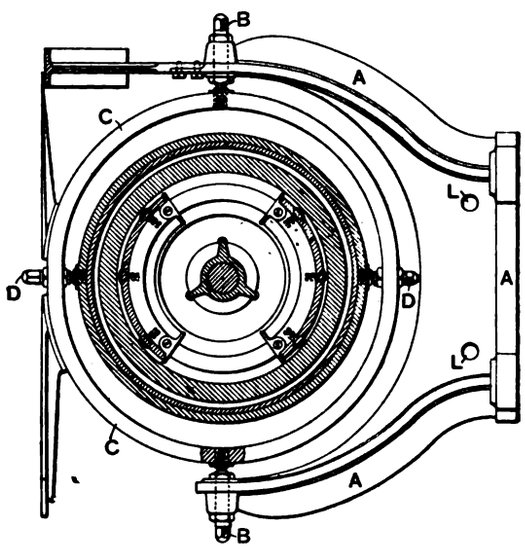


FIG. 4.—Messrs. Guzzi and Ravizza's Oscillometer.

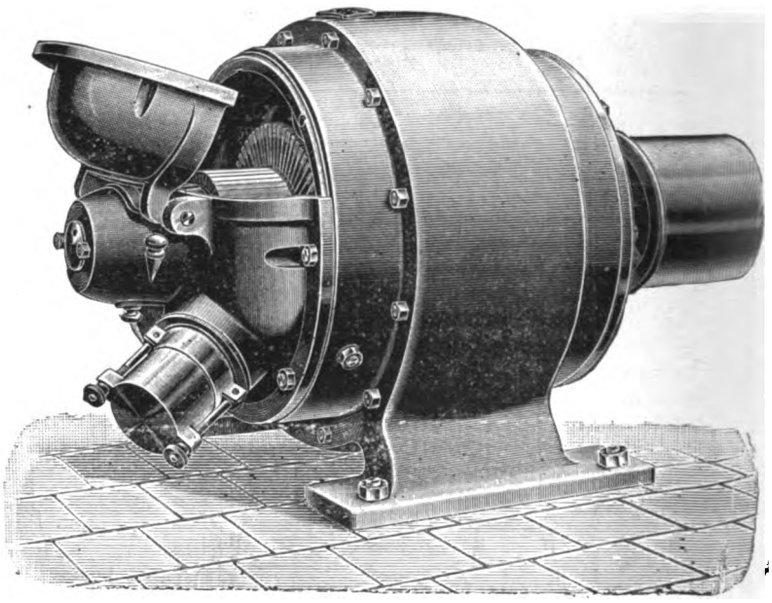


FIG. 7.—Enclosed Motor built by Messrs. Brioschi, Finzi and Co.

Messrs. Morelli, Franco and Bonamico, of Turin, have a very good display of dynamos and motors, both for continuous and three-phase currents. One iron-clad continuous current motor, which is claimed to be perfectly watertight, is of special interest. The motor is entirely enclosed and has a window through which the brushes can be inspected, and a device for adjusting them without opening the case. In order to demonstrate that the machine is absolutely watertight, and at the same time to attract the attention of visitors, a fountain is throwing water over it throughout the day. The same firm also exhibit a very fine switchboard designed for three-phase central stations.

only being used as a mechanical means of holding the parts together. Both armature and field windings are very easily removable. The firm makes a speciality of dust-proof motors, and exhibits various sizes both for continuous and three-phase currents. The smaller sizes of the three-phase machines are fitted with self-contained gears to reduce the speed to about 200 revolutions per minute. The continuous-current motors have the peculiarity that their field-magnets are made of laminated iron, the laminations being in the direction to interrupt the cross magnetising lines of force induced by the armature reaction. By this means, it is stated, the necessity for adjusting the brushesis quite obviated, the machine

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running sparklessly with the same position of the brushes at no load and full load. An external view of one of these motors is shown in Fig. 7.

The Societa Bacini di Carenaggio of Genoa exhibits a number of machines especially designed for ship lighting. These are directly coupled to vertical steam engines, and range in capacity from 5 to 200 kilowatts.

One of the largest collections in this exhibition is that of the Officine di Savigliano. This firm has a 70 H.P. 4-polar continuous-current dynamo running, driven by a gas engine. A fine, well-designed, and apparently very light two-phase dynamo of 66-kilowatt capacity, and working at 110 volts pressure, is also on view. The greater part of this firm's exhibit is in the various mechanical applications of electricity, and I will refer to these later.

(*To be continued.*)

THE INTERNATIONAL MAGNETIC CONFERENCE.*

The Committee on Terrestrial Magnetism and Atmospheric Electricity appointed at Paris in September, 1896, consisted of eight members. These gentlemen found that it was desirable to add to their number, by co-option, and the constitution of the Committee is now as follows :—(Appointed at Paris) Prof. Rücker (President), Prof. Eschenhagen, Prof. Liznar, M. Th. Moureaux, Sig. L. Palazzo, Dr. Paulsen, Dr. Van Rijckevorsel, General Rykatcheff ; (Co-opted) Dr. Bauer, Prof. W. Von Bezold, Sig. Brito-Capello, Dr. Carlheim-Gyllenskjold, Prof. Mascart, Prof. T. Mendenhall, Prof. A. Schmidt, Dr. C. Schott, and Prof. A. Schuster.

International Conference.—In consequence of a suggestion, made originally by Prof. Schuster, that arrangements should be made for an international conference of those interested in terrestrial magnetism, the Committee decided to summon such a conference; and the hospitable invitation of the British Association, to hold the meeting in connection with that of the Association at Bristol (September 7-14, 1898), was accepted.

The Conference thus summoned at Bristol was attended by the following members of the committee, viz., Messrs. Rücker, Eschenhagen, Liznar, Mascart, Moureaux, Palazzo, Rykatcheff, A. Schmidt, C. Schott, Schuster, and various physicists and magneticians took part in some or all of the meetings, amongst whom the following may be mentioned, viz., Prof. W. G. Adams, Prof. C. Vernon Boys, Capt. Creak, Mr. W. Ellis, Prof. Carey Foster, Mr. Kitto, Dr. S. Lemström, Sir Norman Lockyer, Prof. Mathias, Dr. Privat, Dr. Snellen, Prof. H. H. Turner and Prof. Tanakdate. Dr. C. H. Lees, of the Owen's College, Manchester, and one of the secretaries of the section of mathematics and physics of the British Association, acted as secretary of the International Conference and of the Permanent Committee. The Conference was opened by an address by the President. Four meetings were held, on September 8th, 9th, 12th and 13th, at which the questions submitted to the Committee by the International Meteorological Conference were discussed, various Papers were read, and a joint meeting with the physical and engineering sections of the British Association took place, at which the effects on magnetic observatories and metallic pipes of the earth currents produced by electrical railways and tramways were discussed.

Meetings of the Permanent Committee.—During the session of the British Association the Committee also held meetings on September 7th, 9th, 12th and 13th, at which the following resolutions were unanimously approved :—

(*a.*) Matters referred to the Committee by the International Meteorological Conference. Four questions were referred to the Committee. The first of these was the following resolution of M. Dufour (Report of Paris Conference, p. 30) :—

"In calculating monthly means all days are to be taken into consideration. It is left open to each Director to give, in addition, means calculated without taking disturbed days into account." This was approved by the Committee, with the substitution of the words "it is desirable" for the words "it is left open to each Director."

The Committee were also of opinion that the quiet days chosen by the Directors of the different observatories should be communicated to the President of the Permanent Magnetic Committee, and circulated by him, and also that it is desirable to inquire if it will be possible to select the same quiet days for the different observatories.

The second resolution referred to the Committee was the following, proposed by Prof. von Bezold and M. Mascart (Report, p. 31) :—

"It is desirable to publish the monthly means of the components X, Y, Z, and at least for the months of January and July, the differences dX, dY, dZ of the hourly means from the preceding means."

In lieu of this the Committee adopted the following resolution :—

"It is desirable to publish the monthly means of the geographical components of the magnetic force for each month, and also the differences between the hourly means for each month and the monthly means for that month."

The third resolution referred to the Committee was the following, proposed by General Rykatcheff (Report, p. 32) :—

"It is desirable for the progress in terrestrial magnetism that temporary observatories should be installed in certain localities, especially in tropical countries."

On this subject, a report had been prepared at the request of the President, by Prof. von Bezold and General Rykatcheff. After considering the Report, the Committee resolved :—

"That it is desirable that temporary magnetic observatories should be established in places such as the following :—Taschkent, Peking, the Lick-Observatory, Quito, Para, Colombo, Cape of Good Hope, St. Paul or North Amsterdam, Honolulu, and Point Barrow or Sitka, or some other station in a high latitude in North America."

"That these observatories should, if possible, be provided with both absolute and variation instruments, of which the latter should be self-registering instruments, and should be established for at least seven, and, if possible, for 11 or 12 years, *i.e.*, for a complete sun spot period."

The Committee were informed by Dr. C. Schott that it was the intention of the Coast and Geodetic Survey of the United States to establish a magnetic observatory at Honolulu. In the course of the discussion on the above resolution, the Committee also resolved :—

"That it is desirable to point out that observatories at great distances from others should be provided with both absolute and self-registering variation instruments."

The fourth matter referred to the Committee was the question as to the relative advantages of long and short magnets, raised by M. Mascart at the Paris Conference (Report, p. 39). On this subject a report had been prepared, at the request of the President, by M. Mascart. After considering this report the Committee resolved :—

"Unless special reasons exist to the contrary it is desirable that the dimensions of the magnets should be as small as possible, provided that the accuracy of the results is adequately maintained."

(*b*). Resolutions passed by the Committee on matters arising during the International Conference. Prof. Eschenhagen made a statement to the Conference as to his recent investigations on minute disturbances made by very sensitive apparatus with a very open-time scale. In view of this statement, the Committee expressed their sense of the importance of the resolutions on this subject passed by the Paris Conference (Report, p. 35), and the hope that the principal observatories would carry out simultaneous observations of the character proposed.

M. Moureaux informed the Committee that preparations for such observations were already complete in the observatory at Parc St. Maur.

The Committee also passed the following resolution :—

"The Committee is of opinion that the early establishment of a magnetic observatory at the Cape of Good Hope, provided with absolute and self-registering variation instruments, would be of the highest utility to the science of terrestrial magnetism, especially in view of the antarctic expeditions which are about to leave Europe, and that the observatory should be established at such a distance from electric railways and tramways as to avoid all possibility of disturbance from them."

Directions were given that the proper steps should be taken to obtain the approval of the British Association for this resolution, with the request that, if approved, it should be forwarded to the Colonial Government.

On the motion of Prof. Adolph Schmidt, the Committee resolved :—

"That it is desirable that magnetic observations taken in regions not included in a magnetic survey should be repeated from time to time, care being taken to secure the identity of the point of observation."

* Abstract of the Report of the Permanent Committee on Terrestrial Magnetism and Atmospheric Electricity to the International Meteorological Conference.

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Prof. Eschenhagen was requested to draw up a detailed scheme for the exchange between the various observatories of the curves of the self-registering variation instruments taken during important magnetic storms; and to lay the scheme before the next meeting of the Conference.

With reference to certain inquiries which Prof. Eschenhagen suggested should be addressed to the directors of magnetic observatories, the Committee was of opinion that although it would be outside the scope of their duties to make the inquiries, it was desirable that the information should be collected and published.

After the discussion on the magnetic disturbances introduced by electric railways and tramways, the following resolution was adopted by the Committee:—

"The Committee are of opinion that any sensible magnetic disturbance, produced in a magnetic observatory by electric railways or tramways, is seriously detrimental and may be fatal to the utility of the observatory. They consider that special precautions should be taken to prevent such disturbances, and append, as an example, the provisions for the protection of the Kew Observatory inserted in a bill passed by the English Parliament authorising the construction of an electric railway, the nearest point of which is to be at a distance of one kilometer from the Observatory. (Appendix II.)."

APPENDIX II.

Clause for the protection of Kew Observatory:—

1. The whole circuit used for the carrying of the current to and from the carriages in use on the railway shall consist of conductors which are insulated along the whole of their length to the satisfaction in all respects of the Commissioners of Her Majesty's Works and Public Buildings (in this section called "the Commissioners") and the said insulated conductors which convey the current to or from any of such carriages shall not at any place be separated from each other by a distance exceeding one-hundredth part of the distance of either of the conductors at that place from Kew Observatory.

2. If in the opinion of the Commissioners there are at any time reasonable grounds for assuming that by reason of the insulation or conductivity having ceased to be satisfactory a sensible magnetic field has been produced at the Observatory, the Commissioners shall have the right of testing the insulation and conductivity upon giving notice to the Company, who shall afford all necessary facilities to the engineer or officer of the Commissioners or other person appointed by them for the purpose, and the Company shall forthwith take all such steps as shall in the opinion of the Commissioners be required for preventing the production of such field.

3. The Company shall furnish to the Commissioners all necessary particulars of the method of insulation proposed to be adopted and of the distances between the conductors which carry the current to and from the carriages.

BOOKS RECEIVED.

"Electrical Engineering." By W. Slingo and A. Brooker. Revised and enlarged edition. (London: Longmans, Green and Co.) Price 12s.

"The Interpretation of Mathematical Formulæ." By E. J. Houston and A. E. Kennelly. (London: Swan Sonnenschein and Co.) Price 5s.

"Algebra Made Easy." By E. J. Houston and A. E. Kennelly. (London: Swan Sonnenschein and Co.) Price 3s.

"Electricity Made Easy." By E. J. Houston and A. E. Kennelly. (London: Swan Sonnenschein and Co.) Price 6s.

"A Pocket Dictionary of Electrical Words, Terms and Phrases." By E. J. Houston. Fourth Edition. (London: Swan Sonnenschein and Co.) Price 10s.

"The Telephone System of the British Post Office." By T. E. Herbert. (London: Page and Pratt.)

"The Official Gazette of the United States Patent Office," No. 2, Vol. LXXXV. Published by authority of Congress. (Washington: Government Printing Office.)

"Soft Coal Burning," by C. M. Higginson. Fifth Edition. (Chicago: The *Railway Master Mechanic.*)

"Gas and Petroleum Engines," translated and adapted from the French of Henry de Graffigny and edited by A. G. Elliott. (London: Whittaker and Co.) Price 2s. 6d.

"Chemistry in Daily Life." By Dr. Lassar-Cohn. Translated by M. M. Pattison Muir. Second Edition. (London; H. Grevel and Co.) Price 5s.

"The Process Photogram." November, 1898. Edited by H. Snowden Ward and Catherine W. Ward. (London: Dawbarn and Ward.) Price 6d.

Erratum.—In the last line of the footnote on p. 7 of last week's Electricity Works Accounts (Preston), for "£15 Ordinary and Founders' shares," read "£5 Ordinary and Founders' shares."

ELECTRICITY WORKS ACCOUNTS.

Portsmouth Municipal Electric Supply Works.

Electricity supply in Portsmouth having started in operation on June 6, 1894, the accounts of the undertaking up to March 31st last cover the third completed year of working. As our analysis gives evidence of, these accounts show a very satisfactory progress so far as increase of custom goes. On the other hand, in spite of the resulting increased output, the costs have sensibly risen.

The authorised capital now stands at £142,000, and of this a total of £119,651 has been borrowed partly by the issue of Three per Cent. stock and partly by mortgages. The expended capital amounts to £112,174, representing £182 per kilowatt of capacity of generating plant installed. No additions to the mains of street lamps have been made, but through an increase of from 652 to 790 consumers the equivalent 8 c.p. lamp connection has risen some 28 per cent. viz. to 44,616. The corresponding increase in the output is 17 per cent., the units sold last year being 981,273 as compared with 839,392 for the preceding year.

An average price of 3·92d. per unit sold has been obtained, of which 1·14d. accrues from public lighting. The generating, distributing, and public lighting costs all contribute to an increase in the total costs of about 0·2d., as compared with those of 1896-7.

A working profit of £6,862 has been made which has sufficed to wipe out the previous deficit, supply £2,794 towards the redemption of debt, £3,293 interest on loans, and to leave a balance of £384 carried forward.

For the first completed year of working, viz., 1895-6, the output (in units sold) was 406,118, of which 222,398 units were sold to consumers and 183,720 for public lighting. The equivalent lamp connection at the end of the year was 29,490. The revenue was £10,103, and the expenditure £4,011.

Dundee Municipal Electric Supply Works.

Supply by the Dundee undertaking was started on March 15, 1893. The authorised capital stands at £40,000, while £41,450 has been received and £11,750 repaid. A total sum of £39,750 has been expended, representing £71 per kilowatt of plant installed. With an increase of the number of consumers from 257 to 338, an equivalent of 3,429 8 c.p. lamps have been added to the mains, representing an increase in the lamp connections of about 19 per cent. over 1896. The output has reached 323,187 units sold, being 27 per cent. higher than the corresponding value for 1896. The revenue represents an average price obtained of 4·5d. per unit.

It is satisfactory to note that the costs have been materially lowered, viz., by more than a third of a penny, and this in spite of a substantial increase in the items of rents, rates and taxes. Out of the working profit of £2,787 £700 has been paid to the sinking fund, £765 as interest on loans, and £678 repaid to the gas department.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Bedford (Municipal)	Mar. 4	Kensington & Knightsbridge (Co.)	Sept. 30
Belfast (Municipal)	Sept. 23	Kingston-upon-Hull (Municipal)	Aug. 19
Blackpool (Municipal)	Oct. 7	Kingston-upon-Thames (Mun.)	Mar. 25
Bournemouth (Company)	June 3	Lancaster (Municipal)	Oct. 21
Bradford (Municipal)	May 20	Leeds (Company)	April 8
Brighton (Municipal)	May 6	Leyton (Municipal)	Sept. 23
Bristol (Municipal)	July 29	Liverpool (Municipal)	Aug. 12
Burnley (Municipal)	Sept. 16	Manchester (Municipal)	July 29
Burton-upon-Trent (Municipal)	April 15	Newcastle-upon-Tyne (Co.)	April 29
Cambridge (Company)	June 17	Northampton (Company)	April 15
(Central) Kensington (House-to-House (Company)	Sept. 30	Notting Hill (Company)	Mar. 11
		Nottingham (Municipal)	Oct. 28
Charing Cross (Company)	April 22	Oxford (Company)	April 1
Chelsea (Company)	May 20	Preston (Company)	Oct. 28
Cheltenham (Municipal)	Oct. 7	Reading (Company)	Sept. 16
Chester (Municipal)	Oct. 14	Richmond (Company)	Mar. 4
Clerkenwell (Company)	Mar. 18	Scarborough (Company)	April 1
Dover (Company)	Mar. 11	St. James' & Pall Mall (Company)	July 1
Eastbourne (Company)	July 22	St. Pancras (Vestry)	May 13
Edinburgh (Municipal)	Oct. 14	Shoreditch (Vestry)	May 27
Exeter (Municipal)	Aug. 5	Southampton (Municipal)	June 3
Glasgow (Municipal)	Aug. 12	Stafford (Municipal)	Oct. 21
Guildford (Company)	May 13	Sunderland (Municipal)	Aug. 19
Hammersmith (Vestry)	June 10	Taunton (Municipal)	Aug. 5
Hampstead (Municipal)	Sept. 9	Tunbridge Wells (Municipal)	July 22
Hanley (Municipal)	April 8	Wandsworth (Company)	Mar. 18
Harrow (Company)	Sept. 9	Westminster (Company)	April 22
Hastings & St. Leonard's (Co.)	April 29	Wolverhampton (Municipal)	July 15
Hove (Company)	May 6	Worcester (Municipal)	May 13
Huddersfield (Municipal)	Mar. 25	Yarmouth (Municipal)	June 17
Islington (Vestry)	June 24		

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	PORTSMOUTH.		DUNDEE.	
Undertaking Worked by	Portsmouth Corporation.		Dundee Corporation.	
Date of Commencement of Supply	1894.		1893.	
System of Supply	Alternate-current transformer sub-stations.		3-wire continuous current with batteries.	
Chief Engineer	E. Price.		W. H. Tittensor.	
YEAR ENDED	MAR. 31, **1897.**	MAR. 31, **1898.**	DEC. 31, **1898.**	DEC. 31, **1897.**
QUANTITIES—				
Units generated	900,490	1,216,560	319,149	411,521
„ SOLD (TOTAL)	839,392	981,273	254,278	323,187
„ sold to consumers	442,935	591,314	246,804	315,680
„ sold for public lighting, &c.	396,457	389,959	7,474	7,507
„ used on works	37,034	41,298	26,671	41,914
UNITS SOLD PER 8 C.P. LAMP CAPACITY	31·6	37	14·5	18·5
Maximum supply demanded	660	849	346	448
Number of public lamps	257 arc, 482 32-c.p. glow	257 arc, 482 32-c.p. glow	4 arc	4 arc
Number of consumers	652	790	257	338
Connections to mains in 8-c.p. lamps	34,950	44,616	17,945	21,374
CAPACITY OF PLANT IN 8-C.P. LAMPS	26,500	26,500	17,500	17,500
CAPACITY OF PLANT IN KILOWATTS	850	850	560	560
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£109,651 / £129	£,142000 / £167	£40,000 / £71·4	£40,000 / £71·4
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	109,651 / 129	142,000 / 167	40,000 / 71·4	40,000 / 71·4
RECEIVED (TOTAL)	101,651 / 120	119,651 / 141	31,250 / 55·8	41,450 / 74·1
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	101,651 / 120	119,651 / 141	31,250 / 55·8	41,450 / 74·1
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	8,000 / 9·41	22,349 / 26·3	8,750 / 15·6	—[a] / —
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	8,000 / 9·41	22,349 / 26·3	8,750 / 15·6	—[a] / —
REPAID (TOTAL)	— / —	— / —	7,300 / 13·0	11,750 / 21·0
RESERVE OR SINKING FUND	6,333 / 7·45	9,352 / 11·0	191 / 0·341	191 / 0·341
DEPRECIATION FUND	— / —	— / —	— / —	— / —
EXPENDED (TOTAL)	99,744 / 117	112,174 / 132	37,114 / 66·3	39,750 / 71·0
Lands and buildings	13,498 / 15·9	14,010 / 16·5	4,567 / 8·16	4,594 / 8·21
Plant	46,271 / 54·4	50,455 / 59·4	17,686 / 31·6	18,384 / 32·8
Mains	36,938 / 43·5	44,391 / 52·2	11,993 / 21·4	13,904 / 24·8
Miscellaneous	3,036 / 3·57	3,319 / 3·91	2,868 / 5·12	2,868 / 5·12
BALANCE OF CAPITAL ACCOUNT	+1,907 / +2·24	+7,477 / +8·68	−5,864 / −10·5	+1,700 / +3·04
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£14,144 / 4·045d.	£16,025 / 3·922d.	£5,338 / 5·040d.	£6,015 / 4·465d.
Revenue from supply	9,179 / 2·625d.	10,959 / 2·681d.	5,066 / 4·780d.	5,875 / 4·360d.
„ meters, &c.	274 / 0·078d.	383 / 0·094d.	56 / 0·043d.	— / —
„ public lighting	4,519 / 1·293d.	4,646 / 1·136d.	156 / 0·147d.	140 / 0·104d.
„ sale of lamps, &c.	168 / 0·048d.	15 / 0·004d.	— / —	— / —
„ miscellaneous sources	4 / 0·001d.	22 / 0·005d.	60 / 0·057d.	— / —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£7,122 / 2·037d.	£9,163 / 2·240d.	£2,904 / 2·741d.	£3,227 / 2·396d.
WORKS COSTS	5,764 / 1·649d.	7,577 / 1·852d.	1,998 / 1·886d.	2,063 / 1·531d.
Generation of electricity	*4,086 / 1·169d.*	*5,310 / 1·299d.*	*1,647 / 1·554d.*	*1,920 / 1·426d.*
Fuel (including cartage, &c.)	1,968 / 0·563d.	2,622 / 0·642d.	629 / 0·594d.	840 / 0·624d.
Oil, waste, water, stores	521 / 0·149d.	1,000 / 0·245d.	179 / 0·169d.	206 / 0·153d.
Wages at station	790 / 0·226d.	969 / 0·237d.	426 / 0·402d.	532 / 0·395d.
Repairs and maintenance at station	808 / 0·231d.	718 / 0·176d.	413 / 0·390d.	343 / 0·254d.
Distribution of electricity	*550 / 0·157d.*	*813 / 0·199d.*	*329 / 0·311d.*	*26 / 0·019d.*
Wages, &c. } Repairs, renewals of mains, &c.	550 / 0·157d.	813 / 0·199d.	329 / 0·311d.	26 / 0·019d.
Public lighting	*1,128 / 0·323d.*	*1,454 / 0·356d.*	*22 / 0·021d.*	*117 / 0·087d.*
Attendance } Renewals	1,128 / 0·323d.	1,454 / 0·356d.	22 / 0·021d.	117 / 0·087d.
MANAGEMENT AND PROPERTY CHARGES	1,358 / 0·389d.	1,586 / 0·388d.	906 / 0·855d.	1,164 / 0·864d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*320 / 0·092d.*	*397 / 0·097d.*	*498 / 0·470d.*	*701 / 0·520d.*
Management	*1,038 / 0·297d.*	*1,189 / 0·291d.*	*408 / 0·385d.*	*463 / 0·344d.*
Salaries	771 / 0·220d.	965 / 0·236d.	355 / 0·335d.	342 / 0·254d.
Stationery, &c.	54 / 0·015d.	44 / 0·011d.	36 / 0·034d.	38 / 0·028d.
Establishment charges	148 / 0·042d.	168 / 0·041d.	— / —	66 / 0·049d.
Law charges, &c.	65 / 0·019d.	12 / 0·003d.	17[b] / 0·016d.	17[b] / 0·013d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£7,022 / 7·52%	£6,862 / 6·48%	£2,433 / 6·74%	£2,787 / 7·24%
Sum carried to Depreciation Fund	— / —	— / —	— / —	— / —
Sum carried to Reserve or Sinking Fund	1,932[a] / 2·07%	2,794[a] / 2·64%	525 / 1·455%	700 / 1·82%
Net interest on loans (incl. Debenture charges)	2,766 / 2·96%	3,293 / 3·11%	1,019 / 2·82%	765 / 1·99%
BALANCE FROM LAST ACCOUNT	−2,715 / −2·91%	−392 / −0·370%	1,302 / 3·61%	1,064 / 2·77%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	384 / 0·363%	2,191[c] / 6·08%	2,386[d] / 6·21%
Deficit	*392 / 0·420%*	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	50·4%	57·2%	54%	53·7%
Expenditure per kilowatt capacity	£8. 7s. 7d.	£10. 15s. 7d.	£5. 3s. 10d.	£5. 15s. 4d.
REVENUE PER KILOWATT CAPACITY	£16. 12s. 10d.	£18. 17s. 2d.	£9. 10s. 7d.	£10. 14s. 10d.
Expenditure per 8-c. lamp capacity	5s. 4½d.	6s. 11d.	3s. 3¾d.	3s. 8¼d.
REVENUE PER 8-C.P. LAMP CAPACITY	10s. 8d.	12s. 1½d.	6s. 1¼d.	6s. 10½d.
REVENUE PER 8-C.P. LAMP CONNECTED	8s. 1d.	7s. 2d.	5s. 11¼d.	5s. 7½d.
Price charged for lighting, per unit	5d.	4½d.	5d., less 5%	5d. to 4d., less 5%
Price charged for power, per unit	2½d.	2¼d.		
Price charged for public lighting	£18 per arc per ann.	£18 per arc per ann.		

PORTSMOUTH.—REMARKS.—*a* To loans fund for the redemption of debt.

DUNDEE.—REMARKS—*a* £1,450 borrowed over and above the £40,000 sanctioned. *b* Insurance. *c* Out of which £1,127 is "repaid to Gas Department." *d* Out of which £673 is "repaid to Gas Department."

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ELECTRICITY IN CIVIL ENGINEERING.

Electrical engineering receives its highest recognition at the hands of the Institution of Civil Engineers, and the electrical profession is accordingly honoured, by the election of Mr. W. H. Preece to the office of President of that Institution for the ensuing year. As the engineer-in-chief of a State department representing the most important application of electricity to the needs of civilisation, not less than as one whose personal services have done much to advance the uses of electricity in industrial and commercial life, Mr. Preece is well chosen as the representative of the electrical profession to fill that dignified and important post. The presidential address which he delivered on Tuesday evening, upon taking the chair for the first time since his election, attests the manifold and, in the majority of instances, vitally important service which electricity is playing in the direction of the great forces of nature for the use and convenience of man. Itself a "force of nature" that is but little in evidence as a commercially available quantity, it nevertheless serves better than any other of nature's forces the purpose of modifying and directing the energy in nature so that it shall benefit mankind. The address was also, to a large extent, an apology for the State control of the telegraph service of the United Kingdom, and an attempt to show that "the jealousy and contempt so freely displayed for Government work are not justified by results." Mr. Preece believes "it is the fashion to decry the public service," but hopes that his successors will drive home the nail he desires to insert "in the coffin of the traditional general and false belief in the inefficiency of a great and growing public service." A man of many parts, versatile and imaginative, Mr. Preece naturally led his hearers along a large number of paths of electrical engineering, and breathed a breath of life upon the dry bones of manifold statistics and hard technical facts. Passing briefly in review the early part of his address, which deals with the progress of the Institution during the forty years of his membership, we may note that in that period the roll of the Institution has swelled from 894 to 7,088 members; and, at the present time, 71 per cent. are home members, 21 per cent. colonial members, and

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8 per cent. foreign members. An important departure made by the Council of the Institution, comparatively recently, is next commented upon, viz., the system of election by examination which it imposes upon the rank and file of the candidates seeking admission to the Institution. We invite attention to the numbers showing the large percentages of "passes," an indication that the system is working satisfactorily. The popularity of the new measure is shown by the entrance of 71 candidates for the examination last month. Naturally, the subject of engineering examinations leads Mr. PREECE to the kindred topic of Technical Education. Upon this subject, he has some trenchant observations to make. Technical education may be all very well, he implies, but it is possible to do mischief by having the wrong sort of technical education. "We are suffering," he asserts, "from a lack of competent teachers"—a pronunciamento which is followed by a sarcastic diatribe against "the ideal professor of abstract science," who, we are told, "is a very arrogant and dogmatic individual, and, being a sort of little monarch in his own laboratory and lecture-room, surrounded by devoted subjects, his word is law, and he regards the world at large, especially the practical world, as outside his domain and beneath his notice. He is generally behind the age." There are many professors, we think, who do not come up to this "ideal," but who have conferred upon practical engineering many a valuable service, by virtue of their knowledge of the bearing of theory upon practice. Such men are the LODGE and HEAVISIDE and CROOKES of to day, and the FARADAY and DAVY of yesterday.

We now come to the second and major portion of Mr. PREECE'S address, namely, the series of reviews of the progress and present position of the various branches of civil engineering which are associated with the applications of electricity. Telegraphy naturally occupies the premier position. An interesting table shows the extent of the system of British telegraphs, in which there are 485,000 miles of wire belonging to the Post Office and its licencees out of a total of 1,111,866 miles. The crying need for a serviceable insulation compound, to enable wires to be placed undeground, is touched upon; and in this connection the announcement is made that "the cable companies are contemplating leading their long cables from Cornwall up to London" by the same method as that being employed by Mr. PREECE on the 76 conductor buried cable under construction between London and Birmingham, viz., lead-covered paper cables. Under the heading "Railways" Mr. PREECE gives a mass of handy statistical information regarding the extent to which various systems and descriptions of instruments are in use. Telephony also receives due recognition, and to Mr. PREECE, as, indeed, to every Government official, telephony is only a branch of telegraphy. "Telephony," he says, "is an Imperial business, like the post and the telegraph"—a declaration to which we have always subscribed our complete assent. But let it be worked on truly imperial lines, and not for party purposes or in the furtherance of crude socialistic theories. The "assumed bad bargain" in absorbing the telegraphs in 1869 is held to be a deterrent to the absorption of the telephones in the present year of grace. Mr. PREECE makes short work of the assumption, and shows that the present magnificent system of telegraphs has been built virtually out of revenue, and, if now bought out by a syndicate, could be valued at over £30,000,000. The purchase of the "business of the telegraph companies" in 1869 is stated to have been made for £4,989,048; but this is evidently not the whole sum paid and appears to exclude the purchase of plant and other stock. Mr. PREECE, however, is justified by facts in his assertion that "there has been no failure and there was no bad bargain"—and the moral ought to be pointed in the direction of State telephony, which, but for the parsimony in the Treasury of years ago, would long have been *un fait accompli*. Referring, by-the-way, to the same subject of State telephony is an article we publish this week in a later column. Space does not permit of our dealing with the other sections of Mr. PREECE'S address; nor, although these will be read with deep interest, do they call for especial comment. In the address, regarded as a whole, we are presented with a well-instructed and judicial survey of the relation of electricity to civil engineering at the present day.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

A New Magneto-Optic Effect.—D. Macaluso and O. M. Corbino have made the following discovery: A beam of sunlight polarised by a Nicol traverses the magnetic field furnished by a Ruhmkorff electromagnet, and then a second Nicol and a cylindrical lens, finally impinging upon a concave Rowland grating. After introducing between the poles a Bunsen flame with a sodium bead, the two D lines are observed, and they are produced in such a manner that D_2 has a breadth of about a quarter of the distance between them. If, under these conditions, the current is made, bands parallel to the lines are seen on each side of them. From a careful observation of these bands, and their movement on turning the analyser, it is found that they are due to light polarised in various planes, or, more precisely, that the plane of polarisation has undergone, during the passage of the light across the sodium vapour in the magnetic field, a rotation which increases continuously from the outside to the edge of the line. This rotation, which begins to show itself for the line D_2 at a distance more than two-thirds of the interval between the two lines, increases rapidly as the edge is approached, eventually becoming something like 270deg. When the line is broadened, the relative rotation of the outlying portions diminishes, and the bands also broaden out. Examining with Babinet's compensator or a quarter-wave plate, it is found that circularly polarised light is followed by elliptically polarised light in which the ratio of the two axes tends rapidly towards zero. As the lines are broadened, the circularly polarised light disappears completely and the elliptical polarisation is confined to the edges. Similar phenomena, but less pronounced, are obtained with a lithium salt. The explanation must be sought in an inequality of speed of propagation and of absorption of the two circular components of the original radiation under the influence of a magnetic field.

[MACALUSO and CORBINO, *Comptes Rendus*, No. 17, 1898.]

Mutual Influence of Cathode Surfaces.—D. F. Tollenaer endeavours to explain all the phenomena observed by Wiedemann with regard to complex cathodes on the emission theory. Wiedemann introduces a new kind of *horror vacui* by his thesis that cathode rays are incapable of penetrating the dark cathode space of a neighbouring cathode, and cites an experiment in which he mounted a card spread with chalk in the right angle between two cathodes in contact, thus obtaining two dark spaces showing a kind of mutual repulsion. Tollenaer traces out the probable paths of the cathode projectiles and shows that they do penetrate both dark spaces, but are deflected owing to a modification of the field by the vicinity of the other cathode.

[TOLLENAER, *Wied. Ann.*, No. 9, 1898.]

Difference between Röntgen and Cathode Rays.—The argument for the essential identity of cathode and Röntgen rays is based upon the fact that there are various kinds of cathode rays, which, as regards deflectibility and penetrating power, may be arranged in a continuous series. In this series the Röntgen rays obtain an extreme place at the end, where the deflectibility is zero and the absorption by solids a minimum. A

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difficulty occurs at once, through the fact of luminous rays being undeflected and Hertzian waves being unabsorbed under somewhat similar circumstances, which makes the classification of Röntgen rays among cathode rays appear artificial. J. Von Geitler attempts to bring out clearly the essential difference between the two classes of rays by a study of their electrification or ionisation properties. He quotes a number of experiments to show that Röntgen rays are absolutely incapable of conveying a charge. They can equalise opposite charges, by rendering the air between them conducting, but they cannot, like cathode rays, convey an electric charge into the interior of a closed metallic vessel connected to earth, or out of such a vessel into the open air. All this speaks in favour of regarding the Röntgen rays as essentially different from cathode rays, and this desideratum is fulfilled by both the new theories of Röntgen rays now before the public, the English wave theory, in which cathode particles when stopped generate single-wave impulses, and the Dutch corpuscular theory which regards Röntgen rays as discharged cathode particles.

[GEITLER, *Wied. Ann.*, No. 9, 1898.]

Magnetic Iron Ore.—It is interesting to know that certain specimens of magnetite surpass most kinds of steel in their capacity of retaining magnetism. A. Abt has tested specimens of magnetite from Moravicza, in Siebenbürgen. They have a greater degree of remanent magnetism than steel manufactured by the puddling, Bessemer, or Martin processes. But they are surpassed in this respect by certain crucible steels and by tungsten steel, a Westphalian specimen of the latter showing a remanent magnetic moment of 62 units, as against 37 for "diamond steel," 34 for Reschicza crucible steel, 29 for Martin steel, 15 for puddling steel, and only 3 for Bessemer steel. In 122 days a rod of magnetite only lost 1·5 per cent. of its remanent magnetism.

[ABT, *Wied. Ann.*, No. 9, 1898.]

Coherers.—Our knowledge of the nature of coherer actions is not enlarged by the work of E. Aschkinass, but he provides a store of additional material from which to frame the true theory. Without endorsing Branly's view, Aschkinass ventures to advance some important criticisms of the view held by Lodge and his followers, that minute sparks accompanying the coherer action weld the particles together, or form temporary metallic bridges between them. In the first place, that view would not account for the anomalous behaviour of PbO_2 powder, whose resistance is greatly *increased* by the influence of electric radiation, or of copper sulphide, which reacts in a similar way, but not so strongly. Further, when the air is exhausted from a coherer tube to such an extent that all spark discharges cease to pass, its sensitive reaction takes place as before, though the spark explanation hardly holds good. It might be suggested that some temporary chemical action takes place. But this is rendered improbable by the fact that peroxide of lead reacts in the anomalous manner referred to on the slightest provocation, but does not indicate any breaking up into the monoxide or sesquioxide even after prolonged action. And in spite of the observations of Dorn, the author found that good coherers could be made of the noble metals by a somewhat prolonged shaking up. Also, when the surface of copper was chemically cleaned by exposing to a red heat and subsequent plunging into methyl alcohol, the coherer action was as good as ever. The only advantage of a skin of oxide is that the pressure under which the particles are packed may be varied within wider limits. Another item which lacks explanation up to the present is the efficacy of gentle heat in restoring the original resistance. A mere expansion would have just the opposite effect. Neither can a chemical instability of the reduced resistance be called into play, for even a hot coherer acts perfectly. As long as the heating is going on, the coherer will be "self-righting" without concussion—a fact which might be of commercial value. Further, in a complete theory of the coherer the effect of sound waves must find its due place. Lodge's theory, so far the most successful, is probably only a rough approximation to the truth.

[ASCHKINASS, *Wied. Ann.*; No. 10, 1898.]

Duration of Röntgen Ray Emission.—Roiti, Trouton and Colardeau have by various means endeavoured to ascertain the duration of a single X-ray impulse. The values arrived at varied from $\frac{1}{100}$th to $\frac{1}{10000}$th of a second. H. Morize has devised and carried out a method of determining this duration, which he believes to be capable of great accuracy. A photographic plate is fixed on the end of the shaft of a high-speed motor. A metallic slit is mounted in a radial direction just in front of the plate. Photographs are taken when the motor is at rest and when it is moving at a known speed. The images of the slit appear drawn out sideways when the plate moves, and the amount of the broadening is a measure of the duration of the X-ray impulse. The results obtained by this method show that to each current impulse in the primary of the induction coil there correspond several successive impulses of the rays. Successive images of decreasing intensity are thus produced, separated by uniform intervals. On some plates four images can be traced, the last being very feeble. The durations obtained ranged from 65 to 107 millionths of a second, with a mean of 82×10^{-6}. The intervals were 0·00033sec. on the average.

[MORIZE, *Comptes Rendus*, Oct. 17, 1898.]

THE STATE AND THE TELEPHONES.

The Blue Book just issued, containing a verbatim report of the evidence given and copies of documents laid before the Select Parliamentary Committee on Telephones, enables us to recall attention to some of the leading incidents of the inquiry and to the changes of policy, and even of administration, foreshadowed therein. Adopting an intelligent view of its "Reference," which really begged the whole question, the Committee set itself to inquire, Whether the telephone service is now or is calculated to become of general benefit? secondly, Is the Post Office hindered by legal agreement or by good faith from competing itself or through licencees with the National Telephone Co. in exchange areas? lastly, Ought competition to take place, and should municipal or other local authorities be empowered to undertake a telephone service; and if so, on what terms? We have said that the terms of Reference begged the question by virtually assuming that the telephone service may become "of such general benefit" as to justify its being undertaken by local authorities. Many of the members, including the chairman, proceeded on this assumption throughout, their line of cross-examination being directed mainly to elicit evidence that the system is not of general utility now, and that it would be so if local bodies took it in hand. Of course, there was no lack of witnesses representing, directly or indirectly, the two or three municipalities who are prime movers in this inquiry; but their testimony was challenged in every particular by experienced officials, not only of the offending Company but by the permanent and Parliamentary representatives of the Post Office. As to inefficiency, the chief complaint came from Glasgow, where admittedly the Company have been wilfully obstructed by the Corporation; and as regards other charges, they were either disproved altogether, or shown to be ancient history. Even as regards high rentals, the comparisons sought to be made between this and other countries turned out to be fallacious, or were vitiated by circumstances over which neither the Company nor the Post Office has any control, the Treasury alone being responsible. The same explanation was given of the comparative unpopularity of the telephone in these islands—that is to say, of its not being popularly used by the general public, like the telegraphs—the fact being that the Post Office is forbidden to canvass for custom, whilst the Company is bound to work its business as a paying concern. The Treasury is alike answerable for the prohibition, and, primarily, for the telephone business being vested in the hands of private monopolists, with whom the Post Office is not permitted to effectively compete or allow anybody else to compete, for fear of damaging its own sources of revenue. These facts came out early in the inquiry, together with the further facts that successive Postmaster-

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Generals, Secretaries and Chancellors of the Exchequer had, after due experience of competition, expressed themselves emphatically against it in the interests of the public. These views were shared by the Post Office officials, who, while declaring their ability to compete if given a free hand, strongly deprecated it in any shape or form under present conditions, and especially in view of the short period which has to elapse before the State must perforce, as they contend, take the telephone business into its own hands. The Treasury itself was cognisant of these views, and gave expression to similar opinions of its own, though always safeguarding itself by jealously retaining the legal right to compete if the necessity arose—a right which its licensee, the Telephone Company, has never disputed. Its chairman had frequent interviews with the high officials we have named; and notably during negotiations, which lasted from 1892 to 1896 with reference to the acquisition of the company's trunk lines by the Government, the policy of the Department and of the Treasury was fully disclosed and discussed by all the parties—the company endeavouring on its part to get these views of policy embodied in the documents, the Department on its side declining to do more than give verbal assurances, fearing to part with its last remaining weapon of control, namely, the right to compete, or issue competing licences, if the company misbehaved itself.

It is important to bear these facts in mind when considering the line taken up with regard to them by the Committee. The facts could not be gainsaid; how were they to be made of non-effect? One course remained for the Committee if it meant to disregard the assurances of the higher officials and pin them to the legal wording of the documents to which they had put their signatures; and this was to attack the permanent responsible officials of the Post Office. No one present at the enquiry, or who has read the hostile and we may almost say vindictive cross-examination to which those officers were subjected, can fail to see the unfairness of the whole proceeding. Mr. Preece was a very strong witness, his bluff and outspoken declarations provoking a good deal of irritation and futile criticism on the part of his inexpert and ill-informed questioners, who, when they could do nothing better, endeavoured to cast discredit on his estimates, or fasten upon him the responsibilities which had been proved, over and over again, to rest with the Government. In this respect the evidence of Mr. Preece was in entire agreement with that of Mr. Lamb and others, as to the uphill work created for them by the Government, first in granting competing licences without due regard to the Post Office rights, and afterwards by restricting its powers of effective control by competition on business lines. Mr. Lamb, who fared much worse even than the Engineer-in-Chief, put in a document which it may be well to reproduce here, bearing, as it does, upon this material point. It is part of a letter from the Treasury, signed by Mr, Courtney as long ago as 1883, and which has been operative ever since :—

800. . . . "In reply to these arguments my Lords have to observe that they find no evidence that the extension of the business is necessary in order to maintain the profit on the capital already sunk in it. It is new profit, therefore, not the maintenance of the old, which has to be weighed against the general objection to the appearance of the State as a competitor in trade. The sound principle, in the opinion of my Lords, is that the State, as regards all functions which are not by their nature exclusively its own, should at most be ready to supplement, not endeavour to supersede private enterprise, and that a rough, but not inaccurate test of the legitimacy of its procedure is not to act in anticipation of possible demand. My Lords do not propose to push this doctrine so far as to exclude declarations in Parliament, the affixing of notices in Post Offices, and such like means of showing what business you are ready to undertake; but they object to anything in the nature of solicitation, and above all of personal solicitation. For these reasons they are not prepared to approve of the appointment of travelling clerks." Then they go on: "For all these reasons, my Lords do not wish you to do more, in respect of exchanges and private wires, than to bring your offers fairly within the knowledge of the public, and to wait for their demands upon you."

801. Do you know whether that was the Treasury minute that induced Mr. Fawcett, who was then Postmaster-General, to encourage free competition between the companies?—I do not think it was.

802. Was not it the fact that he not being able to carry on the telephone service on behalf of the Postmaster-General in the same way as a private firm would carry it on, he decided to throw the whole thing open to competition?—I think that that letter had its influence, but I do not think that that letter stood alone.

This explains the failure of Departmental competition; and it did not take many years of unlimited competition, outside, to show that the whole system was becoming chaotic and dangerous to public interests. One of the principal competitors gradually absorbed all the rest; and there is evidence to show that this process was countenanced and even encouraged, not by the Post Office alone but by the Treasury, with the obvious aim of more efficiently serving the general public, rendering the control more manageable, and the prospective transfer to the State more easy. The Post Office, in the first instance, appears to have signed away its exclusive rights in the telephone most reluctantly, but being compelled to do so, it made, as Mr. Lamb said, the best of a bad job, always working in harmony with Treasury instructions. These instructions have gradually resulted in the amalgamation of all the companies, the creation of a virtual monopoly in the National Telephone Co., and finally the acquisition of its trunk lines by the State. All this in pursuance of a distinct policy, clearly defined, though slow in operation, openly avowed and freely discussed by all the parties concerned. The Company has, therefore, become sole agent for, or virtual partner with, the Post Office, so far at least as the Exchange areas are concerned, with rights reserved by the Post Office to compete on good reason being shown. Needless to say, no reason has been shown since the negotiations, which began in 1892, and which in their very nature constituted a working agreement between the two contracting parties. Our surprise at the suggestion that one of the parties should now be asked to authorise competitors against the other party would be very great indeed, were it not for the still more surprising manner in which those who make the suggestion have treated the secretary of the Post Office charged with the conduct of those negotiations. Mr. Lamb has been intimately associated with the administration of the telegraphs ever since their transfer to the State, and on the death of Mr. Patey, succeeded him as head of the Telegraph and Telephone Departments. Upon him, therefore, the Committee appear to have thrown the blame of everything not to their liking, in respect of the Department's present relations with the National Telephone Co. To begin with, he was accused of being party to the initialling of the heads of an important agreement with the Company on the eve of Sir James Fergusson's retirement, the insinuation being that the transaction was rushed through to avoid its being upset by his successor. It turned out to be merely the completion of old negotiations, which, amongst other business, it was right and proper should be disposed of by the Postmaster-General who had dealt with them. Mr. Arnold Morley, his successor, not only approved these heads of agreement but handed over the delimitation of areas provisionally arranged therein to Mr. Lamb's discretion, a discretion which he continued to exercise without fresh authority from Mr. Morley's successor, but which the Committee treated as having no authority at all, although shown to be in conformity with official usage. A Treasury Minute quoted by Sir Jas. Fergusson, dated 1892, clearly indicates the policy at that time.

2,248. . . . "As to fresh licences, no further licence for the whole country will be granted; and even for a licence to establish an exchange in a particular town, no application will be entertained unless a formal resolution in its favour has been passed by the Corporation, or other municipal authority, and evidence given that there is sufficient capital subscribed to carry out the undertaking. In this way competition will not be excluded, but a check will be imposed on the formation of companies whose sole object is to force the existing licensees to buy them up."

The drift of this is to put an end to competition, and it is plain that the idea of municipalities themselves competing had not then been thought of; consequently, no steps had ever been taken to facilitate such competition. For this the Committee thought fit to implicitly condemn Mr. Lamb, just as if the objections which are inherent to all schemes of telephonic competition whatsoever were of his creation.

Coming now to the year 1893, one or two powerful municipalities commenced an agitation for telephonic service in their own hands; and the National Telephone Co., who were then negotiating the transfer of their trunk lines, at once wrote to the Post Office expressing alarm, and suggesting preventive measures. The following is an extract from the

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famous letter of February 9, 1898, arising out of an application from the Glasgow Town Council:—

8,596. . . . "With the trunk wires connecting town and town in the hands of the Company, the Company have no reason to apprehend danger but with such trunk wires in the hands of the Government the very existence of the Company is threatened, should it be the policy of the Department either to favour the municipalisation of the local service, or to give way to that policy under Parliamentary pressure. You may say, and with perfect truth, that the *status quo* has undergone no change since the time when the heads of arrangement were signed by Sir James Fergusson and Mr. Forbes, but there is an essential difference between possibilities and probabilities, and as it has now been brought home to us that the condition of affairs which I have indicated is within the range of practical politics, I venture to think that it is the duty of the Board of Directors of this Company to ascertain the views and policy of the Department, and to safeguard the interests of their shareholders in the pending arrangements before it is too late, and they have parted from their great source of strength, viz., the trunk lines. There are two ways of dealing with the matter: (1) The constitution of large areas comprising within them all the towns surrounding each great centre with which such towns have community of interest, *e.g.*, take the case of Manchester. The Company have constituted Manchester and each of the following towns surrounding it, viz., Bolton, Bury, Rochdale, Oldham, Ashton, Stockport, and Glossop, separate areas. All these places centre upon Manchester, and have close business relations with it, and if they were all put together into one area the Company would have the protection which they have now, and to which they are entitled, because the inter-communication between those towns being in the hands of the Company there would be no inducement on the part of the separate municipalities to set up separate systems. It is true that the constitution of large areas such as I have indicated would trench upon the Post Office revenue, but that might be met by providing for an adequate payment by the Company to the Department. (2) The insertion in the agreement now in negotiation between the Department and the Company of provisions rendering it impracticable for the Department to grant licences to municipal or other local authorities. I would venture to point out that there is nothing in the Treasury minute of last session inconsistent with the insertion of such provisions."

To these suggestions the Postmaster-General, in a letter dated March 13, 1898, and signed by Mr. Lamb, gave a courteous but flat refusal, and there the matter ended. The correspondence was duly submitted to the Treasury; but it does not appear to have been brought specially to the notice of the present Chief Secretary of the Post Office or the present Postmaster-General. This correspondence is referred to in the Report as "the two remarkable letters"; and the Chairman's cross-examination was directed to show that Mr. Lamb had secreted these letters away from his chiefs, and that, notwithstanding the refusal to enlarge the areas, he had in reality enlarged them in the interests of the Company. Hours were spent in badgering the witness on these grave points, and it was not until nearly the end of the proceedings that he was permitted to explain the wide distinction between the large areas asked for and the grouped local areas actually granted:—

Chairman.

8,878. "The question of large areas is, of course, a question of degree; what one person might think a large area another might think a small area. The principle involved, as I understand it, in the Company's suggestion was, for instance, that there should be no two towns in one area?—No, sir. The Company mentioned in their letter eight areas which were to be grouped in one district, and each of those eight areas already included more than one town, and the suggestion was that instead of areas based on the principles which had been agreed upon with the Treasury, they should have great districts of country combining areas of that kind; and that suggestion was never accepted, and was never acted upon."

8,879. "I may be wrong, but is not the principle at the bottom of the suggestion of the Company that large areas would interfere with municipal licences; thus, that if you had two municipalities within one area, it would be difficult to get either of those municipalities to agree to be under the jurisdiction of the other for telephone purposes?—No, sir; it was admitted from the earliest days that there ought to be and would be cases in which two or more towns would be grouped together; but what was denied the Company in this case was the amalgamation of a series of areas of that kind into one district."

This explanation, however, not fitting in with the fixed ideas of the Committee, was treated as meaningless, and the history of the "two remarkable letters" pursued with a persistency and ascerbity which could bear but one interpretation, namely, a set determination to make the Secretary for the Telegraphs the scapegoat for the sins of the Government, past and present. That he will be cast out into the wilderness we find it hard to believe, though there are sinister rumours afloat as to his being superseded. But whatever happens, the candid reader of this Blue Book will perceive that a Parliamentary Committee is imbued with party spirit as strongly as Parliament itself, and that it is not exactly a tribunal where questions of personal rectitude or official fidelity can be tried with judicial fairness.

A NEW PATTERN OF PREECE-TROTTER PHOTOMETER.

A new form of illumination photometer, on the Preece-Trotter principle, has been brought out by Messrs. Nalder Bros. and Co. While said to give results of equal accuracy with those of the old pattern, it has the advantage of less than half the weight and bulk, and what is even more important, its cost is also considerably less than the original Preece-Trotter instrument. In place of an incandescent lamp and accumulator, an amyl-acetate lamp is employed. Fig. 1

FIG. 1.—General View of Illumination Photometer.

is a general view of the instrument, and Fig. 2 is a sectional elevation showing the construction. The height of the lamp A is adjusted by screwing the lamp-holder in or out until the top of the flame just touches the point of a bent arm (not shown in the figure), as observed in the mirror M. The cap covering the paper screen S is then removed, and the photometer is set so that the screen is horizontal. There is a slit T in the screen through which the inside screen R is seen, and

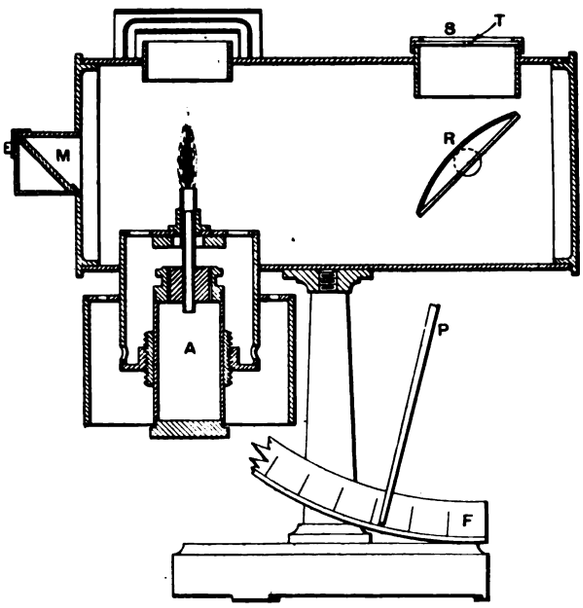

FIG. 2.—Sectional Elevation of Instrument.

the illumination of the slit is balanced to equal that of the upper screen by turning R by means of the arm P. A pointer is attached to this arm, and indicates on the scale F the illumination directly in candle-feet. The inside screen has a slightly bluish tint to remove the colour difficulty to some extent. A convenient case is supplied for containing the instrument, fitted with an oil can and scissors for trimming the lamp, and very explicit instructions for use are issued with each photometer.

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MR. W. H. PREECE'S PRESIDENTIAL ADDRESS TO THE INSTITUTION OF CIVIL ENGINEERS.*

The election to the position of President is the highest possible reward which the Institution can give to those who have endeavoured to serve it well and truly. I have often feared that my position as a specialist might have proved a bar to the attainment of my greatest ambition. It has come at last. I am also proud, not alone for the sake of that branch of the profession to which I specially belong, but also because I am a member of the great Civil Service of this country. Twenty-eight of my 46 years of professional work have been spent in the service of the Crown. The jealousy and contempt so freely displayed for Government work are not justified by results. It is the fashion to decry the public service, My successors will be able to drive home the nail I desire to insert in the coffin of the traditional general and false belief in the inefficiency of a great and growing public service.

Examinations.

Our great European rivals relegate the examination and selection of their engineers to their Governments, but we, under the guidance of our immediate Past-President, have taken this load on our own shoulders ; not before it was needed, for the competition of highly educated engineers of other countries was becoming rather too evident. Loss of business is a potent force to effect reform. The reform itself in our case has materially strengthened the credentials of our Institution. Our task has been a difficult one, for, while we recognise most fully that the practical training of the drawing-office, of the shop and of works in progress are the true school for the engineer, we cannot help thinking that he ought to acquire that knowledge which is the basis of his profession and those exact methods of inquiry and of thought which lead to truthful deduction and to sound judgment, before he can satisfactorily begin his professional experience. The foundation of engineering is science. Science is not only a knowledge of the facts of nature, but of the development of her laws. It is, in the language of Huxley, organised common sense. The man who determines to practise in the business of applying those facts and laws to add to the comfort and happiness of mankind must know something of the mental tools and weapons that mathematics and logic have placed at his disposal. His mind must be trained to habits of inquiry, and he should know something of the experience and teaching of the past. Hence the Institution, as the tutelary genius of the profession, has established a system of qualifying, not competing, examinations for admission into its ranks ; not only to test the education and preparation of those who wish to recruit our numbers, and the qulaifications of those who desire to improve their position in our classes, but also to enhance the standing of the modern engineer as the most scientific and advanced of all the learned professions. The result of the first examinations has been highly satisfactory. Out of 24 examined for studentship, three only failed to pass. Of 40 examined for Associate Membership, seven failed. Of 48 theses submitted in lieu of examination, five only failed to secure a satisfactory report. The popularity of the measure among even the examinees is shown by the entrance of 71 for this last October examination. The examination papers which have been set are by no means of an insignificant character, yet 86 per cent. of marks have been acquired on the whole examination.

Technical Education.

There is a fashion in Great Britain for technical education just now. Enormous sums of money are being annually spent on secondary, intermediate, and more advanced education. It is well that it is so. It is well that the country has awakened from its conservatism and apathy, and that it is putting its schools in order. But is it doing so on a true issue, and are we distributing our money through the right channels? Our trade is suffering even in our own colonies from the competition of our continental neighbours, who are said to be beating us by their technically superior hand labour. It is true we are suffering, but is this the true cause? It is rather from the superior commercial skill of the principals at home and the accomplished polyglot and well-trained traveller abroad, as well as from a financial system that is more moral and more sound than that rampant in England through the gross abuses of the Limited Liability Act of 1862. Our law courts are almost daily the scenes of the exposure of the modern spoiling of the Egyptians. A new industry is designed by some simple, well-devised, and economical process. Capital is required to develop it. In Germany, financial support is readily subscribed by the generous and enlightened policy of its banks. In England we require a syndicate, a pioneer company, and finally an appeal to the public for an enlarged limited company. The financiers, the lawyers, the brokers, as well as the original inventor, have to be satisfied, and this satisfaction grows very much with the state of the money market and the excitement for investment with the public. The industry is established, but with a terribly overloaded capital—overloaded by the harpies who have sprung from the operations of the Limited Liability Act. The same industry could be established in Germany with probably half the capital. Its manufacture would be supervised there with greater skill, and it would be developed as a business by better trained agents. We are thus fairly beaten on our own commercial preserves. Our educational methods have begun at the wrong end. We ought to teach the masters first and then the men. Moreover, we have to teach the teachers and those who have control of the purse-strings. The County Councils of England are scarcely qualified as yet to discharge the very serious duty of properly dealing with a question so few of them understand—though many of them have tackled the matter manfully, especially the London County Council, through its Technical Education Board, on which a large proportion of co-opted experts have seats, who, by supporting existing institutions, have contributed towards the supply of teachers. But how are we to approach the masters? A fault once discovered is half-way to repair. It is difficult to remove the scales from the eyes of the man who has been successful in business and who knows not of his blindness ; but the coming generation will be more enlightened, and the future masters better educated. We are suffering from a lack of competent teachers. A teacher who has had no training in the practical world is worse than useless, for he imparts ideas derived from his inner consciousness or from the false teaching of his own abstract professor, which lead to mischief. In my own experience I have met with very serious inconveniences from this cause. The ideal professor of pure abstract science is a very charming personage, but he is a very arrogant and dogmatic individual, and, being a sort of little monarch in his own laboratory and lecture-room, surrounded by his devoted subjects, his word is law, and he regards the world at large, especially the practical world, as outside his domain and beneath his notice. He is generally behind the age. These are not the men for technical institutes. Such teachers should possess the diploma of this Institution.

Telegraphy.

The extent of the present system of British telegraphs is shown by the following table :—

	Miles of wire.
General Post Office and its licensees	435,000
Railway companies	105,000
India and Colonies	387,966
Submarine cables	183,400
Total	1,111,366

The form of submarine cable and the nature of the materials used in its construction have varied but very little since the first cable was laid in 1851. The recent invasion of our channels and seas by the *Limnoria terebrans*, a mischievous little crustacean which bores through the gutta-percha insulating covering, and exposes the copper conductor to the sea-water, leading to its certain destruction, has led to the use of a serving of brass tape as a defence. It has proved most effective. No one has done more than Lord Kelvin to improve the working of submarine cables. His recording apparatus is almost universally employed on long cables. The number of electrical impulses which can be sent through any cable per minute is dependent upon its form, and is subject to simple and exact laws, but it varies with the quality and purity of the materials used. There is no difficulty in maintaining the purity of copper. The purity of gutta-percha is, however, questionable. The supply of this dielectric has dwindled ; it has failed to meet the demand ; its cultivation has been neglected. The result is a dearth of the commodity, a great increase in price, and its adulteration by spurious gums. India-rubber, its sole competitor for cables, is being absorbed for waterproof garments and pneumatic tyres, but for underground purposes paper is being used to an enormous extent. Paper has the merit, when kept dry, not only of being an admirable insulator, but of being very durable. There is paper in existence in our libraries over 1,000 years old. The difficulty is to keep it dry. This is one of the problems the engineer delights to consider. He has been most successful in obtaining a solution. The lead-covered paper cables, which are being laid in the streets of all our great cities, are admirable. I am laying one of 76 wires for the Post Office telegraphs between London and Birmingham, and the cable companies are contemplating leading their long cables from Cornwall up to London, so as to be free from the weather troubles of this wet and stormy island.

It is impossible to forecast the future of telegraphy. The introduction of the telephone is revolutionising the mode of transacting business. There seems to be a distinct want of some instrument to record the fleeting words and figures of bargains and orders transmitted by telephone. Hence a supplement to that marvellous machine is needed. The telautograph and electrical type-writer will fill this want. Visions of dispensing with wires altogether

*Abstract of an Address delivered by Mr. W. H. Preece, C.B., F.R.S., on November 1, 1898.

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have been fostered by the popularity of Marconi's "wireless telegraphy"; but wireless telegraphy is as old as telegraphy itself, and a practical system of my own is now in actual use by the Post Office and the War Department. Sensational experiments for booming a new financial enterprise are not processes that commend themselves to the Institution. We want practical work and engineering progress.

Telephony.

I was sent, in 1877, together with Sir Henry Fischer, to investigate the telegraph system of the American Continent, and especially to inquire into the accuracy of the incredible report that a young Scotchman named Bell had succeeded in transmitting the human voice along wires to great distances by electricity. I returned from the States with the first pair of practical instruments that reached this country. They differed but little from the instrument that is used to-day to receive the sounds. The receiver, the part of the telephone that converts the energy of electric currents into sounds that reproduce speech, sprang nearly perfect in all its beauty and startling effect, from the hands of Graham Bell. But the transmitting portion, that part which transforms the energy of the human voice into electric currents, has constantly been improved since Edison and Hughes showed us how to use the varying resistance of carbon in a loose condition, subject to change of pressure and of motion under the influence of sonorous vibrations. The third portion, the circuit, is that to the improvement of which I have devoted my special attention. Speech is now practically possible between any two post-offices in the United Kingdom. We can also speak between many important towns in England and in France. It is theoretically possible to talk with every capital in Europe, and we are now considering the submersion of special telephone cables to Belgium, Holland and Germany. The progress of the use of the telephone in Great Britain has been checked by financial complications. It fell into the hands of the company promoter. It has remained the shuttlecock of the Stock Exchange. It is the function of the Postmaster-General to work for the public every system of inter-communication of thought which affects the interests of the whole nation. Telephony is an imperial business, like the post and the telegraph. It ought to be in the hands of the State. The public and the press have frequently kicked violently against the present régime. Committees of Parliament have sat and deliberated upon the question. The report of the last committee is now under consideration.

"*Quidquid delirant reges, plectuntur Achivi.*"

Two causes exist to impede this desirable absorption, the fear of being "done" by watered and inflated capital, and the assumed bad bargain made in absorbing the telegraphs in 1869. The former is a mere bugbear. The public does not want to purchase stock. It wants to acquire a plant and business which can be easily and fairly valued. The latter is a gross fallacy. The business of the telegraph companies—practically an unlimited monopoly—was purchased on absolutely fair terms, viz., 20 years' purchase of the net profits. The sum paid was £4,989,048. The number of messages then sent in one year was about 5,000,000, and the gross income about £500,000. The income has now grown to £3,071,723, the number of messages has reached 83,029,999, and the capital account which was closed in 1891, viz., £10,131,129, including the cost of the Post Office extensions, remained the same. If a syndicate desired now to repurchase the business and acquire the plant, they would have to find a capital of over £30,000,000. In what respect, then, was the transfer of the telegraphs to the State a failure? Our magnificent system has been built virtually out of revenue, our tariff is very cheap, scarcely a village of any consequence is without its telegraph, our Press is virtually subsidised by having its news supplied at much less than cost price; we can rely upon safe and accurate delivery, and upon speedy despatch of messages. We lead the world. There has been no failure, and there was no bad bargain. The present condition of the telephone business in this country is shown by the following return:—

Telephones in use.

National Telephone Co. (June 30, 1898)	.....	133,498
General Post Office	ditto	9,588
Railway Companies	ditto	8,933
Total	.....	152,019

Railways.

The regulation of the traffic on a railway, and the general business of the line, could not possibly be conducted without the telegraph. The safety of the passenger and the freedom from collision are due to the introduction of the block system, which is worked entirely by electric signals, and which has been made compulsory by Parliament on all British railways. The employment of electricity in the working of railways has not only been highly beneficent in the security of human life, but it has vastly increased the capacity of a road to carry trains. The underground traffic of the metropolis is conducted with marvellous regularity and security, though the trains are burrowing about in darkness and following each other with such short intervals of time, that the limit of the line for the number of trains has been reached. Electric traction is going to extend this limit by increasing the acceleration at starting and improving the speed of running. It will also reduce the cost of working per train-mile, so that the advent of electricity as a moving agency is certain to prove highly economical. What it will do as a remover of bad smells and foul air and for personal comfort cannot be estimated. Time alone will enable us to assess the intrinsic value of public satisfaction acquired by the change. The extent to which electrical appliances are used on the railways of this country is shown by the following tables. Table I. gives the length of double and single line in the United Kingdom open for passenger traffic on December 31, 1895, the latest period for which returns have been published, and the length of such lines worked upon the various systems:—

—	Line open for passenger traffic.		Worked on absolute-block system.				Worked on other telegraph systems.		Single lines worked under.		
				Single line.							
	Double.	Single.	Double line.	Combined with train-staff system.	Without train-staff system.	By electrically-controlled train-staff or tablet.	Double line.	Single line.	Single-engine system.	Train-porter system.	Train-staff system.
	Mls.	Mls.	Mls.	Mls.	Mls.	Mls.	Mls.	Mls.	Mls.	Mls.	Mls.
England & Wales.	9,325	4,472	9,310	2,200	20	1,847	15	29	228	1	147
Scotland.	1,314	1,768	1,312	210	32	1,066	1	...	427	1	31
Ireland...	613	2,534	613	494	1	1,824	...	...	118	...	98
United Kingdom	11,252	8,774	11,235	2,904	53	4,737	16	29	773	2	276

Table II. gives the number and description of the various classes of electrical apparatus in use on railways in the United Kingdom in the year 1898:—

Single needle	13,494	Galvanometers	390
Morse sounders	431	Large trembler bells (platform, &c.)	2,063
Morse recorders	105		
Telephones	12,043	Small trembler bells	5,913
Duplex apparatus (complete)	26	Night and day switches	4,527
Bell instruments (for message work, complete, with keys, relay & galvanometers, &c.)	425	Fire-alarm commutators	96
		Train describers	1,122
		Light indicators	1,100
Phonopores (complete)	110	Signal repeater disks	924
Block instruments	27,146	Test-boxes	27
Train staff instruments	673	Water-tank apparatus	13
Tyer's tablet instruments	1,137	Telephone switchboards	17
Interlocking instruments	4,275	Bell indicators	86
Repeater instruments	18,450	Point detector	1
Treadles	1,658	Signal lever lock	230
Fouling bars	452	Extra contact-markers and switches	539
Fouling bar indicators	224		
Replacers	31	Magneto-electric bells	4
Slot selectors	368		
Single-stroke and relay bells	18,447	Total	115,247

Electric Light.

But it is in supplying us with light, without defiling the air we breathe in our dwellings with noxious vapour, that electricity has proved to be a true benefactor to the human race. The Legislature has facilitated the acquisition by municipalities of those local industries that affect the welfare of the whole community, such as road-making, sewerage, the supply of water, tramways, and, above all, electric light. No one doubts that new industries of a speculative character are best pioneered by private enterprise. The company promoter, has, however, so abused the power placed in his hands by the Limited Liability Act that, not only has the development of electric lighting been retarded in this country, but the prospects of private enterprise in furthering other industries has been checked. Fortunately the success, the comfort, the intrinsic value, the economy and the sanitary properties of electric light have commended it to our municipal magnates, and its introduction has become the fashion. The table on the opposite page shows the position of the industry in this country and in the United States at the present time.

In spite of our financial troubles, of the inertia of municipal bodies, of the active competition of vested interests, our progress compares not unfavourably with other European countries, but the progress of the industry in the United States has been phenomenal. The return for the United Kingdom is, however, by no means complete. It omits all private installations. We in the Post Office alone have 50,000 lamps which are not enumerated;

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Electric Light Undertakings.

—	United Kingdom.		United States.	
	M'nicipalities.	Companies.	M'nicipalities.	Companies.
Number of central stations...	72	63	338	2,251
Capital stock ...	£4,599,154	£3,258,343	£3,419,019	£48,207,527
Number of arcs.	5,753	1,259	26,087	265,064
Number of glows	1,393,514	1,936,893	693,984	14,278,358
Kilow'tt capacity	44,219	24,344	41,193	578,051

and if we consider all our great railway companies, banks, warehouses, manufactories, and shops which have their own installations, the statistics will be very considerably extended. Lamps are being improved and cheapened, wiring is being reduced in cost, and the economic distribution of energy is being furthered. But the most promising field for economy is the combination of all classes of electrical industry in one centre, especially that of light and tramway working where fuel is cheap, water abundant for condensing, and nuisances of no account. The cost of the production of electrical energy depends principally upon the continuity of its output. If it can be generated continuously during the 24 hours of the day its cost is only a fraction of a penny per unit. If it is used solely for light, a unit may cost threepence. Hence local authorities, who are undertakers of electric energy, neglect their duty to those who have elected them as the custodians of their interests if they fail to secure the tramways in their district, either as their own property or as customers for their current. For the tramways, by taking energy during the day, reduce the cost of working during the night by removing the incubus of running continuously imposed on undertakers by Act of Parliament. This may enable the ratepayers to be supplied at a price for electric light certainly one penny per unit less than if there were no tramways. The cheaper the supply of energy per unit the more certain and speedy the advent of the electric light as the poor man's lamp, and the more beneficial its introduction into the confined, ill-ventilated and overcrowded homes of the working classes.

It is on board ship that electric light has been pre-eminently successful, and where it filled such a crying want that its introduction met with no check. It was almost immediately and universally adopted. Search lights, prompted by the great development of the torpedo, were introduced into our Navy as early as 1875 by Mr. Henry Wilde. The first ship to be fitted with internal electric lighting was the "Inflexible" in 1882. In 1884 the Admiralty ordered it to be applied to all H.M. warships. The first application of electrical power was in the case of H.M.S. "Barfleur," where motors were used for working guns and for the supply of ammunition. It has subsequently been partially extended to the working of gun-turrets, ventilating fans, capstans, and boat-hoisting gear; but hydraulics, the child of our venerable Past-President, Lord Armstrong, is the form still more generally preferred and used for power in our Navy, though other nations make a much more extended use of electricity. The technical reports received by the United States Navy Department indicate that the electrical appliances on their warships worked very successfully during the recent war. Electrical conductors are readily stowed away in safe quarters, and easily repaired when severed by shot. The electrical energy used in a first-class battleship is expended thus :—

Internal lighting	60	E.H.P.
Search-lights	65	"
Ventilation	30	"
Capstans, hoists, &c.	60	"
Reserve	45	"
Total	260	"
Number of glow-lamps	1,000	
" " search-lamps	6	
" " ventilating fans	16	
" " motors	2 to 8	

The following table illustrates the progress of electric work done by that branch of the service which is so eminently presided over by our Vice-President, Sir W. H. White :—

Year.	Ships fitted with electricity.		Total number fitted.		Electric machinery.	
	Search lights.	Internal lighting.	Search lights.	Internal lighting. Number of lamps.	Number of sets fitted.	Total E.H.P.
1876	Nil	Nil	Nil	Nil	Nil	Nil
1876 to 1880 ...	19	Nil	38	Nil	19	33
1880 " 1884 ...	30	1	50	...	30	120
1884 " 1888 ...	150	30	220	8,000	180	3,700
1888 " 1894 ...	265	126	750	50,000	450	15,000
1894 " 1898 ...	500	240	1,100	95,000	800	25,000

(To be concluded.)

PHYSICAL SOCIETY.

At an ordinary meeting of the Physical Society, on October 28th, Mr. Shelford Bidwell, president, in the chair, a Paper was read by Mr. W. R. PIDGEON on

"An Influence Machine."

The machine, which was exhibited, consists of a pair of glass discs, rotating in opposite directions upon a spindle. They are partially covered on one face with narrow radial sectors of tinfoil, each provided with a small brass knob. This face of the disc, including its sectors, is then coated with insulating wax, leaving only the knobs projecting through the wax. Two earthing brushes pass through two insulated fixed inductors, and support them. The inductors are kept charged by exploring-points connected to each, and placed so as to collect electricity from the revolving discs. By means of brushes, the sectors on each of the discs are successively earthed at the moment they pass the fixed inductors, *i.e.*, at the moment that their capacity is a maximum; and they are made to deliver up their charge to the main collecting brushes at the moment when they are electrically farthest from the inductors, *i.e.*, when their capacity is a minimum. Hence, if there is no loss of electricity in the process, the potential at the collecting brushes is proportionately high. Each sector of a particular disc, as it moves away from its inductor with rising potential, induces a corresponding potential on the sectors opposed to it on the second disc; this action is cumulative. The thick coating of wax restricts leakage to the small area of the contact knobs, so that surface effects of dirt and moisture are minimised.

Capt. J. H. THOMSON, R.E., said that, apart from its electrical merits, the machine possessed advantages in mechanical construction. He thought there was still room for improvement in this respect. The countershaft should be done away with, and ball-bearings should be introduced. The inductor was a distinct improvement; he thought the efficiency might be increased by adding other inductors. Platinum-iridium was the best material for brushes of such machines.

Prof. AYRTON asked what efficiency was obtained with modern influence machines, in general.

Capt. THOMSON had found that when running a machine by a motor, about 80 per cent. of the power was wasted in mechanical friction, and of the remaining 20 per cent. a great deal was lost as electrical leakage.

Dr. S. P. THOMPSON thought it had been pointed out by Mr. Wimshurst that influence machines did not work well unless there were at least two thicknesses of glass between the inducing and induced conductors. That was why Mr. Wimshurst put his sectors on the outer faces of the glass disc. Mr. Pidgeon had departed from this. The advantage of the narrow spacing of the sectors was not very apparent.

Mr. WIMSHURST (abstract of communication): Waxing the discs reduces leakage, and increases the output; the wax-coating virtually doubles the number of plates. Inductors contribute a further increase to the output. In 1883, Mr. Wimshurst tried thick coatings of shellac, and also, duplicating the glass, with, in some cases, sectors upon the second glass to increase the capacity. The output was increased, but the construction lost simplicity. The indifference of Mr. Pidgeon's machine to dirt and dust was a most valuable result.

Mr. PIDGEON, in reply, showed a set of secondary inductors such as Capt. Thomson had just proposed. They improved the output by about 15 per cent., but they were troublesome to keep in order, for they increased the tendency to "reverse."

Dr. S. P. THOMPSON then repeated an experiment discovered by Prof. Righi, on

"A Magneto-Optic Phenomenon."

It was originally described in *Roma, R. Accad. Lincei, Atti.* 7, *ser.* 5, 1898. A substance absorptive of light is submitted to a powerful magnetic field between the pole-pieces of an electromagnet. The pole-pieces are drilled so that a beam of light from an arc-lamp can traverse the gap *along* the magnetic lines. A polarising prism is placed between the arc-lamp and the electromagnet. After having passed through the magnetising apparatus, the beam thus polarised is examined by an analyser. The analyser must be turned to "extinction" before the magnetising current is turned on. If this is done, brightness is restored at the analyser as soon as the magnetic field is established. The substance absorbing the light in the gap may be nitric oxide fumes, or an ordinary spirit-lamp sodium flame. The second effect to be noticed is that when the emergent beam is examined, there is a splitting of the lines. Righi explains this by supposing that when light of frequency n is brought into a magnetic field and passed *along* the lines of the field, it is split up into two sets of circular waves, a right-handed and a left-handed set, one of which sets is accelerated and the other retarded. There are now two frequencies, n_1, n_2, one a little higher and the other a little lower than n. But since the analyser is adjusted to extinguish n there is brightness for n_1, n_2. Normally, nitric oxide absorbs green and red is observed, but when the magnetic field is set up, blue-green light is seen at the analyser, for there are now two different kinds of light being absorbed, one of higher and one of lower frequency than the normal, and what is observed is the complementary spectrum. Again, if a tube of sodium is warmed

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to a point far short of that which would cause it to emit visible rays, and the vapour is passed into the magnet gap at the moment when the magnetic field is set up, the D line becomes visible in the observing spectroscope, *i.e.*, the emission spectrum is obtained of a substance which is not actually emitting light.

Mr. BLAKESLEY said that no doubt the analyser was used at the position of extinction for convenience merely. In other positions the eye would be overwhelmed with light.

Mr. ALBERT CAMPBELL then read a Paper on

"The Magnetic Fluxes in Meters and other Electrical Instruments."

He has recently undertaken the measurement of the magnetic fluxes and fields in certain instruments, to determine the order of magnitude of the flux density. In other cases the *total* flux is measured; and in the tests on meters the power lost in the various parts of the instruments is determined. For the measurement of B, the ordinary ballistic-galvanometer method is employed, with an exploring coil. But, for alternating fluxes, two special methods are adopted, in the first of which the exploring coil is in series with a heating-coil associated with a thermopile; in the second, a telephone is connected in series with the search-coil and a potentiometer resistance strip. A constant current is sent through the strip from the main alternate-current circuit supplying the meter or other apparatus; the telephone and search-coil, therefore, forms a shunt to that circuit at the strip. The search coil is put into position in the field to be tested, and the strip is then adjusted to give silence in the telephone. All these methods are described in detail in the Paper, and very important deductions are made, especially as regards the influence of the earth's field on instruments generally assumed to be independent of the earth's H. In a few cases, diagrams are given of the fluxes in magnets, showing exactly what proportion of the total flux is effective at the gap.

Dr. S. P. THOMPSON suggested that as the Paper was of great significance to all who were interested in the design of electric meters and other measuring instruments involving a knowledge of magnetic fluxes and their variation, an opportunity should be given for a full discussion.

The PRESIDENT proposed votes of thanks, and adjourned the discussion of Mr. Campbell's Paper to the next meeting on November 11th.

ELECTRICITY IN MOROCCO.

In the course of a recent visit to Gibraltar, we found it a subject of general remark that, while the residents of the Rock still languish for the supply of electric current for both public and private use, the old-world city of Tangier "on the other side of the water" had been for years lighted electrically. However, Gibraltar will soon have its electricity supply, and in a form greatly in advance of anything to be found in Barbary. The particulars of the lighting at Tangier are not without interest. The first installation was started in November 1891, and, except for a short period in 1892, when considerable modifications were made in the plant and cables, the advance of electric lighting in public favour has gradually increased. The Moors have now begun to lose their old antipathy to anything that marks Christian progress in their country, and are gradually having the electric light installed in their houses. The wires are now drawn all over the antique quarter behind the telegraph station, and branches are gradually being carried into the Moorish quarter—that part of the town where neither Europeans nor Jews are allowed to reside. Even the tiny Moorish shops (more like cupboards than places of business) in the main streets are beginning to be wired for the electric light. The Moorish Minister for Foreign Affairs has the light installed in his offices, but, so far, the Moorish Governor (or Pacha) stands aloof. Visitors for the first time to Tangier are naturally surprised to see this old world Moorish town lighted by electricity. Others, who return to visit the place after a lengthy absence, express the view that the quaint city is being spoiled, but these same visitors, when making a call or visiting the outskirts by night, must appreciate the vast improvement that is to be recorded. Nearly all the chief residences of the legations, the hotels (and many of these are large and well managed establishments), offices and shops are lighted electrically. There are 100 public and 1,500 private incandescent lights in use. The street lighting would be on a much more general scale but for the absence of any properly-constituted municipal body to regulate the lighting and to collect the necessary rates for covering the cost. The existing local Commission of Hygiene has no power to force house or property owners to pay rates, and in the government of the country no municipal body exists for such a purpose. Many of the chief residents, however, subscribe to a fund for lighting the immediate vicinity of their properties, and amongst these may be mentioned the Eastern Telegraph Company, which pays for the lighting by electricity of the approach to the station and offices. Little or no interruption has occurred in the lighting from the start. The plant consists of two Pieper continuous current dynamos, supplied by the Allgemeine Elektricitäts Gesellschaft of Berlin and one Helvetia-Alioth machine—the former of 120 volts 300 amperes, the latter 120 volts 242 amperes. The former machines are driven direct by two 60 H.P. Willans engines and the latter direct by a 55 H.P. Carels engine. One 40 H.P. and one 60 H.P. Babcock-Willcox boilers and one 120 H.P. boiler by De Naeyer and Co. are included in the plant. The lighting is almost entirely incandescent, except that a few 250-c.p. enclosed arcs are sometimes employed for the theatre lighting. The cables are all overhead, and, except for a small portion of the work, are covered. The works are owned by the Compania Transatlantica of Barcelona, and are ably managed by the general manager of the Company, Don Mariano Viado, and the electrical engineer, Don Jose Canales.

Well to the fore in electric lighting, Tangier has also had for many years a public and private telephone service. This was established in 1881 by its present proprietor, Don Emilio Rotondo Nicolau. For some time only a very few subscribers were obtained, but the number has now reached 140, and is slowly increasing. Public telephones have been established at the customs house, on the pier, &c., and these instruments are free to subscribers. The installation extends to Mount Washington (about four miles on the road to Cape Spartel), where the representatives of foreign States and many of the chief citizens have their summer residences. The telephone subscription is 120 pesetas (about 65s.) per annum for one instrument, and 180 pesetas for two.

Electricity is gradually extending its popularity to other places in Morocco, and, though at present only Tangier has local telegraphic communication, a central telephone service has recently been established at Casablanca, a port about 160 miles south of Tangier, and has at present rather more than 30 subscribers.

CORRESPONDENCE.

THE BREAKDOWN AT BRIGHTON.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice in your issue of Oct. 28 some editorial notes on the above subject, which conclude by offering a suggestion for avoiding a repetition of this unfortunate occurrence. You suggest the temporary expedient (for it can be no other) of pinning up the minimum cut-outs and inserting maximum cut-outs in the shape of fuses. Now, I venture to submit that this would not overcome the difficulty, and that if an armature were to "short-circuit" under these conditions, the result would be precisely the same, viz., a complete cessation of supply.

To make myself clear, I must refer to the explanation you offer as to the dropping out of all the cut-outs, it being that the combined effect of decreased speed and armature reaction reduced the dynamo fields to zero. This is undoubtedly the correct explanation, and is a perfectly well-known result on the short-circuiting of a shunt dynamo.

From this it must be perfectly clear that the falling of the minimum cut-outs was the *result* and not the *cause* of the cessation of current, and that, therefore, the pinning up of those cut-outs would not have saved the station from a "shut-down."

It appears to me that there is a definite and very serious danger introduced by the adoption of this method. Suppose that a bad "short" occurs somewhere on the network or feeders, instead of on an armature (which can be quickly disconnected), and that it "shuts down" the station. The engineer finds himself in the extremely awkward predicament of being unable to locate the "short," without current on the mains, and at the same time unable to "re-start" to obtain the necessary current.

The only conclusion that I can come to in considering the foregoing is that the use of "non-return cut-outs" and "separate excitation" are not only possible remedies, but are *absolutely essential* and afford *complete* security against the class of breakdown under consideration.—Yours, &c.,

Nov. 1, 1898. WM. C. P. TAPPER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Is it not possible that a break in the shunt circuit of the damaged dynamo at Brighton may have occurred, and that this will, therefore, account for the general breakdown?

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Such a break may have occurred either accidentally or it may have been done intentionally in order to prevent the short-circuited armature from completely burning out, and this if done too rapidly would produce an effect analogous to an accidental breakage of the shunt, that is a sudden rise of voltage at the end of the broken shunt coil which was originally at the lower potential, and would therefore tend to reverse or would at any rate weaken for an instant the shunt currents in all the other machines in parallel.

I should imagine that if all instruments which could be damaged by a sudden and short rise of potential were removed from the bars, a test as to whether this was really the case or not could be made during light load upon two or three of the machines without much danger of damage.—Yours, &c.,

Bristol, Nov. 2, 1898. ARNOLD PHILIP.

FOREIGN-MADE APPARATUS IN GOVERNMENT AND MUNICIPAL CONTRACTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We ask for permission to call attention through your columns to a disadvantage, under which we as English inventors and manufacturers in England of electricity meters, suffer, in having to compete with foreign meters made abroad with all the advantages of long hours and low wages.

Notwithstanding the fact that Parliament has decided that in all Government contracts there shall be a clause, that where practicable all goods supplied under them shall be of British manufacture, and that this clause has been adopted by a majority of municipal corporations, yet there still remains a number of municipal contracts under which foreign-made meters are not excluded though the English manufacturer is additionally handicapped by the requirement that for all his goods the trades union hours and wages shall be followed, thus leaving, so far as price and profit are concerned, a still greater advantage in the hands of the foreigner.

We think it is only necessary to call attention to the matter for municipal authorities and consulting engineers to bring their tender forms into line with those of the Government, for it is a recognised principle, at least as regards goods paid for with public money, that the competition of cheap foreign labour should not be encouraged. It must be understood that we do not at all object to the competition in meters of foreign inventors, we only ask that their inventions, if sold in England, should be made in England, and should thus contribute, as ours do, to the support and encouragement of native industry and to the relief of our municipal rates and Imperial taxes.—Yours, &c.,

ARTHUR CHAMBERLAIN, Director.
(For Chamberlain and Hookham, Limited.)

Birmingham, Nov. 1, 1898.

SHOREDITCH DUST DESTRUCTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: No one wishes for the success of the utilisation of towns' refuse for the generation of electricity more than myself; but let us not be led away by random generalisations and data unsupported by facts as to works costs, and inasmuch as the published accounts of the Vestry must be assumed to be correct, I await the promised figures for the year's working; although if the "initial expenditure that would not recur" were credited against the loss as stated, the true working results would be apparent and Mr. Kershaw and Dr. Mansfield Robinson have evidently missed this salient fact in their respective replies to my previous communication; but the aforesaid gentlemen having imported into the controversy deliberate personalities, such as "virgin experimentalist," "amateur adventurer," and being guilty of "school-boy carelessness," these epithets call for some contradiction by me. I now give the facts that did occur.

In June, 1893, I was requested by the Vestry Clerk, being a ratepayer, to give him some idea of how and at what cost I would propose to light the Shoreditch area. I did so, and handed him a report as a ratepayer, which I understood was of some value at this initial stage. In November, 1893, I was employed and received payment for a design and scheme to bring in the then idle large property in Ivy-street for the purposes of a similar scheme with baths and washhouses as now erected. In 1894 a representative of the contractors and designers of the present destructor called on me, and asked if I would grant my patent rights to them for the Shoreditch schemes and "row in their boat," which on the terms mentioned I refused. In 1895, upon the request for competing schemes by the Shoreditch Vestry, I designed the special scheme, according to my patents, that was submitted by the eminent firm of Messrs. Daniel Adamson and Co., who were lowest in price and whose guaranteed cost for labour for 20,000 tons of refuse per annum was £1,100, and I beg to subjoin Messrs. Kincaid, Waller and Manville's report thereon to the Shoreditch Vestry:—

MESSRS. DANIEL ADAMSON AND COMPANY, OF DUKINFIELD.

This firm is one of the highest reputation in the manufacture of steam-raising apparatus, and they have submitted a scheme which in many respects is different from the majority of those placed before you, and for which, if erected in accordance with the specification issued by you, the cost will amount to £14,400. They propose to supply only 10 cells in place of 12, but these cells will be of larger area than the 12 stipulated for, and will, therefore, burn the requisite amount of refuse daily. The refuse furnaces, in place of being ranged alongside the boilers, are placed, as in Messrs. Fraser and Sons' scheme, under the boilers. This likewise involves the clinkering floor being somewhat enclosed, since a second floor in addition to the tipping floor is provided opposite each row of furnaces, from which the boilers will be fired by coal so far as that is required, and on which also the refuse may be screened to separate some of the cinder from it, should you adopt that portion of their scheme. The destructor furnaces are of a type that would enable the perfect combustion of the refuse and its gases to be relied upon, and the furnaces provided by them are arranged to both feed and clinker automatically.

The amount of coal this firm considers necessary to obtain the necessary evaporation is extremely high, namely, three tons per day. We think, however, that this is probably only due to the fact that, as they have not heretofore erected a dust destructor, they have probably not attached sufficient importance to the calorific value of the refuse to be dealt with, and in any case the arrangement of their boilers and furnaces is such that the same evaporation could be relied upon as that suggested by other tenderers. They also estimate the cost of labour in working the plant at £1,100 per annum, but they do not make any statement as to the amount required to maintain the apparatus, merely stating that this would be very low.

The scheme put forward is an extremely well-worked-out one, and considering the extra amount of work in the erection of the two extra floors which are included in their tender, is not by any means a dear one. They make an alternative tender at £13,150 if double-flued tubular boilers are provided by them in place of the water-tube boilers, and we have no objections to offer to this alternative should you be prepared to consider their tender for recommendation. They also quote as extras for a screen and apparatus in connection therewith, and for other sundries, which you would probably not be prepared to consider at the present moment.

The Society of Engineers in 1894 awarded me their gold medal for my Paper on "Utilisation of Towns' Refuse for Generating Steam."

Further comment is needless.—Yours, &c.,

T. W. BAKER.

7, Broad-street House, E.C., Nov. 1, 1898.

[This correspondence is now closed.—ED. *E.*]

ELECTRIC CANAL HAULAGE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In his Paper on electric haulage, which you reprinted in your last issue, Mr. A. H. Allen mentions the system I installed in 1893 on the Burgundy Canal, at Pouilly, and he says that this system could not be suitable for general canal navigation. Mr. A. H. Allen recalls also American attempts, none of which have attained any degree of success. These statements of Mr. A. H. Allen are misleading, as your readers would conclude from them that the question of electric haulage on canals is still now in the same state of affairs as it was after the attempts of the American engineers and after my installation on the Burgundy Canal in 1893.

When working my system at Pouilly I soon realised that, although it was well adapted for the case, there were difficulties in the way of its general adoption, and I began to study new systems with a view to haul separately each barge, one after the other. I gave a first intimation about these systems to the International Congress on Navigation held in La Hague in August, 1894; but, at that time, my studies were not yet completed. First experiments took place in 1894 and 1895 on the Burgundy Canal, at Dijon, and these having resulted

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in a decided success, a company patented the devices and asked from the Government powers to work the system on the canals from Aire to the river Escaut, in the north of France.

The authorities wishing to have a full, practical experiment of the system before granting this licence, bade the company first to work only 26 kilometres, extending from Aire to Pont à Vendin, on the Aire and Deule Canals. This installation was completed in the beginning of 1898, and immediately set into operation. M. La Rivière, Ingénieur-en-Chef des Ponts et Chaussées, in Lille, who is in charge of these canals, gave a full account of the results to the International Congress on Navigation, held last August at Brussels. Those who are interested in electric haulage will find an exhaustive specification of the system in his Paper read before the Congress.

The system consists of tricycles running on the tow-paths and fitted with electric motors, which receive the current through overhead conductors and trolleys. We have now in operation two generating stations, each of a capacity of 200 H.P.; they suffice to work 26 kilometres of canal. These stations are distant by 13 kilometres from one another; they generate continuous current, transmitted through wires supported on wooden poles alongside the tow-path. The system dispenses with any aërial or other railway, thus minimising the capital spent on construction.

The only objectionable feature of the scheme is the running of the tricycles on the common tow-path, as it seems it should result in a very low efficiency; but tests have shown that, on very common roads, the total efficiency of a tricycle, viz., the quotient of the power received at the brushes of the motor by the power available on the tow-rope, averages 60 per cent.

The motors are 6 B.H.P. dynamos, made by the St. Alsacienne, of Belfort. This power is necessary to haul over 300-ton barges at the rate of 1½ miles per hour. The assumption by Mr. A. H. Allen that a power of 2 B.H.P. could haul 100 tons at the speed of 2½ miles per hour does not agree with my own experience, nor with the experiments carried out on different French canals by M. de Mas, Ingénieur-en-Chef des Ponts and Chaussées, in Paris, who summed up his tests in a Paper read before the Congress in Brussels last August. In our canals and with our barges, a power of 2 B.H.P. per 100 tons of cargo does not result in a greater speed than 1½ miles per hour.

The Aire and Deule Canal carries a very heavy traffic; barges follow each other at 290 to 300 metres from one another, and the number of barges passing through the section now in operation averages over 17,000 every year. The traffic entrusted to the Company has been very feeble in the beginning, owing to the opposition they met with from the horse-owners and bargemen; but it is rapidly increasing, and they hope it will increase still more rapidly when they have completed their installation up to the river Escaut. As the system has proved successful, the company have been authorised to extend their lines over 84 kilometres, from Aire to the river Escaut; a new section of 30 kilometres is now being constructed, and the complement will soon follow.

They haul gratis all empty barges, and charge 1 franc per kilometre barge carrying 290 to 300 tons, the ordinary load on this canal. This fare corresponds to $\frac{10\text{d.} \times 1{\cdot}6}{300}$, say 0·053d. per ton mile. Though not cheaper than horse traction, electric haulage begins to be a favourite with bargemen, because of its superior speed and regularity, and the company are confident they will soon carry on the whole traffic.

I refrain from calculating the profit when such is the state of affairs; this calculation, as it has not been ascertained by practice, would be liable to the same objections and doubts as those given by Mr. A. H. Allen in his Paper. Nevertheless, as the through traffic averages 17,000 barges every year, and the total capital, including reserve fund, is 3,400,000fr., this profit cannot fail to be very large.

I wonder whether the Allen system would prove adequate in the conditions just referred to, and whether it would be possible to erect an aërial railway to resist the weight and tractive force of the locomotives which are necessary on this navigation. But I do not intend to criticise the very interesting system devised by Mr. A. H. Allen, which may attain success on English waterways. I only wished to mention what I have done since my installation on the Burgundy Canal, at Pouilly, to which Mr. A. H. Allen has alluded, and to give, respecting the present state of the question, some information which I supposed would be welcome to engineers dealing with inland navigation and with electricity.—Yours, &c.,

F. GALLIOT,
Ingénieur-en-Chef des Ponts et Chaussées à Dijon.

Dijon, France, Oct. 26, 1898.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *October 14, 1898.*

An Arc Light Regulator Without a Clutch.—An extremely simple arc light controlling mechanism has just been patented by Mr. Sigmund Bergmann, of this city. The armature or plunger of the controlling solenoid which is in series with the arc travels through the full range of carbon consumption, the plunger being rigidly attached to the carbon. To obtain a uniform vertical lift (equal to the weight of the holder and upper carbon) through the entire travel of the plunger, the solenoid is wound with an increasing number of layers towards its upper and particularly towards its lower end. The pole of a uniformly wound solenoid on a core equal to or greater than the solenoid in length is, as is well known, a maximum when one end of the core is about in a mid-position within the solenoid. By increasing the number of turns towards the ends of the solenoid the pull of the ends of the core near either end of the coil is increased, and a practical uniformity of pull obtained over a considerable travel. In the lamp described, the upper end of the hollow spool on which the core is wound is sealed, and the core fitting tightly within the spool acts as the plunger of its own dashpot. The spool is of metal, and the tightly fitting core always serves as a contact for the current. The series resistance is wound in a helical coil wrapped in an annular chamber around the controlling solenoid.

An Electrically-Driven Turntable.—The Erie Railroad Co. has just put into operation in its Jersey City yards a turntable which is operated by an electric motor. The two longitudinal girders supporting the table platform are pivoted on 7½in. shafts, each girder carrying its own bearings. The girders rest upon an equalising drum, and the entire weight rests on a set of rollers, as in drawbridge practice. In laying out the electrical application the problem to be solved was to keep the motor in a fixed position relative to the gears, so that their alignment would be unaffected by any tilting end motion of the table caused by the weight of the locomotive passing on to the platform. To effect this the motor is set on a circular base between the girders, and is thus independent of any vertical motion of the ends of the table. The power is communicated by a double reduction system of gearing from a 13 H.P. series-wound motor installed with its armature and shaft in a vertical position. The turntable is double-ended, each end being equipped with a controller with a reversing mechanism. When an engine has been turned the operator walks back to the other end of the table and operates it from that end, thus saving the power that would otherwise be necessary to turn the table back. The wires are brought from a near-by pole underground, through a cast-iron pipe to the centre of the table, where they are brought up through the vertical steel tube forming the central pivot. By means of copper collector rings at the top of the tube connection is maintained with the motors and controllers. Proper protective devices, switches, &c., are placed in a box on the pole referred to. The amount of power required to turn the table through an arc of 180deg. is very small. In practice it is cut off when the table has moved over an arc of about 85deg., the momentum then acquired sufficing to carry it around through the remaining degrees of a semi-circle. The

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motion of the table as it approaches the stopping point is retarded by a hand-brake acting on the friction wheel. The turntable is moved over an arc of 180deg. in about one half a minute, and engines are turned about with practically no delay. Prior to the installation of this table it was almost impossible to avoid an accumulation of engines on the adjacent tracks. It is estimated that this turntable will effect a saving of $270 a month in its operation as compared with a hand-turned table. The electrical equipment was furnished by the General Electric Co.

October 21st, 1898.

Electrical Decorations.—On the occasion of the conclave at Pittsburg of the Knights-Templar, October 11th-14th, the electrical decorations were probably the most elaborate and extensive ever attempted. The main feature was a series of metal skeleton arches, 29 in number, spanning Fifth-avenue in Pittsburg and its extension into Allegheny. Over 7,000 50-volt lamps were used in the work. The current was supplied by the large central station of the Allegheny County Light Co. Each arch was supplied with current by a specially installed transformer, that for the quadruple arches being of 875-lights capacity and for the single arch of 150-lights capacity. The number of lights varied from 125 to 165 on the single arches and from 350 16 c.p. lamps to 450 of 10 c.p. on the quadruple arches. Besides these arches, there were many elaborate private display signs, the total additional load on the station due to the conclave being estimated at about 3,500 H.P., making the evening peak of the combined arc and incandescent service in the Company's two stations almost 9,000 H.P. A triumphal arch, erected by the city in front of the building occupied by the Department of Public Safety, was illuminated by 1,685 incandescent lights, supplied with current from the isolated plant of the adjacent building. Among the electrical signs may be mentioned a cross, 110ft. in height and 60ft. in width over all, the trunk and arms being 12ft. wide, and the whole illuminated with 300 incandescent lights. Letters ran down the upright and across the arms of the cross, which was outlined with a double row of 688 red lamps, the letters being composed of 2,300 frosted white lamps.

A New Telephone Exchange.—The New York Telephone Co. is now erecting in Harlem, in the upper part of Manhattan Borough (old New York City), a new exchange which will embody all of the latest improvements in practical telephony. The new multiple board being installed will have a capacity of about 1,500 lines, and will be fitted throughout with visual signals and all the latest improvements. This will be the first board erected in this city on the common battery system.

A New Telephone Company.—New York city would seem to offer a particularly inviting field for telephone competition, but hitherto nothing in this direction has been attempted. During the past week, however, a company has been organised in this city to establish a telephone system in competition with the strongly intrenched New York Telephone Co., which represents the Bell interests. The new Company is developing plans rather quietly, and not much has been given out for public information. Some well-known business men are said to be at the back of the enterprise. The Company has a capital stock of £1,000,000, and it has been given out that it intends to make a charge for unlimited service in Manhattan Borough of £20 per year, against £48 charged by the Bell Company, and will grant besides several privileges and concessions not enjoyed by the patrons of the old company. The new Company proposes to develop a field that has hitherto been untouched, namely, securing subscribers among families living in apartment houses. To these patrons the Company promises to give unlimited service for 4s. a month on group lines. The new Company claims to have all the needed rights to engage in active business, but just how it came into possession of these rights has not yet been divulged. It claims that it can serve 40,000 subscribers with its capital.

LEGAL INTELLIGENCE.

Cambridge Electric Supply Co. (Limited) v. The Cambridge Union.

The hearing of this appeal against the assessment for rating purposes of the Cambridge Electric Supply Co. was resumed in the Outer Temple, London, on the 29th ult. We have received the following brief report of the proceedings:—

Mr. RAWLINSON, Q.C., opened the case for the respondents.

Mr. W. G. COOKE, rating surveyor, stated that he considered the life of electric lighting machinery was at least 40 years, and that a sum representing four-ninths of 1 per cent. annually was a reasonable and sufficient amount to allow for depreciation. This length of life and depreciation would apply to all classes of machinery. Respecting cables, he looked upon them as if they were a pane of glass, and if they broke down they would need to be wholly renewed out of revenue, as they could not be repaired. Under these circumstances nothing should be allowed for depreciation.

Mr. BARNETT, engineering valuer, stated that he had examined the works, and considered 20 years was a reasonable life, but his opinions differed from Mr. Cooke. He thought £300 per annum, or two-thirds of 1 per cent., was ample depreciation on a capital of £45,000. He had seen the company's works, and thought there were not £500 worth of spare plant, cables, or material on the premises. Asked if he was aware that there were at least 12 drums of cable in stock on the day of his visit worth from £40 to £50 apiece, representing more than the sum he stated, he said he had not seen them. He also considered that a hypothetical tenant should be quite satisfied after paying £2,100 rent if he made £500 a year profit.

Mr. A. H. PREECE was asked what he considered a fair life for electricity undertakings, and he thought about 25 years. Asked did he consider Lancashire boilers at 200lb. pressure would last that time, he said he considered they would. India-rubber cables he gave a life of at least 15 years, and transformers up to 100 years. It was pointed out that companies, such as the Westminster Electric Supply Corporation, allowed 3½ per cent. on their capital for depreciation, although they had no rubber mains, and that Manchester and other large towns allowed more. He agreed with the previous witness that £300 was quite enough for depreciation on £45,000.

Mr. RAWLINSON addressed the Recorder on behalf of the Respondents, and Mr. RYDE replied for the company.

The learned Recorder reserved his decision, and promised to deliver judgment on Dec. 1.

Everard v. Higgs.

This case came before Mr. Justice Wright and a jury on Friday last, and was an action brought by Mr. F. E. Everard, electrical engineer, against Mr. J. Limbrey Higgs, solicitor, to recover £60 in respect of certain shares. It appeared that plaintiff purchased a patent for an electrical accumulator, and formed the I.E.S. Accumulator Co. to work it. Plaintiff had 100 shares in the company, and in March, 1896, the defendant informed him that he had arranged to sell 10,000 or 20,000 shares, and as he had not that number, he asked plaintiff to transfer his 100 shares, and promised to pay him the amount realised by their sale when he received the money. Plaintiff transferred his shares, and subsequently heard that there had been a pooling arrangement. He asked the defendant for the money which the shares had realised, and the defendant alleged that the plaintiff was a member of the pool, and would have to take his share of the pooling arrangement, which would entitle him to 60 vendors' shares, 17 out of 5,000 new shares purchased out of the proceeds of the pool and £1. 13s. 4d. in cash. Eventually the plaintiff agreed to accept this, but the defendant failed to take any steps to transfer the shares until after proceedings for the winding-up of the company had been instituted. He now submitted that he was entitled to stand by his original arrangement to receive the price realised by the sale of the shares, 12s. each. Defendant said he offered, and plaintiff agreed to accept, the vendors' shares and the new shares in satisfaction of his claim. These had been tendered, but had not been accepted.

The jury gave a verdict for the plaintiff for £50, and judgment was entered accordingly.

Defendant's counsel asked for a stay of execution for 10 days, which was granted.

Howell v. Howell's Simplex Anti-Inductive Telephone Syndicate (Limited).

In the City of London Court last week, before Mr. G. Pitt-Lewis, Thomas J. Howell, described as an inventor, sought to recover £8, two weeks' salary, due from the defendants. Plaintiff's case was that the company employed him as their electrical engineer at £4 per week. Defendants said they had never taken any step by which they had become liable to pay the plaintiff the salary claimed. As a matter of fact the plaintiff was in the service of a Mr. Macintosh, and defendants never adopted the contract. Judgment for plaintiff, with costs.

Wilson v. Easton, Anderson and Goolden (Limited).

On the application of a debenture-holder for £69,000 of an issue of £180,000 debentures, on the 28th ult., Mr. Justice Romer appointed Mr. W. B. Peat as receiver and manager of the defendant company. Mr. Ralph Neville, Q.C., said the company was in a difficult position, mainly in consequence of an arrangement for purchase by the Hooley Syndicate having fallen through. It had on its books contracts to the amount of

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£120,000, including installations of the electric light, and many of these contracts were nearly completed. His lordship authorised Mr. Peat to borrow £7,500 for wages, at interest not to exceed 5 per cent., and instructed him not to act as manager for more than three months without coming to the Court. He also directed the receiver to apply to the Court in the event of his wishing to enter into any further or fresh contracts of any magnitude.

Mannesmann Tube Co. (Limited) v. Lander and Larsson.

In the Queen's Bench Division, on Tuesday, the Mannesmann Tube Co. (Limited) sued the defendants to recover £5,500 damages for alleged breach of contracts. In 1896 the parties entered into several contracts, under which the defendants purchased a large quantity of tubing, but failed to take delivery, and plaintiffs alleged that, owing to the slump in the cycle trade and a combination of cycle manufacturers to purchase none but Swedish material direct from Sweden, they had sustained a loss of £5,500. Mr. Justice Mathew gave judgment for plaintiffs, and assessed the damages at £3,000.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London :—

NOW READY.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. The Author hopes that, besides Telegraph and Telephone Engineers, it may, perhaps, also prove of service to those in charge of cables for the transmission of light and power. The localisation of faults has been very fully investigated, including the different degrees in which the various methods are affected by the presence of a second fault or of general leakage.—*Extract from Preface.* Demy 8vo, fully illustrated. 10s. 6d., post free; abroad 11s.

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d.

"The Students' Guide to Submarine Cable Testing."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition ready in November.*

"Practical Notes for Electrical Students."—By Messrs. A. E Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"Laboratory Notes and Forms."—With the above title we have ready the New Edition of a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves."—By Dr. O. J. Lodge, with many original illustrations. *Enlarged Edition*, 2s. 6d. net, 2s. 9d. post free.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"The Manufacture of Electric Light Carbons."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated. price 1s. 6d.; post free, 1s. 9d.

"The Bibliography of X-Ray Literature and Research, 1896-97.' A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. Prospectus on application.

"Electrical Engineering Formulæ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. A fine large paper edition with wide margins for notes can also be supplied. Price 12s. 6d.; post free, 13s.; abroad, 13s. 6d. *New Edition in the press.*

"The Alternate Current Transformer," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *New Edition.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"The Electrician" Primers.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth 2s. 9d. Single Primers, 3d. each, post free.

"Electromagnetic Theory."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s. *Nearly ready.*

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"The Potentiometer and its Adjuncts": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free; abroad, 6s. 6d. Digest post free.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free; abroad 13s. 6d. Prospectus post free.

"The Manufacture of Carbons for all Electrical Purposes."—By Francis Jehl. *In the Press.*

"Secondary Batteries, their Design and Manufacture."—By E. J. Wade. *In the Press.*

"Practical Telephony."—By Dane Sinclair and F. C. Raphael. *In the Press.*

"Primary Batteries: Their Construction and Use."—By W. R. Cooper. *In the Press.*

"'The Electrician' Wireman's Pocket-book."—*In the Press.*

"The Electrician" Electrical Trades' Directory and Handbook.—An important announcement in connection with the 1899 issue of the "Big Blue Book" will be found in an advertisement on another page of the present issue, to which our readers will please refer.

TENDERS INVITED.

The Electric Lighting committee of the *Salford* Corporation invite tenders for the supply and erection of the following: (1) boilers, (2) engines, (3) dynamos, (4) boiler feed-pumps, (5) mechanical stokers, (6) superheaters, (7) economisers, (8) condensers, &c., (9) steam and water pipes, (10) cranes and weighing machines, (11) tanks, &c., (12) switchboards, and (13) booster. Further particulars are given in an advertisement in another column, and specifications, forms of tender, &c., may be obtained from the borough electrical engineer (Mr. C. L. Turner), Walness-road, Broughton. Tenders, addressed to the chairman of the Electricity committee, must be delivered at the offices of the town clerk (Mr. Samuel Brown), Town Hall, Salford, by Dec. 1.

The Electric Lighting committee of the borough of *Middlesbro'* require tenders for the supply and erection of the following plant:—(*a*) Lancashire boilers and accessories, mechanical stokers, feed pumps, injector, economiser and electric motor; (*b*) slow speed steam dynamos and accessories; (*c*) condensing plant and pipe work; (*d*) overhead travelling crane; (*e*) switchboard and instruments; (*f*) accumulators; (*g*) trenching, cables, &c.; (*h*) meters. Further particulars are set out in an advertisement in another column. Specifications, &c., may be obtained at the offices of Mr. R. Hammond, consulting engineer to the Council, 64, Victoria-street, Westminster, S.W., after Nov. 2. Tenders to the town clerk (Mr. Geo. Bainbridge), Municipal Buildings, Middlesbro', by Tuesday, Nov. 29.

The *Great Northern Railway Co.* (*Ireland*) invite tenders for (1) Lancashire boilers; (2) engines, dynamos, pumps, steam and exhaust pipes, &c., cranes, feedheaters and tools; (3) switchboards. Further particulars are set out in an advertisement elsewhere, and copies of specifications, &c., can be obtained from the secretary, Mr. T. Morrison. Specifications may be seen, but not obtained, at the office of Prof. A. B. W. Kennedy, 17, Victoria-street, Westminster, London, S.W. Tenders must be delivered at the offices of the Company, Amiens-street Terminus, Dublin, by the 19th inst.

The *Redditch* District Council invite proposals for the wiring of premises on the hire-purchase or deferred-payment system. Further particulars are set out in our advertisement columns, and tenders are to be addressed to Mr. J. A. McMullen, M.I.E.E., consulting electrical engineer, Hornchurch, Essex.

As will be seen from our advertisement pages, the *Glasgow* Corporation invite tenders for providing and erecting switchboards and instruments at the new electricity works, Port Dundas. Copies of the specification, &c., may be had from Mr. W. A. Chamen, city

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electrical engineer, 75, Waterloo-street, Glasgow, and tenders must be lodged with the town clerk (Sir J. D. Marwick), City Chambers, Glasgow, not later than Monday, Dec. 5.

The *Glasgow* Corporation also invite tenders for the supply of about 800ft. of cast-iron pipes (21in. diameter) and certain cast-iron pipes (22in. and 29in. diameter), with special castings for the electricity works at Port Dundas. Tenders to town clerk, by 22nd inst.

The Electric committee of the *Belfast* Corporation require tenders for the supply and erection of four 400-kilowatt steam dynamos. Some particulars are given in an advertisement on another page, and specification, &c., can be obtained of the city electrical engineer (Mr. Victor A. H. McCowen). Tenders to Sir Samuel Black, town clerk, Belfast, by noon of Thursday, 17th inst.

The *British Electric Traction Co. (Limited)* require tenders for about 400 tons of about 4in. cast-iron socket and spigot pipes for electric cables, with about 400 large socket and spigot bell mouths. See advertisement.

The *Shoreditch* (London) Vestry invite tenders for three months' supply of coal to the electricity station. Tenders to clerk by Nov. 14.

The *Hornsey* District Council invite tenders for the supply and erection of electric lighting plant at the Council's central public library, Tottenham-lane, Hornsey. Tenders to Mr. F. D. Askey, by Nov. 7.

The *Hornsey* District Council also invite tenders for the supply of 1,500 cast-iron telephone pipes and 30 telephone pit covers. Tenders by Nov. 7.

The Corporation of *Barrow-in-Furness* invite tenders for the supply and erection of cast-iron lamp columns, arc and incandescent lamps, automatic switches and fittings. Tenders to Mr. C. F. Preston, Municipal Offices, Barrow-in-Furness, by noon of Nov. 14.

The *Belfast* Harbour Commissioners require tenders for the supply of nine iron latticed-built electric light masts, 70ft. high from the ground lines with suitable base. Tenders to Mr. W. A. Currie, Harbour Office, Belfast, by Nov. 14.

The *Edinburgh* Corporation invite tenders for the following plant for their electric lighting station in McDonald-road :—(1) Marine type boilers and mechanical stokers, (2) engines and dynamos. The engines must be of the Willans or Belliss type. Tenders to the offices of the town clerk (Mr. Thomas Hunter), Town Hall, Edinburgh, by Nov. 14.

The *Leatherhead* District Council invite offers from persons willing to take over their Electric Lighting Order (1898). Offers to reach Council Offices, Leatherhead, by Nov. 21.

Tenders are invited for the supply and fixing of two engines and dynamos at the *Southampton* County Lunatic Asylum, Knowle, near Fareham. Tenders to Mr. John R. Wyatt, Knowle, by Nov. 16.

Tenders are required by the *Wimbledon* District Council for the supply, delivery and erection of transformers and accessories. Tenders to Mr. W. H. Whitfield, Wimbledon, by 5 p.m. Nov. 7.

The *East Indian Railway Co.*, Nicholas-lane, London, E.C., invite proposals for the supply of 18 instruments for nine blocks (for single line); 80 instruments for 41 stations (for double line), and six spare instruments. Tenders to secretary by 1 p.m. Nov. 23.

The Paving and Highways committee of the *Manchester* Corporation require tenders for the laying of a system of underground telephone pipes, &c. Tenders by 5 p.m. Nov. 8.

The *Cheshire* Lines committee require tenders for various stores, including telegraph materials, instruments, wire, &c. Tenders to secretary, Central station, Liverpool, by Dec. 2.

Tenders are invited for lighting the Sailors' Orphans' Homes, *Kilmalcolm*, N.B., by electric light, gas, or oil. Particulars from Messrs. D. and H. Barclay, 245, St. Vincent-street, Glasgow.

The Consul-General of the *South African Republic*, Amsterdam, requires tenders for the supply of telegraph insulators and spindles. Tenders by 12th inst, to 9, Nicolaas Witsenkade, Amsterdam.

The Municipal Authorities of *Cebreros* (Avila, Spain) invite tenders until Nov. 10 for the concession for the electric lighting of the town for 15 years. Particulars from and tenders to el Secretario del Ayuntamiento.

TENDERS RECEIVED AND ACCEPTED.

The *Sheffield* Corporation have affirmed the contract for points and crossings to be supplied by Messrs. Askham Bros. and Wilson, for use on the Sheffield tramways.

The *Burnley* Corporation have accepted the tender of the Burnley Ironworks Co. for the supply of steam piping for the electricity department, at £400. The tender of Leach's, Limited, has been accepted for mechanical stokers.

The *Bedford* Town Council have accepted the tender of Mr. J. Source for the supply of ironmongery for the electric lighting works at £11. 15s. 10d. The tender of Mr. G. Mence Smith has also been accepted for the supply of chandlery at £15. 19s. 4d.

The tender of T. Medcalf, Limited, of Bradford, has been accepted by the *Edmonton* Board of Guardians for the electric lighting of the workhouse at £2,460.

The Gas and Electric Lighting committee of the *Aberdeen* Town Council have accepted the tender of the Callender Co. for the supply of cables, and that of Mr. Alex Spark for house main services.

The Electric Lighting committee of the *Hull* Corporation have accepted the tender of Thomas Parker (Limited) for a dynamo at £1,900, and of W. H. Allen, Son and Co. for a steam engine at £2,150.

APPOINTMENTS VACANT AND FILLED.

The London County Council invite applications for the position of chief officer of tramways. Salary £1,500 per annum. Applications to the clerk, County Hall, Spring-gardens, S.W., by 10 a.m., Nov. 14.

Agents are required by Messrs. W. M. Still and Co., of 24, Charles-street, Hatton Garden, London, E.C., for the sale of the "Still" incandescent electric lamp in all parts of England. See advertisement.

Agents in this country are required by M. A. Larnaude for the sale of incandescent lamps of his manufacture. See advertisement.

The Electric Light committee of the Southampton Town Council have appointed Mr. F. Hardress Chaplin (at present chief assistant engineer at Portsmouth) to the position of borough electrical engineer, in succession to Mr. J. H. Lee, at a salary of £250 per annum.

Mr. Thomas Reid, of Dundee, has been appointed to the post of head teacher of the engineering department at the Birmingham Municipal Technical School.

BUSINESS NOTICES.

Messrs. Gambrell Bros., electricians and manufacturers of scientific instruments and apparatus, have taken premises at 17, Giltspur-street, London, E.C. The new firm announce that they have had large practical experience in electrical testing and scientific instruments and that all work entrusted to them will be executed under the personal supervision of members of the firm.

Messrs. J. G. Goulding and G. F. Rimmer (trading as Goulding, Rimmer and Co.), electrical engineers, 8, Drury-buildings, 23, Water-street, Liverpool, have dissolved partnership.

Mr. Frederick William Ames has withdrawn from the partnership of Ames, Garrard and Co., art metal workers, &c., 1 and 2, Goldney-place, Harrow-road. Debts by Messrs. F. T. Ames and W. C. Garrard, who continue.

As already announced in these columns, the business of George F. Milnes and Co., Birkenhead, has been turned into a limited liability company. The new company, which has adequate capital for filling all contracts for tramway and light railway rolling stock, has taken over all the stock and assets of the old firm. Mr. G. F. Milnes and Mr. A. Hughes occupy the positions of managing director and director of the car construction department in the new company. The partnership hitherto existing between Messrs. Milnes and Hughes has been dissolved.

Messrs. Williamson and Joseph notify that Mr. A. E. Bennett is no longer in their employ.

The offices of Le Carbone, of Carteret-street, Queen Anne's-gate, S.W., will, from the 11th inst., be removed to 36, Lime-street, London, E.C.

Thomas John Palmer and Russell Oswald Wright, trading as electricians, &c., under the style of Russell O. Wright and Co., at Blackburn and Darwen, Lancs., have dissolved partnership. Debts by Mr. Palmer.

BANKRUPTCIES, LIQUIDATIONS, &c.

Mr. J. H. Fox, c/o Wm. Gray and Co., Hull, has been appointed trustee in the bankruptcy of C. H. Kitching, electrical engineer, &c., 20, St. Hilda-street, 172, Beverley-road, and 42, Chariot-street, Hull.

In the London Bankruptcy Court on Tuesday, a receiving order was made against Claude Vautin, electro-chemist, metallurgist, &c., lately carrying on business at 66, Old Broad-street, E.C., and residing at Hamilton-terrace, St. John's Wood, London. It was alleged as the act of bankruptcy that debtor has departed out of England with intent to defeat or delay his creditors. It is further reported that debtor, when leaving England, had in his possession £5,000 in Bank of England notes, a large sum in gold, and a large quantity of bearer bonds in American railways. The amount is variously given from £15,000 to £70,000.

A statement of affairs in the failure of Jacob Gütmann, trading as J. Goodman and Co., shows liabilities £3,850. 15s. 8d., deficiency ditto. The assets appear to comprise shares scheduled at £4,000, but of uncertain value. Mr. B. Newstead, 3, Church-passage, Guildhall, London, E.C., is trustee, with a committee of inspection. The bankrupt is 25 years of age, and started business

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in 1893 as the Victoria Lamp Maintenance Co., and shortly afterwards, having inherited about £500, commenced trading as J. Goodman and Co., electrical engineers and fittings dealers. On April 7 last the business, which was then insolvent, was converted into a private limited company, with debtor as managing director at £5 per week, and receiving 4,000 fully paid-up £1 shares. Failure is attributed by bankrupt to want of capital and losses in trade.

At a meeting of J. Goodman and Co. (Limited), electrical engineers and fittings dealers, on Oct. 12, it was decided to wind up the company voluntarily and to appoint Mr. J. F. Lovering, 3, Church-passage, London, E.C., liquidator.

The public examination of E. A. Ingold, electrical engineer, 66, Wandsworth Bridge-road, London, S.W., was held last week at the London Bankruptcy Court. Liabilities are given at £1,790. 10s., assets £2. Debtor commenced business at Ilford in 1892 with £100 capital, and had since traded at various addresses, alone and in partnership. Failure caused by loss of £1,000 at law, £200 in attempting to float a company, and a £300 liability attaching to one of his patents. Examination concluded.

CATALOGUES, PRICE LISTS, &c.

Messrs. Newsome, Pinching and Co. forward a price list of cast-iron accessible bends, arc lamps, &c.

A list of scientific specialities patented and manufactured by Messrs. A. J. Beaumont and Co., of York, is to hand, and includes a number of automatic and hand-feed arc lamps, resistance frames, projectors, &c., for use for cinematograph displays, and for other purposes.

A list of British-made machine tools, travelling cranes, hoisting tackle, &c., for which Mr. Henry Pynegar, 5, Dowgate-hill, London, E.C., is agent, has been forwarded to us. Particulars are given of a large variety of English-made machines and accessories.

Liquidation Petition.—A petition for the winding up of the Apostoloff Automatic Telephone Parent Syndicate (Limited) has been presented to the High Court by Messrs. J. A. White and E. I. de Buriatte, 38, Holborn-viaduct, London, E.C. The petition will be heard on 9th inst.

Sale by Tender.—Mr. J. H. Thornton, liquidator of the National Company for the Distribution of Electricity by Secondary Generators (Limited), offers for sale by tender certain patents for secondary generators belonging to the said company. Tenders to Mr. Thornton, 2, Warwick-street, London, W., by noon of Nov. 28.

Enclosed Arc Lamp Patents.—We are informed that the Jandus Arc Lamp and Electric Co. have retained leading counsel and experts in connection with the case which is pending between themselves and Messrs. Beanland and Perkins over the "Ajax" lamp. After the legal proceedings have started it is said to be unlikely that the company will grant further licences.

The "Strela" Enclosed Arc Lamp.—Messrs. Krupka and Jacoby, of 61-62, Watling-street, London, E.C., forward us some particulars of the "Strela" enclosed arc lamp, for which they are agents in this country. The lamp is made for continuous or alternating currents, and is claimed to be of very simple mechanism, burning with one pair of carbons up to 200 hours. We learn that this lamp is in use by several electricity supply undertakings in this country.

New Portable Testing Battery.—Messrs. Niblett and Sutherland send particulars of a new battery which they have recently introduced, for which lightness and compactness are claimed.

"Cassier's Magazine."—The contents of the November issue of this magazine include "Electric Power in Mining," by John McGhie; "Mechanical Draught for Steam Boilers," "Pneumatic Grain Elevators and Conveyors," "Mine Timbering in the United States," "Coal Washing," "Compressed Air on Warships," "The Distilling Ship 'Iris' for the United States Fleet," and a biographical sketch of Sir William Arrol.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Oct. 26 to Nov. 1, with the ports of destination:—

Argentina—Buenos Ayres, £797 (including £474 telegraph material). *Australasia*—Adelaide, £51; Lyttelton, £17; Otago, £63; Rockhampton, £8; Sydney, £446. *Belgium*—Antwerp, £35; Ostend, £45. *Brazil*—Rio Janeiro, £186. *Burma*—Rangoon, £49. *Ceylon*—Colombo, £72. *China*—Shanghai, £14; Tientsin, £80. *Egypt*—Alexandria, £40; Port Said, £11,520 (telegraph cable). *France*—Boulogne, £216; Paris, £25. *Germany*—Hamburg, £50. *Holland*—Amsterdam, £207; *Hong Kong*, £514. *India*—Bombay, £486; Calcutta, £188. *Italy*—Spezia, £121. *Japan*—Yokohama, £600. *Malta*—£47. *Mexico*—Vera Cruz, £51. *Norway*—Christiania, £150; Christiansand, £46. *Russia*—Helsingfors, £19. *Siam*—Bangkok, £270. *South Africa*—Cape Town, £271; Durban, £135; East London, £10; Port Elizabeth, £198 (including £180 telegraph material). *Spain*—Santander, £7. *Sweden*—Gothenburg, £46; Stockholm, £613 *Turkey*—Constantinople, £14. *Uruguay*—Monte Video, £3 (telegraph material). Total £17,710, against £10,354 in the corresponding week last year (Oct. 27 to Nov. 2).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Alleged Fraud.—Ernest John Thomas, alias Ward Thomas, electrical engineer, of Drayton House, Laira, Plymouth, was again brought up at Exmouth Police Court, on Thursday, on the charge of obtaining goods from various electrical and engineering firms by false pretences, Accused was committed for trial.

Arbroath.—The Town Council have decided in favour of applying for electric lighting powers.

Aston.—The question of utilising the heat from the refuse destructor in the generation of electric current has been reported upon by Mr. J. C. Vaudrey, of Birmingham, who points out that the saving effected by using the destructor heat would be apparent only in the early stages of the supply, as on the demand becoming greater the dependence on coal will increase, and a point will be reached when the saving by the use of the destructors will be more or less lost. Mr. Vaudrey does not, however, condemn the proposal to utilise the destructor heat for a smaller plant to be used in connection with the yard lighting. The council are recommended to provide a plant for lighting the buildings, yard, and fire-station at Chester-street. The whole work of improving the present destructor, building new cells, and providing electric plant, is estimated to cost £11,500, and application is to be made for powers to borrow this sum.

Barnsley.—A Local Government Board inquiry has been held into the application of the Town Council to borrow £25,000 for electric lighting purposes. The town clerk (Mr. H. Horsfield) gave evidence in favour of the application, and the consulting electrical engineer (Mr. T. L. Miller) gave technical details of the scheme. It was proposed to lay down plant capable of supplying current to the equivalent of 6,000 h.c.p. lamps. The three-wire system of distribution would be employed, and the plant would be so designed as to supply current for tramway purposes. Provision had been made so that the available capacity of the plant could be doubled for an expenditure of £2,000 on plant and £500 on buildings. There was no opposition.

Bath.—At a meeting of the Electric Lighting committee last week, Mr. R. Hammond presented his monthly report on progress in the erection of the electricity works. The first set of generating plant had been working satisfactorily for some weeks, and the second set would be running about Christmas. The question of introducing electric tramways has been referred to the Works and Surveying committees for consideration and report.

Belfast.—At the meeting of the Electric committee last week, the city electrical engineer (Mr. V. A. H. McCowen) submitted an estimate of the cost of laying mains from the station to Mountpottinger Junction. One side of the route would cost £2,178; both sides £3,477. The matter will come before the next meeting.

Brentford.—The Highways committee, at a meeting of the Middlesex County Council, reported having considered drawings from the London United Tramways (Limited) in connection with electric tramways for Brentford, Hounslow, Hanwell and Acton. The committee approved these plans, and this approval has been endorsed by the Council.

Brentwood.—The Parish Council is not satisfied with the presen lighting arrangements, and the Lighting committee has been instructed to obtain information concerning electric lighting. The Council have decided to oppose any application for a provisional order for the district.

Buenos Ayres.—The Capital Tramways Co. has now 14¾ miles of tramways in this town which are operated electrically, the section between Comercio and the Government House, Plaza de Mayo, recently under conversion from horse to electric traction, having been inaugurated on the 27th ult. La Capital (Extensions) Company successfully inaugurated their electrical service out to the Nuevo Chicago on Sept. 11.

Chelsea (London).—The Lighting committee of the Vestry are considering an offer by the Chelsea Electricity Supply Co. to provide current for public lighting at cost price. The Vestry could provide the necessary arc lamps, standards, &c., or the company would provide the necessary capital therefor (for a 14 years' agreement), charging 6 per cent. per annum, and a renewals fund to provide for the replacement in 20 years. Repairs of lamps, standards, mains, &c., would be at the cost of the Vestry.

Chichester.—The city surveyor has been instructed to prepare a report for the City Council on electric lighting for the streets.

Church Lighting.—St. Mildred's Church, Bread-street, London, is now lighted electrically.—The electric light has recently been introduced into St. John's Church, Hastings. The vestry and school are also lighted electrically.

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Colombo (Ceylon).—The Fort will shortly be lighted electrically. The contractors (Messrs. Boustead Bros.) hope to have the work completed by Jan. 1. Thirty Jandus arcs will be employed.

Diss.—The Town Council have received from Mr. Napier Prentice, Secretary of the Suffolk Electricity Supply Co., a request for permission to erect overhead electric wires in the district. A decision has not yet been come to, but no opposition is likely to arise.

Dublin.—Sir F. Marindin opened an inquiry here on Wednesday into the application of the Dublin United Tramways Co. for authority to increase the speed of the electric trams on their Dublin and Clontarf and Dublin and Dalkey sections. In opening the inquiry, Sir F. Marindin said that in the case of the Clontarf line there was no limit of speed specified in the Order, and the Board of Trade had now to decide what a safe speed meant. As to the other line, the Board were advised that as eight miles an hour was the scheduled speed, it was outside their powers to increase that maximum. Therefore the company went for an Act last year and obtained it, and under that Act the Board of Trade had now the power to increase the speed to whatever they thought safe. But they must not exceed the maximum speed allowed on the Clontarf line. It was decided to deal with the Dublin-Clontarf section of the application first. The Clontarf Commissioners had passed a resolution that the speed of the trams should not at any time exceed 10 miles an hour. The county inspector of the Royal Irish Constabulary (Mr. Alcock) said in his opinion the cars could be allowed with safety to travel at 12 miles an hour. At night the speed should not exceed 10 miles an hour. Several other witnesses concurred. Mr. Campbell, Q.C., M.P., who appeared for the Dublin, Wicklow and Wexford Railway, to oppose the application, contended that sufficient notice of the holding of the inquiry had not been given. Sir F. Marindin said he would close the inquiry as to the Clontarf line. The inquiry into the other section would be postponed in order that a fortnight's notice might be given.

Dudley-Wolverhampton Tramways.—The purchase of the Dudley, Sedgley and Wolverhampton tramways by the British Electric Traction Co. is almost completed. The Company will continue to work the existing lines by steam until the work of reconstructing and electrically equipping the Dudley-Stourbridge line is completed. It is proposed to unite the Dudley and Stourbridge line with the Dudley and Wolverhampton line by extending the latter in two directions, from Priory-street and Stone-street and from Wellington-road. The method of construction and equipment of the Dudley, Sedgley and Wolverhampton line will be the same as that adopted on the line from Dudley to Stourbridge.

Electricity in the Printing Office.—The *Rangoon Times* has now 12 English cylinder printing machines worked by electric motors, these latter made in the States.

Electric Railways in Shanghai.—This plan for these railways contemplates about 18 miles of railways on the overhead trolley system. The routes are to be three in number, viz. :—(1) From the French waterworks along the Chinese Bund (if practicable), and thence along the French and English Bunds, to the point by way of Broadway, Seward, and Yangtzepoo roads ; (2) From the Bund to the Bubbling Well, by way of the Kiukiang, Kiangse, Hankau, and Nankin roads ; (3) From the Shanghai station of the Woosung-Shanghai railway to the west gate of the Chinese city. A concession is to be given for the construction of the line and all accessories to the Shanghai Tramway Company. The concession is to be for 30, 40, or 50 years, according to the tender the ratepayers may decide to accept, and the company is to pay the council a percentage of the total gross receipts for the period of the concession. Notification to tenderers by public advertisement will follow in due course, and the tender finally selected will be submitted to the ratepayers for ratification.

Electric Trains in Belgium.—An experimental trial of an electrically-drawn train has just been made on the Brussels-Liège railway system. A special train made the journey between Renory-Liège and Tirlemont, and back, stopping on the way at the principal stations. The experiment was, it is reported, a complete success, and the substitution of electricity for steam, at any rate on one of the fast day trains to begin with, is mentioned.

Employers' Liability.—At Brompton (London) County Court a labourer named Pearson succeeded in obtaining compensation for an accident which took place in May last at the works of the Charing Cross and Strand Corporation, Commercial-road, Lambeth. Pearson was wheeling a barrow of cement along some planks, which owing to the wet had warped, when the wheel of the barrow fell between and Pearson was overturned. His wages were £1. 9s. 2d. per week, and he claimed £150, obtaining a judgment for £60 and costs.

Erith.—A special meeting of the District Council was held last week to sanction an application to the Board of Trade for a provisional order. A formal resolution authorising that application was unanimously agreed to.

Exhibition.—There is to be a provincial exhibition at Ghent in the summer of 1899, at which a section will be devoted to lighting, heating and ventilating apparatus. All particulars can be obtained from the executive committee, 47, Boulevard Léopold, Ghent, Belgium.

Fiji.—Among the public works in course of construction in Fiji is a telephone line 100 miles in length, from Suva to Ba, through Kausori, Viria, Vunidalva and Nadarivatu. The line is to be worked by the Government, the Colonial Sugar Refining Co. and the Union Steamship Co.

Glossop.—The Town Council have decided to apply for a provisional order. The question of transferring the order to a company will be considered at a special meeting of the Council on Wednesday next.

Grays (Essex).—Mr. A. H. Preece has been appointed consulting engineer to the District Council at a fee of 50 guineas.

Great Yarmouth.—A special meeting of the Town Council was held on Monday to consider a scheme for the construction of electric tramways in the town, at an estimated cost of £40,000. The total length of the projected lines is 3¾ miles. Current will be supplied from the Corporation's mains, and the lines will be equipped on the overhead system. The Council are in favour of the project.

Hull.—A Local Government Board inquiry was held here on Tuesday into the application of the Town Council to borrow, amongst other sums, £26,000 for electric lighting purposes and £4,103 for a refuse destructor. Evidence in support of the application was given by the Town Clerk, the City Engineer, and Councillor Skinner, and technical details were submitted by Mr. A. S. Barnard, the borough electrical engineer.

Mr. Barnard has prepared a report, in which he states that the demand for current renders it necessary to again consider the question of making additions to the generating plant. Before the winter of next year, the plant will be insufficient to meet the demand, and it is necessary to place the orders for the engine and dynamo now and the remaining plant later. He recommends that application be made for sanction to a loan of £16,000 for these extensions, and the Electric Light Committee have endorsed his recommendation.

Ilfracombe.—The Town Council have invited the local gas company to make an offer for the transfer of the Ilfracombe provisional order. A London company has already submitted terms for leasing the order, but members seem disposed to give preference to the local company.

Kirkcaldy.—A unanimous resolution in favour of applying for a provisional order was passed by the Town Council on Saturday.

Lambeth.—The Vestry have decided to defer for a week the question of appointing a committee of eight members to investigate the statements and charges made in connection with the transfer of the Vestry's provisional order. At the next meeting Mr. Price will move that those members who voted against the Vestry exercising its electric lighting powers be asked to sign an undertaking to take no legal or other action if Messrs. Hubbard, Wightman and Lock will attend the committee and state particulars of the information which they declare to be within their knowledge.

Law Courts (London).—The electric light has now been laid on at the quadrangle entrance and for the whole of the basement of the main block of the Royal Courts of Justice. In a short time the whole of the Courts will be lighted electrically.

Light Railways.—It is proposed to construct an electric tramway for Esher, Ditton, Surbiton and Kingston-on-Thames. The promoting syndicate offer to take current from the Kingston Corporation, and the lines, if the sanction of the interested local authorities can be obtained, will be equipped on the overhead trolley system.

The Light Railway Commissioners recently held an inquiry into the application to construct a light (electric) railway from Redditch to Astwood Bank. The Redditch District Council opposed the scheme, on the ground of the narrowness of one of the main streets, and the Commissioners intimated that the objection was a vital one. Efforts are being made to induce the Council to reconsider their attitude. As a result of negotiations, the Council, who favour generally the principle of the scheme, have decided to approach the owners of property in the narrow thoroughfare.

The Atherton District Council have unanimously resolved to support the scheme for the construction of a light electric railway from the terminus of the St. Helen's tramway system to Bolton.

Lincoln.—The City Council decided on Wednesday to apply to the Local Government Board for sanction to borrow a further £19,000 for electric light extensions. Alderman Page said they applied to the Local Government Board to borrow, and it was stated that they proposed to spend £22,000. It was satisfactory to know that that expenditure for what they proposed to do was not likely to be exceeded, and that there was every probability that towards the end of the month the Corporation would be in a position to commence electricity supply. A considerable extension of plant would be necessary if the requirements of the year 1899 were to be reasonably met, and additional capital would be required. £19,000 would enable them to increase the mileage of cables from four to

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something like 10 miles, and would also enable them to increase the capacity of the station from the equivalent of 5,000 to 18,800 8 c.p. lamps.

Llandudno.—The Electric Light committee of the District Council have decided to switch on electric current for the first time to-morrow (Saturday) evening. The formal opening of the works has been postponed until the spring of 1899.

London County Council.—At Tuesday's meeting the Finance committee reported on an application from the Newington Vestry for a loan of £50,000, repayable on the instalment system within 42 years, to defray the cost of the installation of the electric light in the parish. The Vestry asked that £10,000 be advanced at once, and they proposed to take up the remaining £40,000 in instalments of £10,000 as required, and to postpone the repayments for five years in each case, from the date of the advance. This was the first case in which the Council had been asked to sanction the postponement of repayment, and the committee thought that such a postponement might in certain cases be allowed, but were not prepared to recommend that the repayment of the instalments should in this instance be deferred for so long a period as five years. The Vestry had agreed that the repayment of principal should be postponed until after the expiration of three years from the date of the advance of the loan, and the committee recommended that the loan be made on those terms. Approved. A further loan of £10,470 (balance of a loan of £22,949 to defray the cost of the purchase of land and the installation of electric light in the parish) was made to the Shoreditch Vestry.

Malta.—£9,123 was collected as revenue from the municipal electric lighting undertaking in 1897, against £347 in 1896 (the station was open for one month). Nearly £7,000 of this sum was paid by the Government for street lighting, and a further portion for the lighting of military and public buildings. The cost of street lighting in Malta by the adoption of electricity has somewhat increased, but general satisfaction is expressed at the vastly superior lighting which is now a conspicuous feature of the main thoroughfares.

Newington (London).—At the meeting of the Vestry, last week, the Electric Lighting committee brought up a report recommending the appointment of Mr. J. H. Lee, late borough electrical engineer at Southampton, as electrical engineer to the Vestry at a salary of £250 per annum. Considerable discussion ensued, and eventually it was decided to advertise the position, and that a salary of £250 a year be offered.

Newmarket.—The Newmarket Electric Light Co. hope to be able to commence supply in December.

Orrel (Liverpool).—An interesting experiment is being made in this district by Mr. Jones, proprietor of large brickworks, in the lighting of the houses of the workmen employed at the works. For the accommodation of his workpeople and others, eight streets have been formed, with 76 houses in each, or about 600 in all. It is Mr. Jones's intention to supply electric current to each of the houses, which are rented at 5s., 7s. and 8s. per week. The estimated initial cost of the electric lighting installation to supply between 2,000 and 3,000 lights is estimated at £3,000. To the 5s. house two 8 c.p. lights will be allotted, to the 7s. house three lights, and to the 8s. house four. These will be supplied at a charge, including the fittings, of 3d., 6d. and 9d. per week respectively.

Police Telephonic Communication.—Attention is called to the remarkable fact that neither the City nor the Metropolitan police services are in telephonic connection with the system of the National Telephone Co., so that in the event of a police officer being hastily required it is necessary to either telegraph or employ a messenger. Seeing that the telephone is available in thousands of places where prompt assistance could be obtained if this telephonic communication were established, it seems most remarkable that this connection has not been made before now. It is also asserted that the Metropolitan Fire Brigade arrangements, so far as the telephone is concerned, are of a somewhat primitive character.

Portobello.—A lengthy report on the subject of the motive power to be used on the Portobello tramways is just published. The report is by Prof. A. B. W. Kennedy, and was presented to the Edinburgh Corporation as far back as February last.

Provisional Order Notices.—The District Councils of Knutaford and Rugby, and the Vestry of St. Mary Abbotts, Kensington, London, give notice of intention to apply for provisional orders.

Rathmines and Rathgar (Dublin).—A Local Government Board inquiry will be held here on Monday into the application of the Township Commissioners to borrow £50,000 for electric lighting purposes.

Retford.—The Town Council decided on Monday to apply for a provisional order. An arrangement has been made with a company for carrying out the provisions of the order as soon as it is obtained

Sebastopol (Russia).—This town is provided with an excellent electric lighting installation and also with electric tramways. The necessary capital for these ventures was subscribed by French and Belgian capitalists. This is, a correspondent writes us, another case where the British contractor has been forestalled.

Sheffield.—The Tramways committee of the Corporation have decided that, as soon as the whole of the electric cars are running, advertisements on these cars shall be entirely discontinued.

Shoreditch (London).—The Lighting committee have considered a report from Mr. Newton Russell, the chief electrical engineer, concerning applications for the supply of electric current from the Haggerston district. From a personal canvass, it has been found that more than a sufficient number of persons had promised to take a supply to justify putting down a sub-station in that locality, which the committee recommended should be done, at a cost of £2,200. The recommendation was adopted. The committee further recommended the purchase of a further supply of meters, at a cost of £520. Approved. The Lighting committee have been empowered to advertise for tenders for the sinking of a well at the Coronet-street works.

Siam.—General complaint is made of the deplorable condition of the telegraph lines in Siam and the consequent lack of telegraphing facilities. In the southern districts the lines are down in all directions. The short subaqueous cable connecting the mainland with the island of Koh-si-chang, in the Gulf of Siam, where large steamers load, was laid last year, and has been found of great service to commerce; but regarding the land lines complaints are general. The telegraph and postal department of Siam are separate, to which fact the unsatisfactory condition of things is attributed. It is suggested that the appointment of a competent European officer to take entire charge of the land lines would have the effect of speedily improving matters.

Sleaford.—A meeting of the Tradesmen's Association was held last week to consider the question of improving the lighting arrangements. An electrical engineer was present and answered questions as to the cost, &c., of electric lighting, and eventually it was resolved to ask the District Council to appoint a sub-committee to go fully into the matter, in order that a definite scheme might be brought forward. Should the Council decline the overtures of the Association an attempt will be made to form a local company to establish electricity works.

South Africa.—A company, entitled the Umtali (Rhodesia) Electric Power Company (Limited), has been formed with a capital of £25,000 for putting down an electric water-power mining plant at the Penhalonga gold mines, Rhodesia. The plant is to consist of five 100 H.P. and two 50 H.P. dynamos, and five motors of 50 B.H.P. each, besides two 250 H.P. Pelton water wheels.

The Cape Town Council are about to place an order with the Jandus Co. for the supply of 30 enclosed arc lamps.

Southampton.—The Town Council have rescinded their recent resolution in favour of adopting the overhead trolley system of traction on the tramways, and the Tramways committee have been given 12 months' further time in which to investigate the most suitable form of traction for the lines.

Steam Omnibuses.—Mr. E. H. Bayley presided on Monday at a meeting of the London Steam Omnibus Co., and expressed his full confidence in the future of the concern. The company work the French De Dion steam-car engine, as well as the German Daimler petroleum machine. It was stated by the Chairman that the steam 'buses can be worked at a cost of about £9. 10s. per 'bus per week, against £15. 10s. for a horse-driven vehicle. It was announced that 14,800 shares of £10 each had been allotted, and that two steam and two petroleum 'buses had been built for the company.

Sydney (N.S.W.)—The telephone is increasing in favour in this city. A large number of applicants have applied, both in the city and suburbs. In August 113 connections were made—30 central, 70 branch, and 13 country exchange lines. The totals for June and July were 134 and 140 respectively. Since Jan. 1 the number has been 1,367, the total number at the end of Sept. was 7,745. The number of telephones in use at the end of August was 8,677. The receipts from the Newcastle line for August were £75. 12s. 6d., bringing the total revenue from the line for the eight months during which it had been established up to £464. 7s. 6d. During the months of June and July the receipts from the same source were £76. 18s. 9d. and £67. 13s. These figures are considered highly satisfactory. The telephone service is under Government control.

The Telegraph in the Congo Free State.—The expedition of Mr. D. Mohun, which will, as previously announced in *The Electrician*, construct the telegraph line from Lake Tanganyika to Stanley Falls, has now completed its number, and has left Zanzibar for the interior. The expedition is elaborately organised and equipped, and numbers, it is said, 12,000 persons.

Twickenham.—A discussion arose at the meeting of the District Council, last week, upon the advisability of allowing a company to obtain a provisional order for the district. The usual arguments

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for delay were used, and Mr. Webb asserted that "electric lighting was now in its infancy"—a remark which shows he is up to date. No decision was arrived at by the Council.

Water Power Utilisation in Canada.—The *Commercial Advertiser*, of New York, states that work has been begun in connection with the ambitious plan of the Shewanagan Water and Power Co. for the development of the power of the St. Maurice River at the Shewanagan Falls, near Three Rivers. A contract has been let to Messrs. Barry, Ross and McRae for the construction of electricity generating plant, which will cost over $1,000,000, and take over a year to complete. Besides supplying current for light and power, it is proposed to run an electric line to Three Rivers, 19 miles away, and the transmission of power to Montreal, 80 miles away, is also mooted.

Winsford (Cheshire).—The District Council is at present considering the advisability of adopting electric lighting, and it is probable that a provisional order will be applied for.

Wolverhampton.—At a special meeting of the Council last week Ald. Mander, chairman of the Lighting committee, said that the breakdown of the electric light on the previous Saturday was due to the fact that the Art Gallery transformer station was unsuitable for its purpose. It was so damp that water had to be pumped out of the transformer beds daily. He understood that this was due to the rain-water sewers being above the level of the station, but certain alterations had now been made. With regard to the possibility of the tramways being worked by electricity in the future, he thought that in addition to the £33,000 which was being asked for to extend the generating plant, another £5,000 or £10,000 should be granted to bring it further up to date.

Workhouse Lighting.—The Barton (Lancs.) Guardians have instructed Mr. G. R. Peers to prepare a report on electric lighting of the workhouse, and particularly as to the advisability of taking current from the Eccles Corporation mains.

Staff Dinner.—The annual staff dinner of the Electrical Power Storage Co. took place at the Holborn Restaurant, London, on Monday last, when 36 members of the staff sat down. Mr. J. Irving Courtenay, chairman of the company, presided, and was supported by Mr. Frank King. Music, singing and thought-reading interpersed the usual toasts.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom all information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

October 14, 1898.

21,633. G. HOOKHAM. London. Improvements in electricity meters.
21,652. S. WORTHINGTON and R. J. CROWLEY. London. An improved system of electric traction.
21,669. J. W. SWAN. London. Improvements in or connected with incandescent electric lamps.
21,689. W. LANGDON-DAVIES, London. Improvements in induction motors.

October 15, 1898.

21,695. E. A. STOKES, E. J. STOKES and R. J. CROWLEY. London. A circulating electric battery.
21,715. J. FERGUSON and J. WHITE. Glasgow. Improvements in automatic means of breaking electric circuits.
21,716. W. THOMSON, Baron Kelvin of Largs. Glasgow. Improvements in electric measuring instruments.
21,718. ENGLISH INDUSTRIALS (LIMITED). London. Improvements in electric arc lamps. (Elektricittäs Aktiengesellschaft, Germany.)
21,733. H. E. DOLPHIN. Liverpool. Tubes and fittings for electrical purposes.
21,755. B. J. B. MILLS. London. Improvements in electric meters, parts of which are applicable to the reduction of friction of rotating shafts. (R. S. White, United States.)*
21,758. F. E. CASE. London. Improvements in systems of train control for electric motors. (Date applied for under Patents, &c., Act, 1883, Sec. 103, April 12, 1898, being date of application in the United States.)*
21,759. W. B. POTTER. London. Improvements in electric train systems. (Date applied for under Patents, &c., Act, 1883, Sec. 103, March 31, 1898, being date of application in United States.)*

October 17, 1898.

21,785. E. PRICE. Portsmouth. A mercury contact for automatic switches or for "knock over" switches.
21,829. J. E. DE MARCAY. London. Improvements in incandescent electric lamps.
21,835. W. J. STILL. London. Improvements in storage batteries.
21,841. SIEMENS BROS. AND CO. (LIMITED), R. DUMAS and G. S. GRIMSTONE. London. Improvements in the armatures of multipolar dynamo electric machines.*
21,843. H. C. HODGES. London. Improvements in electrical safety fuses.

October 18, 1898.

21,866. L. HUPFELD. Manchester. Mechanical music instrument with tune combs and interchangeable discs provided with electric carbonic-acid or other motor power.
21,906. A. SKROBANEK. London. A new or improved switchboard or frame for electro-physical experiments.*
21,941. F. J. BEAUMONT. London. An improved electricity meter for registering the amount of current consumed on direct or on alternating current circuits.
21,943. R. HADDAN. London. Improvements in electrical contact breakers. (The Allegemeine Electricitäts Gesellschaft, Germany.)*
21,944. O. D. LUCAS. London. Improvements in multiple electric switches.
21,947. SIEMENS BROS. AND CO. (LIMITED) and E. HOLMES. London. An electric winch suitable for ash hoists and such like appliances.*
21,961. W. M. MORDEY. London. Improvements in electric arc lamps specially suitable for projectors.

October 19, 1898.

21,974. S. O. COWPER-COLES. London. Improvements in the electro-deposition of metals.
21,985. J. H. KRAUS. Middlesbrough-on-Tees. A new and improved screwless casing for electrical wires.
21,997. W. SIMPSON. Manchester. Improvements in or relating to the reflector fittings of incandescent electric lamps.
22,027. P. W. NORTHEY and the ELECTRIC MOTIVE POWER CO. (LIMITED). London. Improvements in and relating to electricity meters.
22,036. H. H. BIGLAND. Manchester. Improvements in electric arc lamps.
22,037. W. P. THOMPSON. Birmingham. An improved machine for wrapping thread, silk and other workable materials around wire rod or cord lengths; especially applicable for wrapping electrical conducting wire. (J. Schmidt, Germany.)

October 20, 1898.

22,046. F. H. HEADLEY. Cornwall. Improvements in electrical regulating resistances.
22,070. C. LEVETUS. Leeds. Improvements in and relating to galvanic and other batteries.
22,071. J. A. FLEMING. London. Improvements in safety devices for use with electric cables.
22,079. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in carbon holders for dynamo electric machines or motors. (A. L. Rohrer, United States.)*
22,080. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in protecting static voltmeters. (E. M. Hewlett, United States.)*
22,081. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in means for adjusting the reluctance of magnetic circuits. (E. Thomson, United States.)*
22,082. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in trolley cars for electric railways. (H. Geisenhoener, United States.)*
22,085. C. H. MEYERS. London. Improvements relating to electric railways.*
22,096. H. C. BULL, A. G. BATE and B. A. SPAULL. London. Improvements relating to electric storage batteries.
22,115. E. BARESCH, R. M. A. BARESCH, E. M. TOSLER and W. VON ZABERN. London. Improvements in galvanic batteries.

October 21, 1898.

22,130. W. G. HEYS. Manchester. Improvements in electric railways and tramways. (J. J. Heilmann, France.)*
22,165. B. S. WESTON. London. Improvements in electric light message or advertisement indicators.
22,171. J. H. GRAEBER and H. TOBLER. London. Improvements in insulating devices for the electrodes of accumulators.*
22,181. J. S. HIGHFIELD and J. M. CATER. London. Improvements in electrical conducting mains.
22,183. W. C. JOHNSON and A. WUNDERLICH. London. Improvements in electric arc lamps.
22,190. G. WILKINSON. London. Improvements in joint boxes and switches therefor in connection with concentric systems of electrical conductors.*

October 22, 1898.

22,223. W. B. BENNS. Glasgow. A phosphorescent button or indicator for use in connection with electric light switches.
22,238. T. S. SHEVLING. Birmingham. New or improved means for preventing the breaking of the cords of electric incandescent lamp holders and lamps.
22,240. A. ECKSTEIN and E. S. SHONETS. Manchester. Improvements in automatic electric cut-outs.
22,259. F. J. BORLAND. London. Improvements in or connected with electric arc lamps.
22,261. E. E. RIES. New York, U.S.A. Improvements in methods of and means for manufacturing metal tubing andin utilising the heating effect of electrical energy in connection therewith.
22,282. W. AUBERT, Junr. London. Improvements in electric traction especially applicable to tramcars.

October 28, 1898.

6,991A. E. WATSON. London. Improvements in index needles or pointers for electrical and other indicating or measuring instruments. (Date claimed under Patents Rule 19, March 22, 1898.)*

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October 24, 1898.

22,315. C. E. KELWAY. London. A method of and improvements in apparatus for electrically indicating time.

22,344. HIPPOLYTE DELAVAN and F. F. BRÉRAT. London. Improvements in electric arc lamps. (Date applied for under Patents, &c., Act 1883, Section 103, March 24, 1898, being date of application in France.)*

October 25, 1898.

22,383. R. KENNEDY. Leeds. Improvements in closed conduit electric traction.

22,396. J. F. MORRIS. Middlesbrough. An electrical fish-pond (improved).

22,442. C. J. BEAVER and J. E. BAXTER. London. Improvements in electric discharging apparatus for use in the manufacture of waterproof cloth.

22,449. A. G. WILD. London. Improved combined brake-pipe and electrical coupling for railway trains.

22,461. J. Y. JOHNSON. London. Improvements in primary batteries. (H. J. Dercum, United States.)*

October 26, 1896.

22,486. T. WILSON. Glasgow. Improved means of electric communication between the passengers, guard, and driver of railway trains.

22,523. M. H. SMITH. London. Improvements in conduits for electric tramways.

22,537. G. MARKT. London. Improvements in or connected with electric push buttons.

22,545. W. P. THOMPSON. Liverpool. Improvements in automatic telephone exchanges. (The Strowger Automatic Telephone Exchange, United States.)*

22,547. S. HARRISON. Liverpool. Improvements in appliances or apparatus for automatically replacing fuses in electric light and power installations.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1897.

22,444. W. P. DRABBLE and F. E. BRACEWELL (executors of the late J. W. Hulse). Machinery or apparatus for transmitting motion from electric motors to other machinery.

22,717. PHILLIPS. Interrupters for electrical circuits, more particularly applicable to induction coils.

22,978. PESCHEK. Fusible cut-out for electric lighting and the like.

23,097. NISBETT. Electrical conductor or cable.

24,051. FABIAN. Electrodes for primary and secondary batteries in chemical cells.

24,884. HARRIS. Electro-deposition apparatus.

25,061. TURNER, TURNER, TURNER and AVEYARD. Switches for electric motors.

25,183. DARRAH and GIBSON. Brackets, chandeliers, electroliers and the like.

25,245. LAKE (Cantono). Method for varying the speed of electric motors or the electromotive force of dynamo-electric machines.

25,412. GAMBRELL and HARRIS. Electrical resistances.

25,434. DAWSON. Trolley wire hangers for use in overhead lines of electrical railways or tramways.

25,582. H. M. L. CRONAN. Electric lighter for gas and petroleum motors.

25,599. CHAMBERLAIN AND HOOKHAM (LIMITED) and HOLDEN. Electricity meters.

25,647. DUNLAP. Manufacture of globes and shades for electricity and other lamps.

26,057. BAIR. Porous cells or receptacles for galvanic batteries.

1898.

12,763. THOMPSON (Maggiorani). Apparatus for electro-therapeutic purposes.

13,273. THE BRITISH THOMSON-HOUSTON CO., LIMITED (Steinmetz). Systems of electrical distribution.

15,300. SNOW. Electrically heated rolls for drying paper or fabric and for similar purposes.

15,430. THOMPSON (Langguth). Diaphragm for electrolytic apparatus.

16,834. PETERSEN. Means for the automatically regulated charging of electrical accumulators.

COMPANIES' MEETINGS AND REPORTS.

Monte Video Telephone Co. (Limited).

The annual general meeting of this Company was held on Monday at Winchester House, Old Broad-street, London, under the presidency of Mr. HERBERT WARD.

The SECRETARY (Mr. E. M. Reiss) having read the notice calling the meeting,

The CHAIRMAN said: In comparing the past year's working with the previous year I have again the pleasure of reporting an improvement in the Company's business, which, if small, is certainly appreciable, and marks continued progress. The subscriptions show an increase of £640, the number of subscribers being 108 more on July 31st than at the corresponding date last year, and the subsequent two months show a further increase of 32. The working expenses at Monte Video were £400 heavier. This increase, however, was not all due to extra expenditure consequent on the increased number of subscribers, but also to an unusual number of changes in the list of subscribers, which entailed continued expenditure for removals and repairs to instruments, and helped to swell our working expenses. The last debit item in the profit and loss account is £388 written off the stock of materials in Monte Video. It will be recollected that £800 was written off last year, when I explained that much of the stock comprised old materal that was now almost obsolete; and in order to bring the amount carried in our balance-sheet still nearer its realisable value the Board decided to write off this further amount this year. Referring to the balance-sheet, the only item on the side of liabilities I would refer to is that of sundry creditors, £1,951, in order to tell you that this item chiefly consists of the balance of a loan against securities from our bankers for dividend purposes, which is to-day all repaid. Under the head of assets we show the £60,000 by which our capital has been reduced deducted from the original purchase price of the property. The additional capital outlay for the year of £1,675 is small in proportion to the increase of 108 subscribers, and represents the additional money put into the business in the shape of new instruments, new wires and poles, &c., the item being partly provided for out of revenue by the £1,000 placed to reserve. Freehold premises stand at £500 more than before, owing to the purchase for that amount of one of our sub-office buildings, the Paso del Molino. I may mention that as an investment this item of freehold property in Monte Video represents in annual rent saved, and rent now obtained from sub-letting a small portion, a return of 7 per cent. per annum. Stock of materials in Monte Video, £1,728, is the reduced value after the amount written off this year. Sundry debtors (£2,108) are chiefly subscribers for outstanding subscriptions, all of which amount is considered good and collectable, as far as can be judged at present. The item of securities stands in the balance sheet at cost price; they are to-day worth £900 more. With reference to the rearrangement of the capital of the Company, as was announced in the report, the Court confirmed the reduction of the Ordinary share capital by £60,000 on October 19th. The time at our disposal since has been quite insufficient to arrange with the holders of the Company's promissory notes for their exchange for Preference and Ordinary shares. These shares have yet to be allotted, and before this can be done it is necessary, in order to protect them as fully paid, to file a contract or contracts at Somerset House between the Company and the noteholders. The preparation and execution of this contract may take considerable time to accomplish. The Board had anticipated that it might be possible at this meeting to recommend a dividend on the Ordinary as well as on the Preferred shares. It was not possible to say in the report that they would do so, for the advisability of such a recommendation depended in a measure upon the receipt of the promissory notes, or of nearly all of them, before making it, and at the date of the report, of course, none had been received. Sufficient of the notes to warrant such a recommendation have not been sent in; consequently, a dividend upon the Ordinary shares cannot be recommended. There will not, in the minds of some of the leading shareholders, be any disappointment in this, as they have expressed their conviction that it is to the best interest of the Company that at the beginning of the new arrangement in regard to shares, any surplus that there may be in its funds above the payment of the full dividend upon its Preferred shares should be held as a reserve for contingencies or for dividend purposes in the future. There are, of course, two ways of looking at this matter, but undoubtedly the one stated is the safest for the Company's future, and, under the circumstances, it is the only course that can be recommended. The considerable amount carried forward adds materially to the assurance of future dividends and at the same time provides for additional capital expenditure, which is to be expected in the natural growth of the business, and these facts, the Board feel, will largely offset any disappointment on the part of shareholders who expected a small dividend on their Ordinary shares. Before closing my remarks, I must refer with regret to the enforced retirement last December, through ill-health, of our former colleague, Mr. Edward F. Powers. His seat on the Board has been filled by Mr. J. E. Kingsbury, an electrician of great experience, well known in the telephone world, whose technical knowledge is an especially valuable feature of his connection with the Company. I now move—

"*That the report and accounts for the year ending July 31st last, as submitted, be approved and adopted.*"

Mr. FRANK W. JONES, in seconding the motion, referred to the success which had attended the efforts for re-arranging the capital. At their meeting last July he remarked that under the then existing circumstances and those likely for an indefinite number of years to prevail, they could not prudently pay away in dividends a greater sum than they had been paying for several years before; and he wished now to emphasise this statement. The necessity for an ample and an available reserve in their business was very apparent to anyone who had had intimate connection with a South American Telephone Co.

A discussion followed, in the course of which Mr. LOCK referred with satisfaction to the increase in the revenue and net profits, as indicating increasing business, but confessed great disappointment at the way in which it was proposed to deal with the net profit. He suggested that the Directors would be acting wisely if they did not withhold a moderate dividend on the Ordinary shares. The amount of promissory notes required could probably be got in within 24 hours. He moved an amendment adjourning the meeting to November 14th, to enable the Directors to get in the outstanding promissory notes, after which the Board could recommend a dividend of 2½ per cent. on the Ordinary shares.

The CHAIRMAN and Mr. JONES replied, defending the recommendations in the report.

Mr. COLE supported the action of the Directors.

The amendment was not seconded, and the report was put and declared adopted.

Mr. Lock demanded a poll, which the Chairman said would be taken immediately. Mr. Lock stated that this would render the poll nugatory,

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as his desire was that the shareholders might all vote. He thereupon withdrew his demand.

The dividend of 5 per cent. on the Preferred shares was afterwards declared.

NEW COMPANIES, STATUTORY RETURNS, &c.

NORTHALLERTON ELECTRIC LIGHT AND POWER CO. (LIMITED).—This company was registered on Oct. 27 with a capital of £2,000, in £1 shares, to carry on at Northallerton, Yorks, and elsewhere, the business of electricians, electrical and mechanical engineers and contractors, suppliers of electricity for the purposes of light, heat and motive power, and manufacturers and dealers in electrical apparatus of all kinds. The first subscribers are: John E. Hutton, electrical engineer (150 shares), W. J. Plews and A. de L. Long, engineer (with 10 shares each), Major W. A. Chauncey, C. E. L. Ringrose, W. G. Jackson, W. Baigent, M.D., J. A. Hutchinson, M.D., and Sir H. B. Peirse, Bart. (with five shares each).

PAYNE AND BATES (LIMITED).—This company was registered on Oct. 28, with a capital of £7,000, to acquire the business carried on by Walter S. Payne and Henry Bates under the style of Payne and Bates, and to carry on the business of general engineers, manufacturers of and dealers in electric, steam, gas, oil and other engines and motors, and parts and accessories of the same.

POROUS ACCUMULATOR CO. (LIMITED).—The statutory return to September 27 gives the nominal capital as £3,000, in £1 shares, the whole of which has been taken up, and 1,993 shares have been issued as fully paid.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Oct. 13, 1898). Price of silver 28½d. per oz. (Nov. 3). Consols (2¾ per cent.) 109—109⅛ for money, 109¼—109⅜ for account; 2½ per cent. 104—104½ (Nov. 3). Stock Exchange Settling Days: Consols, Nov. 4; Stocks and Shares Continuation Days, Nov. 9 and 28; Ticket Days, Nov. 10 and 29; Pay Days, Nov. 11 and 30; Mining Share Carry-over Days, Nov. 8 and 26.

ALDERLEY AND WILMSLOW ELECTRIC SUPPLY CO. (LIMITED).—The statutory meeting of this company was held on Thursday, last week, Mr. W. P. J. Fawcus presiding. The secretary (Mr. W. E. Rowcliffe) explained the progress made in the erection of the generating station at Belmont. It was further stated that the contract for the cables had been placed, and that the work would be proceeded with forthwith, and consumers might anticipate a supply of current in the early spring. Mr. Philip Whyman, Alderley Edge, and Mr. John Royle, Wilmslow, were elected directors.

ALLGEMEINE ELEKTRICITATS GESELLSCHAFT.—A dividend at the rate of 15 per cent. for the past year (the same as in 1897) has been declared.

COMPAGNIE DE L'INDUSTRIE ELECTRIQUE (GENEVA).—This company, which was founded originally with a capital of 2,500,000fr., made a profit during the year 1897-98 of only 1,038fr., against 18,060fr. in the previous year. This result is due to the Genoa branch establishment losing 112,028fr. against a profit of 17,631fr. in 1896-97. It has been decided to wind up the Genoa branch.

HAMPSTEAD ELECTRIC SUPPLY CO. (LIMITED).—It is stated that share certificates in this company are ready to be exchanged for bankers' receipts and allotment letters.

LINOTPYE CO. (LIMITED).—Lord Kelvin has accepted a seat on the Board of this company in succession to the late Dr. John Hopkinson.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has appointed Thursday, Nov. 10, a special settling day for 40,000 "A" £5 (£2 paid) Six per Cent. Cumulative Preference Shares (Nos. 1 to 40,000) and 27,500 "B" £5 fully paid Six per Cent. Cumulative Preference Shares (Nos. 1 to 27,500) of the Buenos Ayres and Belgrano Electric Tramways Co. (Limited), and have ordered the same, as well as the £4,000,000 Ordinary stock of the Eastern Telegraph Co. (Limited) (in lieu of the 40,000 Ordinary shares of £10 each now quoted) to be quoted in the Official List.

VENEZUELA TELEPHONE AND ELECTRICAL APPLIANCES CO. (LIMITED).—The eighth report of the directors of this company for the year to June 30th last, states that the accounts show a profit of £9,942. 0s. 8d., to which is added £744. 3s. 4d., brought forward. After providing for interest on debentures and dividend on preference shares, there remains £5,499. 2s. 7d., and the directors recommend a dividend at the rate of 4 per cent. per annum on the Ordinary shares absorbing £2,800; that £1,500 be written off; that £500 be carried to reserve, and that £699. 2s. 7d. be carried forward. Capital outlay for the year was £1,754. 8s. 1d., against £8,423. 8s. 7d. for the previous year. The company's property has been fully maintained. On June 30th, the number of subscribers was 2,640. During the year commerce in Venezuela has experienced considerable difficulties. An outbreak of small-pox has, in some districts, been so serious as almost to stop business.

WESTERN AND BRAZILIAN TELEGRAPH CO. (LIMITED).—The Directors of this Company, after placing £8,000 to reserve, recommend a dividend at the rate of 5s. per Ordinary share (or £3. 6s. 8d. per cent. per annum) free of tax, for the six months to June 30th last, carrying forward £1,427. 18s. 11d. This company's traffic receipts for the week ended Oct. 28 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Co., Limited) were £3,255.

WEST INDIA AND PANAMA TELEGRAPH CO. (LIMITED.)—The estimated amount of the traffic receipts of this Company for the half-month ended Oct. 31st is £3,175, against £2,028 in the corresponding period of 1897.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
*Birmingham Tramways.	Oct. 29	4,068	+ 481	...	...	...
Blackpool Corporation...	,, 27	198	+ 32	30	15,097	+ 2,210
Blackpool and Fleetwood Co.	,, 29	262	...	16	12,943	...
*Bristol Trams & Carriage	,, 28	2,819	+ 249	17	53,874	+ 7,278
City & South London Ry.	,, 30	1,000	- 18	18	17,277	+ 738
Dover Corporation	,, 29	190	+ 73	30	5,824	...
Dublin United (Southern)	,, 28	823	+ 341	17	17,730	+ 5,512
Liverpool Overhead Rly.	,, 30	1,407	+ 43	18	28,793	+ 2,704
*Sheffield Tramways.....	,, 30	1,105	+ 144	...	...	...
*South Staffs. Trams.....	,, 28	665	+ 36	43	27,224	- 252

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Previous Week's Price Oct. 26.		Price Wednesday, Nov. 2.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 2.	
			ELECTRICITY SUPPLY COMPANIES.					£ s. d.		Highest	Lowest
6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	10	10⅞	10	10⅛	—	—	..	—
6,000	10	6/8⅓	Do. 4½ per Cent. Cumulative Pref.	10⅜	11⅛	10⅜	11⅛	..	..	..	—
80,000	5	3/0	Charing Cross & Strand Electricity Supply Corp. ..	11⅛	12⅛	11⅛	12⅛	2 16 0	February & August	..	—
20,000	5	2/8	Do. 4½ per Cent. Preference	6	6½	6	6¾	3 9 3	,, ,,	—	—
£34,000	5	2/6	Chelsea Electricity Supply Ordinary	8	9	8	9	3 6 8	March	..	—
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	113	115	113	115	3 18 3	June and December	—	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red)	103	105	103	105	4 15 3	..	..	..
50,000	10	5/0	City of London Elec. Lighting Ord. 40,001 to 90,000	23	24	23½	24½	5 2 0	February & August	24½	23¾
10,000	10	1/9	Do. Ordinary 90,001 to 100,000	23½	23½	23	24	..	..	..	—
40,000	10	6%	Do. 6% Cumulative Pref.	15½	16½	16½	16½	3 13 9	January and July ..	16	—
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	127	131	127	131	3 16 1	June and December	131	..
30,000	10	..	County of London & Brush Prov. Ord. (fully paid)	12½	13⅞	12½	13⅞	—	—	13⅞	..
10,000	10	..	Do. (£8 paid)	10	11	10	11	..	..	—	—
20,000	10	6/0	Do. 6% Cumulative Preference	14½	15½	14½	15½	4 0 0	March & September	14¾	14¾
15,660	5	2/6	House-to-House Electric Lighting Supply Ord.	9	9½	9	10	2 0 0	..	9½	9⅜
17,000	5	3/6	Do. 7 per Cent. Preference	9½	10⅛	9½	10⅛	3 6 8	March & September	..	—
15,000	5	10%	Kensington and Knightsbridge Ord.	13	14	13	14	3 18 7	..	..	—
10,000	5	6%	Do. 6% 1st Pref.	7⅞	8¼	7⅞	8¼	3 12 9	January and July ..	..	—
111,000	8	..	London Electric Supply Ordinary	3¾	3¾	3¾	4	—	—	3⅞	—
50,000	5	..	Do. Preference	6¼	6¾	6	6½	—	—	6⅝	—
62,400	10	5/0	Metropolitan Electric Supply Ordinary	15	16	15½	16½	3 2 6	April and October ..	16¼	16
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	121	117	121	3 14 9	June and December	..	—
6,452	10	6/0	Notting Hill Electric Ordinary	15	16	15	16	3 15 0	March	15½	..
275,000	1	..	Rand Electric	⅞	1⅛	⅞	1⅛	—	—	—	..
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb	88	93	88	93	5 8 1	—	—	..
150,000	$100	$2	Royal Electric Company of Montreal Shares ...	155	160	155	160	5 0 0	—	..	—
130,900	100	4½%	* Do. 4½% 1st Mort. Debs.	104	106	104	106	4 5 0	April and October	106	..
31,980	5	5/0	St. James and Pall Mall Electric Ordinary	15½	16½	16	17	4 14 2	February & August	—	—
20,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	,, ,,	..	—
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.)	104	107	105	108	3 15 6	June and December	107	105½
65,000	5	..	South London Electric Supply Ordinary (£3 paid).	2¾	3¼	2¾	3¼	..	..	..	..
79,200	5	5/0	Westminster Electric Supply Ordinary	14½	15⅝	14½	15½	4 3 10	March & September	15⅝	15
18,848	5	5%	Yorkshire House-to-House	7¾	8	7¾	8	3 2 6	February and July ..	—	—
18,636	5	5%	,, Do. (£4 paid)	5¾	6¼	5¾	6¼	3 18 5	February and July ..	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Oct. 26.		Price Wednesday, Nov. 2.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 2.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS								
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	100	104	100	104	3 17 4	January and July	103	..
25,000	10	..	Amazon Telegraph	6	7	6	7	—	—	..	—
£125,000	100	5%	Do. 5 per Cent. Debentures	92	95	92	95	5 5 3	—	—	—
£905,560	Stock	15/0	Anglo-American	61	64	61	64	4 13 9	Feb., May, Aug., Nov.	..	..
£3,047,220	Stock	30/0	Do. Preferred	111	112	112	113	5 14 6	" "	113	112½
£3,047,220	Stock	..	Do. Deferred	13⅜	14½	13⅜	14½	—	—	14 7/16	13 15/16
180,000	10	5/0	Brazilian Submarine	15⅜	16½	15½	16	4 7 6	Mar., June, Oct., Dec.	16	15⅝
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	111	115	111	115	4 8 0	June and December	..	..
10,000,000	$100	$13⅜	Commercial Cable Capital Stock	180	190	180	190	4 4 3	Jan., Apr., July, Oct.	182	181½
£918,297	Stock	4%	* Do. 4 per Cent. Debenture Stock	104	106	104	106	3 15 6	" "	105½	..
16,000	10	..	Cuba Submarine Ordinary (Deferred)	8½	9½	8½	9½	—	February and August	—	—
6,000	10	..	Do. Preference 10 per Cent.	15½	16½	15½	16½	—	" "	..	—
12,951	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October	—	—
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	..	—
£30,000	50	4½%	Do. 4½ per Cent. Debentures	104⅞	107⅞	104⅞	107⅞	4 4 8	January and July	..	..
60,710	20	3/0	Direct United States Cable	11½	11⅞	11⅝	12	5 8 4	Jan., Apr., July, Oct.	11 13/16	11 7/16
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	101	104	101	104	4 7 5	" "	..	..
400,000	10	6/6	Eastern	17⅞	17⅞	17⅞	17⅞	3 18 11	Jan., Apr., July, Oct.	17⅞	17½
£1,295,000	Stock	17/6	Do. 3½ per Cent. Pref. Stock	104	107	104	107	3 5 5	" "	104½	..
*£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.) xd	126	130	124	128	3 2 6	May and November	125	—
£89,900	100	5%	* Do. 5 per Cent. Debentures, 1899	100	103	100	103	4 17 1	February & August	..	..
£500,000	Stock	8/9	Do. Provisional Certificates 50% paid	52	55	52	55	..	..	—	..
250,000	10	2/6	Eastern Extension	17½	17⅞	17½	17⅞	3 18 11	Jan., Apr., July, Oct.	17⅞	17⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	129	125	129	3 2 4	February & August	..	..
£16,200	100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900 (reg.)	100	104	100	104	4 16 10	January and July	..	..
£64,400	100	5%	Do. (Bearer)	101	104	101	104	4 16 10	" "	..	..
£35,100	100	5%	*Eastern and S. African 5 p. c. Mor. Deb., 1900 (reg.)	100	104	100	104	4 16 10	" "	—	—
£46,500	100	5%	Do, (Bearer)	101	104	101	104	4 16 10	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102	105	102	105	3 16 4	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.) xd	104⅞	107⅞	102⅞	105⅞	3 16 2	May and November	..	—
180,227	10	1/9	Globe Telegraph and Trust xd	12	12½	12	12½	4 2 0	Jan., Apr., July, Oct.	12⅜	12⅛
180,042	10	6%	Do. 6 per Cent. Preference xd	16⅜	17½	16½	17	3 10 7	" "	17	—
150,000	10	5/0	Great Northern of Copenhagen	28⅜	29⅛	28½	29½	3 7 10	January, April, July	28⅝	—
£150,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B"	100	103	100	103	4 17 10	March & September	..	..
£97,800	100	4½%	Halifax and Bermuda Cable 4½% 1st Mort. Deb. (red)	101	104	101	104	4 7 0	June and December	..	—
17,000	25	12/6	Indo-European	52	55	52	55	4 10 11	May and November	54½	54
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	109	112	109	112	5 7 7	March & September	..	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red)	105	108	105	108	3 14 3	June and December	—	—
11,839	8	4/0	Reuter's	7½	8½	7½	8½	4 14 1	April and October	—	—
3,381	£100 Cert.	6%	Submarine Cables Trust	133	138	133	138	4 6 11	" "	—	—
15,609	10	..	West African Telegraph	3½	4½	..	..	—	—	—	—
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	4 18 0	March & September	..	—
30,008	2½	..	West Coast of America	½	¾	½	¾	..	—	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	104	107	104	107	3 15 2	June and December	..	..
88,321	10	0/6	West India and Panama	1⅛	1⅜	1⅛	1⅜	—	May and November	1 5/16	..
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½	9⅞	9½	9⅞	6 3 1	" "	—	—
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7	9	7	9	6 13 4	" "	..	—
£80,000	100	5%	* Do. 5 per Cent. Debentures	106	109	106	109	4 12 10	January and July	..	—
64,269	15	6/9	Western and Brazilian Ordinary	12½	12⅝	12½	12⅝	3 16 6	May and November	12⅝	..
33,129	7½	6/0	Do. 5 per Cent. Preferred Ordinary	8	8½	8	8½	4 8 2	" "	..	—
33,129	7½	0/9	Do. Deferred Ordinary	4	4½	4	4½	—	" "	4⅛	—
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	107	110	107	110	3 13 1	June and December	..	—
1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	105	110	—	—	6 7 10	Feb., May, Aug., Nov.	—	—
£158,100	100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	98	103	98	103	5 16 6	March & September	—	—
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	2½	3½	2⅝	3½	6 8 1	August	—	—
224,850	10/0	1½d.	Consolidated Telephone Const. & Manufacturing	1/16	3/16	1/16	3/16	6 7 0	July	..	—
28,000	5	4/0	Monte Video Telephone 6 per Cent. Preference	..	..	—	—	7 5 6	October	—	—
£84,597	5	3/0	National	5½	5⅝	5½	5⅝	5 11 7	February & August	5½	5⅛
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	12	14	12	14	4 5 9	" "	13⅜	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	12	14	12	14	4 5 9	" "	..	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	5⅛	5⅜	5⅛	5⅜	4 13 0	" "	5⅛	..
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	100	105	100	105	3 6 8	June and December	—	—
171,504	1	0/8	Oriental xd	⅜	½	⅜	½	6 13 4	April and October	—	—
58,000	5	6/0	United River Plate	4½	4⅝	4½	4⅝	6 6 5	July	—	—
£151,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	106	103	106	4 14 4	June and December	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	2	1/2½	Brush Electrical Engineering	1⅝	1⅞	1⅝	1⅞	3 4 0	—	—	..
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2	2½	2	2½	5 6 8	..	2⅜	—
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	109	113	109	113	4 0 4	February & August	—	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	103	106	101	105	4 7 0	June and December	103½	..
£20,000	5	5/0	Callender's Cable Construction xd	10	11	9½	10½	6 8 7	" "	—	—
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	110	113	110	113	4 0 6	November and May	..	—
300,000	1	9/8	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	..	1⅛	—
50,000	1	..	Chadburn's Ship Telegraph Ordinary	1⅛	1⅜	1⅛	1⅜	—	—	..	—
50,000	1	7½	Do. 6 per Cent. Cumulative Pref.	⅞	1⅛	⅞	1⅛	5 6 8	..	—	—
32,098	3	..	Crompton and Co. (Nos. 1 to 32,098)	1½	2	1⅝	2	..	..	—	—
£82,850	100	5%	* Do. 5% First Mort. Deb. (red.)	91	96	91	96	5 5 10	January and July	..	—
99,261	5	2/1½	Edison and Swan United ("A" Shares) (£3 paid)	2⅛	2⅜	2⅛	2⅜	6 10 5	February & August	2⅛	—
17,139	5	3/1⅝	Do. (£5 paid)	4	5	4	5	6 0 0	" "	..	—
£194,023	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	105	107	101	103	3 18 8	June and December	—	—
17,400	5	5%	Edmundson's Electric Corporation Ord (fully paid)	5	5⅛	5	5⅛	4 10 11	Half-yearly	..	—
110,000	2	1/2⅜	Electric Construction Co. (Limited)	2⅛	2⅜	2	2⅛	5 2 3	February & August	2 1/16	—
25,000	2	2/0⅜	Do. 7 per Cent. Cumulative Pref.	2⅜	3⅛	2⅜	3⅛	4 6 2	August	2⅛	—
£111,100	Stock	4%	Do. 4% First Mortgage Deb. (red.)	105	107	105	107	3 16 2	" "	103½	—
91,196	1	..	Elmore's Patent Copper Depositing	⅜	⅝	⅜	⅝	..	—	—	—
12,500	10	8/0	Henley's Telegraph Works Ordinary	20½	21½	20½	21½	6 0 11	February & August	21½	—
3,000	10	7/0	Do. 7 per Cent. Preference	18	19	18	19	3 13 8	" "	—	—
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 3	" "	—	—
40,000	10	5/0	India Rubber, Gutta Percha, &c., Works	22	25	22	23	4 7 0	" "	—	—
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	102	106	102	106	3 15 6	March & September	..	—
37,350	12	12/0	Telegraph Construction and Maintenance	37	41	37	41	4 6 2	March and July	33½	—
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	104	107	104	107	4 14 9	January and July	105	—
£80,000	5	4/0	Willans and Robinson Ordinary	7⅜	8½	7⅜	8½	4 17 0	April and October	—	—
£30,000	5	3/0	Do. 6% Cumulative Preference	6⅜	7½	6⅜	7½	4 2 9	" "	—	—
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	108	110	108	110	3 18 8	May and November	—	—
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	..	Blackpool and Fleetwood Tramways	15½	16½	15½	16½	..	—	16½	15⅜
25,000	10	6%	Bristol Tramways and Carriage	21½	22	21½	22	2 14 7	—	—	—
25,000	10	6%	Do. (£7. 10s. paid)	18⅜	18⅞	18⅜	18⅞	1 14 1	—	—	—
£90,410	Stock	4%	Do. 4% Debenture	121	123	121	123	3 5 1	—	—	—
80,000	10	..	British Electric Traction Ordinary	16	17	16½	17½	..	—	17⅛	16⅞
10,000	10	2/4 1/10	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm.pd.)	13	14	13	14	4 5 9	—	—	—
34,440	10	..	Calcutta Tramways	5	6	5	6	..	..	—	—
£35,250	10	3/0	Central London Ordinary	9⅜	10½	9⅜	10½	2 18 6	June and December	10½	10
178,303	10	1/9⅜	Do. (£6 paid)	5⅜	6½	5⅜	6½	2 16 6	" "	..	..
£630,000	Stock	2½%	City and South London Railway Con. Ordy.	70	72	69	71	2 16 8	January and July	71½	69
22,500	10	..	Do. Ordinary (£4 paid)	2⅜	3½	3½	4	..	..	—	—
9,251	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	3 4 6	January and July	—	—
£137,701	Stock	4%	Do. 4% Perpetual Debenture xd	136	138	134	136	2 18 10	May and November	—	—
20,000	10	6%	Imperial Tramways Ordinary (old £6 shares)	16½	16⅝	16½	16⅝	2 3 9	March & September	—	—
10,000	10	6%	Do. 6% Preference	15	15½	15	15½	3 18 8	" "	—	—
37,500	10	3%	Liverpool Overhead Railway Ordinary	10 7/16	10 9/16	10 7/16	10 9/16	3 1 6	February & August	—	—
10,000	10	5%	Do. 5% Preference	15½	16	15½	16	3 2 6	" "	—	—
125 000	Stock	4%	Do 4% Debenture	107	109	108	110	3 13 1	January and July	—	—
20,000	5	3/3½	New General Traction 6% Cumulative Pref	4⅜	5½	4⅜	5½	—	—	—	—
£540,000	Stock	3%	Waterloo and City Ordinary	106	111	106	111	2 15 1	June and December	109½	107

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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CONTENTS OF THE CURRENT NUMBER.

NOTES	65	The Commercial and Business Aspects of Municipal Electrical Supply. By A. H. Gibbings, M.I.E.E. Illus. Continued	79
Meetings of Scientific Societies.	67	Mr. W. H. Preece's Presidential Address to the Institution of Civil Engineers. Concluded	82
The Folkestone Electricity Supply Works. Illustrated	68	Testimonial to Mr. Richard Collett	83
Currents in Branched and in Mutually Inducing Circuits produced by Harmonically Varying Electromotive Forces. By Prof. T. R. Lyle. Continued	72	Correspondence	84
Electricity Works Accounts	74	Legal Intelligence	85
SHAFTING *versus* DIRECT-DRIVING	76	Trade Notes and Notices	85
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe. Illustrated	77	Companies' Meetings & Reports	91
		City Notes	93
		Companies' Share List	94

NOTES.

THE annual report of the Queensland Post and Telegraph Department for the year 1897-8, which has just reached us, is not less formal and not more exciting than such Colonial publications usually are; but there is one item relating to telegraph and telephone business well worth noticing here just now. Queensland has commenced the construction of trunk lines connecting its principal urban telephone exchanges; and upon one of these lines we have the result of a full year's working from July, 1897, to June, 1898. The experiment was between Charters Towers and Townsville, and its effect was to reduce the revenue from telegrams from £76 to £52, the earnings of the trunk telephone wire rather more than compensating for this loss. Simultaneously there was a very large increase in the number of subscribers to the exchanges at both ends. Fortunately the exchanges, as well as the telegraph and telephone lines, all belong to the Government, which consequently clears a satisfactory profit on the businesses as a whole. It is a pity we cannot be supplied with similar figures for this country.

IN the POSTMASTER-GENERAL'S written reply to last week's deputation from the Manchester Corporation we have a further insight into what is to be the policy of the Department with regard to the telephones. There is, we are told, no immediate intention of establishing Post Office competition in a city like Manchester, where the Post Office has not hitherto instituted any *local* exchange. The italics in the last sentence are ours. Manchester has an exchange for the operation of the trunk wires, so has London, and so have other large towns, but these are not local exchanges. Consequently, we must assume that Post Office competition is to be confined to those districts in which it has already been tried. In fact, it would appear that the POSTMASTER-GENERAL agrees with the evidence given by the Post Office experts before the Select Committee as to the futility of telephonic competition, and his Department, having tried the experiment already, prefers to leave further trials in this direction to the municipalities themselves—if they can get powers from Parliament. These local authorities will then only have themselves to blame when their ratepayers realise the annoyance caused by having two telephone systems in the same town.

THE Corporation of London and the London County Council are also eager to know what is to be the outcome of the Select Committee's report. The former body is content to "take steps to urge upon Her Majesty's Government the extreme desirability of action being forthwith taken . . ;" but the County Council is, as usual, more energetic. They have written to the POSTMASTER-GENERAL to inquire whether there is to be competition in London, but the reply they have received is much less definite than that sent to Manchester—Her Majesty's Government are considering the report of the Committee. But the County Council will be put off with no evasive answer, and are writing again to remind the POSTMASTER-GENERAL that what they primarily want is an answer to the question, "Will the Post Office compete in London?" The County Council might read its answer in the portion of the reply to the Manchester Corporation quoted above.

THE presidential address of Mr. J. A. BRODIE before the Liverpool Engineering Society, an abstract of which will be found in another note, makes timely reference to the electric traction scheme for that city, now that the so-called experimental electric tramway is practically completed and will shortly be put in operation. Mr. BRODIE takes a sensible, business-like view of the overhead trolley system, regarding it as superior to other systems "from all points of view except that of appearance"; and he looks forward to the completion of a continuous line of surface tramways extending from Liverpool landing stage to the colliery district of Haydock, 15½ miles away. The reason there is such a pronounced foreign element in electric traction, Mr. BRODIE considers, is because we have lagged 10 years behind American and Continental engineers.

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It will interest our readers to learn that in not a few places in this country time-expired men from the British navy are permanently engaged at electric supply works as foremen in charge of work on mains and in other jobs requiring some technical knowledge of electrical matters. At a time when patriotic feeling is deeply stirred it may be appropriate to refer to this fact. We may add that, quite apart from any such feeling, the employment of these men is distinctly to be encouraged, for the regular course of training they receive in electrical subjects is not surpassed by that to be had at technical colleges on land, while the discipline of their naval career has a decidedly healthy effect on their character.

Cable Interruptions and Repairs.—

	Date of Interruption	Date of Repair.
Bissao—Bolama	Aug. 3, 1898 ...	—
St. Louis and Noronha	Oct. 17, 1898 ...	—
Gibraltar—Tangier	Oct. 18, 1898 ...	Nov. 4, 1898
Pernambuco - Ceara	Oct. 19, 1898 ...	—

The Llandudno Electric Supply Station.—The electric light was switched on at Llandudno on Saturday last. An account of the combined dust destructor and electric supply station will be found in our issue of Oct. 28. The official opening has been postponed until next Easter. There are at present about 2,000 8-c.p. incandescent lamps converted to the mains and 48 arc lamps for street lighting.

Obituary.—According to the Paris correspondent of the *Standard* it appears that we have lost, under painful circumstances, another of the pioneers of electrical industry. M. de Meritens, the constructor of the historical dynamos bearing his name, several of which machines are still in use in many lighthouses, has died at Pontoise, at the age of 65. It is sad to hear that M. de Meritens was in such poverty that both himself and his wife put an end to their lives by poison.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on Monday afternoon, the 7th inst., Sir James Crichton-Browne, M.D., F.R.S., Treasurer and Vice-President, presiding. The special thanks of the members were returned to Mr. John B. Carrington, for his donation of £25, and to Mr. Charles Scott Dickson, Q.C., Solicitor-General for Scotland, for his donation of £100 to the fund for the promotion of experimental research at low temperatures.

Electro-Zinc Precipitation of Gold.—In the September 17th issue of the *Johannesburg Star*, a copy of which is in our hands, there is a lengthy article descriptive of the Bettel process of precipitating gold. The process is one involving the replacement of zinc by gold, by electro-chemical action. It appears to give satisfactory results on the comparatively small scale on which it has been tried, and efforts are being made to introduce the process more widely on the goldfields of South Africa. It is claimed, among other things, that "from 2s. to 3s. more per ounce fine gold will be realised from the gold (bullion)."

Personal.—We are pleased to learn that Sir Eyre M. Shaw, chairman of the Metropolitan Electric Supply Co., who last week underwent a painful operation, is progressing satisfactorily towards convalescence.

Mr. A. H. Walton, who has been the Metropolitan Electric Supply Company's engineer for the last four years, has been appointed by the British Thomson-Houston Company chief engineer for the erection and maintenance of the electrical plant in connection with the Central London Railway, and will act as chief resident engineer when the line is in operation. We hear that Mr. R. R. Todd has been appointed Mr. Walton's successor.

The Corporation of London and the Telephones.—At a meeting of the Court of Common Council on Thursday last week, the telephone question came up for discussion. On the motion of Mr. Moojen it was referred to the Streets Committee to consider the necessity of the Corporation's applying for a licence to establish a telephone service either solely or in conjunction with the London Council. The Streets Committee submitted a report narrating the recommendations of the Select Committee of the House of Commons on the telephone service and appending a report of the City Solicitor upon it. They advised that the necessary steps should be taken to urge upon Her Majesty's Government the extreme desirability of action being forthwith taken to give due effect to the recommendations of the Select Committee. This was adopted.

The Society of Arts.—The first meeting of the new session will be held on Wednesday next, when Sir John Wolfe Barry will deliver his presidential address. Among the Papers down for reading before Christmas is one by Prof. G. Forbes on "Long-Distance Transmission of Electric Power," to be read on November 23rd. After Christmas, Papers will be read on—"Canals and Inland Navigation in the United Kingdom," by L. F. Vernon-Harcourt; "Preservation of Timber," by S. B. Boulton; "Electric Traction and its Application to Railway Works," by Philip Dawson; "Coal Supplies," by T. Forster Brown; "Wireless Telegraphy," by W. H. Preece; and "Leadless Glasses," by Wilton P. Rix. A course of four Monday evening Cantor lectures on acetylene will be commenced by Prof. Vivian B. Lewes on November 21st.

"Etherion."—In an article in the *Chemical News* of Nov. 4th, under the heading "On the Supposed New Gas, Etherion," Sir William Crookes gives an account of some old experiments of his, which would tend to show that etherion is nothing more than—aqueous vapour. After giving in detail the reasons that have made him of that opinion, Sir William concludes by admitting that he has up to the present only seen an abstract of Mr. Brush's Paper. On the evidence at present available, however, he considers it more probable that etherion is water-vapour than that it is a new elementary gas, and he points out that this is corroborated by the observations made by Mr. Brush that etherion is absorbed by phosphoric acid and soda-lime, as well as by the powdered glass from which it has been previously driven off by heat.

Interruption in Electrical Supply.—An interruption to the supply at High Wycombe on Wednesday, last week, was attended with rather amusing consequences. At 10.30 in the evening, a triple concentric feeder broke down, the neutral conductor, which formed the outer concentric ring, becoming practically short-circuited to the negative main. The effect of this was to blow the fuses at the station end of the feeder, and at the same time to melt the copper bridges at the station end of all the middle-wire feeders. As a result, the voltage on the positive side rose considerably, blowing a number of fuses, bursting some lamps and fusing some lampholders. To make matters worse, the breaking of the earth connection caused several of the fire alarms in the firemen's houses and police stations to operate. Fortunately, the central fire alarm was not affected. It must have been a disappointment to the High Wycombites that the occurrence took place on November 2nd instead of November 5th, though, perhaps, from the firemen's point of view April 1st would have been a more suitable date. It is only fair to the contractors to add that the construction of the works at Wycombe is still proceeding, and that the final arrangements of the switchboard and mains, which will preclude the possibility of a repetition of this accident, had not yet been made. The supply to nearly all the lamps was resumed a few minutes after the occurrence.

On Saturday last there was a failure of the electric light in some streets in Dublin.

The Manchester Corporation and the Telephones.—The following letter has been received by the Manchester Corporation from the Postmaster-General:—

General Post Office, London, Nov. 3, 1898.

The Postmaster-General has had under consideration the series of questions which were handed to him by the deputation from the Special Committee of the Corporation of Manchester which waited on him on the 31st ult., and has instructed me to inform you in reply that the report of the Select Committee on Telephones is now engaging the attention of Her Majesty's Government, and that until the decision of Her Majesty's Government is known it is impossible to give a definite reply to the various inquiries addressed to him. The Postmaster-General, however, directs me to add that:—

1. He has no immediate intention of establishing Post Office competition in a city like Manchester, where the Post Office has not hitherto instituted any local exchange.

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2. He has no intention of conferring any licence on any private company for carrying on the business of a telephone exchange.

3. In the event of the report of the recent Select Committee being approved by Her Majesty's Government a Bill will be introduced into Parliament to give effect to its recommendations. This Bill would *inter alia* authorise the Postmaster-General to grant provisional orders to enable a local authority to lay down and work telephones in its own district or the districts of other authorities within the exchange area.

4. The Postmaster-General is not in a position at the present time to state what conditions may be inserted in the licence so granted for the purchase by the Post Office of the land, buildings, and plant, acquired by the Corporation for the purposes of the exchange. But in framing the provisions due weight will, at the right time, naturally be given to the recommendations of the Select Committee on the subject.

5. The Postmaster-General does not consider it any part of his duty to lay down the conditions on which local authorities should be allowed to borrow money for the purpose of opening a telephone exchange.

6. In the event of any licence being granted to a municipality the Postmaster-General would not propose that it should extend over an area larger than that already granted to the National Telephone Co.—Your obedient servant, S. WALPOLE.

The London County Council and the Telephone Service.—The Postmaster-General has sent the following letter to the London County Council, in reply to their inquiry whether the necessary measures were being taken for the establishment of a competing telephone service in London :—

With reference to your letter of the 14th inst., in which you state that the London County Council have had under consideration the recommendations of the Select Committee on Telephones of last session with regard to competition with the National Telephone Co., and that they are of opinion that such competition in London should be undertaken by the Post Office, I am directed by the Postmaster-General to acquaint you, for the information of the Council, that her Majesty's Government are considering the report of the Committee and that, if they adopt its suggestions, Parliament will be asked to legislate on the subject.—Yours, &c., S. WALPOLE.

In connection with this letter, the Highways Committee of the Council have now drawn up a public report in which they set out an account of the interview between a deputation of the Manchester Corporation and the Postmaster-General, to which we made reference in our last issue. They point out that it would appear, from the reply of the Postmaster-General to the Manchester deputation and from the letter from the secretary of the Post Office, that there was some doubt whether the Post Office would at once, as it had power to do, establish this competing service. It was now too late for the Council itself to ask in the ensuing session for powers to establish a London telephone service, and should the Government fail then to introduce a general Bill to enable local authorities to establish services for their respective districts, either alone or in combination, the matter would be very seriously delayed, and the period within which the local authorities could expect to recoup some portion of the outlay would be shortened, which might render it impracticable for them to undertake the service. They accordingly recommend the Council to address a letter to the Postmaster-General embodying these views on the subject and pointing out the extreme urgency of the matter, and the desirability of a decision being promptly arrived at by the Government upon the question whether the Post Office shall establish a competing telephone service. This recommendation was adopted unanimously at Tuesday's meeting of the Council.

The Liverpool Engineering Society and Electric Traction.—At the inauguration of the new session of this society, on the 3rd inst., Mr. John A. Brodie, city engineer, the newly-elected president, delivered an inaugural address dealing with some of the more important questions relative to the local transport of goods and passengers, and gave a short history of the rise and progress of traffic inland from Liverpool. He particularly referred to the recommendations contained in the report of the Committee formed by the Liverpool Chamber of Commerce with regard to the construction of a goods railway to Manchester, and, while expressing his general approval of these recommendations, he doubted whether a railway pure and simple would be likely to meet the requirements, and he believed for short distances the principle of the plateway would ultimately come to the front. If Liverpool really grasped the great importance of the issue at stake, the matter of the few hundred thousand pounds required for the construction of a metal way would not long be allowed to handicap the progress of the trade of the port of Liverpool and of Lancashire. The proposed junction of the future Liverpool electric tramway system with those of Prescot and St. Helens was interesting, as, if carried out, it would form a practically continuous line of electric tramways from the Landing Stage to the colliery district of Haydock, a distance of 15½ miles, and, if authorised, there could be little doubt that important extensions on the Lancashire side would follow. This would go far to prove whether heavy goods traffic could be safely and conveniently conveyed over ordinary tramway lines in public streets, and there could be little doubt on this head when it was considered that the present horse tramway traffic passing over the single line in front of the Town Hall represented a weight of vehicles and passengers of approximately 4,000 tons a day, or 1,500,000 tons per annum, and that the same number of electric trams would mean a weight of not less than 11,000 tons per day, or 4,000,000 tons per annum. On the question of motor cars, he pointed out the developments that were likely to accrue in the direction of heavy motor-waggon traffic. There should be a considerable opening for a motor vehicle in the sweeping and collection of dust and the street watering, and he was satisfied that where the length of cartage exceeded two miles the cost of conveyance, including all proper charges, would be considerably below that of horse cartage. Referring to the tramways traction and the various forms of mechanical traction on the market, he said that the surface contact system could hardly be said to be beyond the experimental stage though giving considerable promise. Comparing the advantages of the overhead trolley and conduit system, he said there could be no question of the superiority of the first-named from all points of view except that of appearance. It was in the centres of large towns, if anywhere, that the heavy additional expense of a well-constructed conduit was warranted, and, where it was decided upon, the design should be of ample dimensions and the construction of the most substantial character. The conduit system involved delays for special parts and much more interference with street traffic during construction than the trolley system, especially in narrow streets, and the experience of Berlin, where electric cars were being run by accumulators over well-constructed conduit lines, should not be lost sight of. In the matter of electric tramways we had lagged ten years behind our more enterprising American and Continental engineers, and we could not legitimately grumble if we found that those countries which had spent their money in experiments and done hard pioneer work, now stepped in to equip our lines with materials that could not be obtained at home in sufficient quantity to meet requirements.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, November 11th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Agenda :—(1) Discussion on Mr. A. Campbell's Paper on "The Magnetic Fluxes in Meters and other Electrical Instruments"; (2) "On the Propagation of Damped Electrical Oscillations along Parallel Wires," by Prof. W. B. Morton; (3) "On the Properties of Liquid Mixtures," by R. A. Lehfeldt.

TUESDAY, November 15th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read with a view to discussion :—"Electrical Transmission of Power in Mining," by W. B. Esson.

WEDNESDAY, November 16th.

INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Annual General Meeting of the Students' Section in the Library of the Institution.

ROYAL MICROSCOPICAL SOCIETY.

7:30 p.m. Ordinary Meeting at 20, Hanover-square, W.

SOCIETY OF ARTS.

8 p.m. The Opening Address of the Session will be delivered by Sir John Wolfe Barry, F.R.S., on "Internal Traffic of London."

FRIDAY, November 18th.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7:30 p.m. Second General Meeting of the Session in the Literary and Philosophical Society's Lecture Hall, Newcastle-on-Tyne. Paper to be read :—"Repairs to Iron and Steel Vessels in way of Boilers and Stokeholes," by M. W. Aisbitt.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting, when the following Paper will be read :—"Liquid Air: A Short Description of its Production and Summary of its Application to the Chemical or other Industries," by Cecil Lightfoot.

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THE FOLKESTONE ELECTRICITY SUPPLY WORKS.

As in most provincial towns, the question of electric lighting was raised in Folkestone some 13 or 14 years ago, and it met with considerable opposition, especially from those members of the Corporation who happened to be shareholders in the local gas company. Since then several schemes were considered by the Corporation, including one for a combined electric light and dust destructor; but none of these obtained general approval, and finally in November last year the Provisional Order, acquired by the Corporation in 1896, was transferred to the Folkestone Electricity Supply Co. The contractors for the whole of the plant were Edmundson's Electricity Corporation, who have, we believe, a considerable interest in the Company, there being also a number of local shareholders. The capital of the Company is £50,000. The first sod at the works was not cut until the first week in February, but yet by March 27th a supply from plant, part of which was temporary, was given to an important consumer, and a general supply for private lighting was commenced by July 1st. On the occasion of the inaugural ceremony, referred to in our last issue, the public arc lighting was started, the station being nearly complete. The present lamp connection is 24 arcs and the equivalent of 9,000 8 c.p. incandescent lamps.

Considerable difficulty was experienced in securing a site for the central station, and, finally, one had to be taken at over a mile from the centre of the town. The position is seen from Fig. 1. As regards coal supply, the station is placed very conveniently; but, of course, its outside situation must have its effect on the economy of distribution. The land, as is most of the newer part of Folkestone, was the property of Lord Radnor, and it was at his suggestion that the elegant chimney, seen in Fig. 2, was built more or less in imitation of Messrs. Doulton's in Lambeth. Coal is delivered from a private siding by the Shorncliffe station of the South-Eastern Railway, straight into the coal bunkers. These have a capacity of about 150 tons, and are placed close to the boilers, as seen in Fig. 3, being fitted with a movable front to allow of the boiler tubes being draw for repairs. The Company owns 1½ acres of ground, so that there is ample room to extend the buildings.

The buildings were erected by Mr. D. Baker, of Folkestone, under the supervision of Mr. Reginald Pope, the architect. Their arrangement is clearly shown in Figs. 2 and 3. They are entirely of fireproof material, the roof being constructed of steel, slate and glass. The slates are fastened to the angle iron purlins by lead clips, and expanded steel lathing, plastered, is attached to the inside of the engine-room roof. The cast iron water tank over the coal bunkers has a capacity of 17,500 gallons. The chimney is 150ft. high, and its area at the narrowest part is 49 sq. ft.; it is lined with firebrick to about 50ft. It is interesting to note that the chimney was built from the inside, an electric motor being employed to drive the winch (through ordinary belting and friction gear) used for lifting the workmen and the materials.

The boiler-house (Fig. 4) is at present equipped with three boilers of Messrs. Davey-Paxman's "Economic" type, 14ft. long by 8ft. diameter. There is space left in the boiler-house for two more of similar size if required. Each of the boilers is

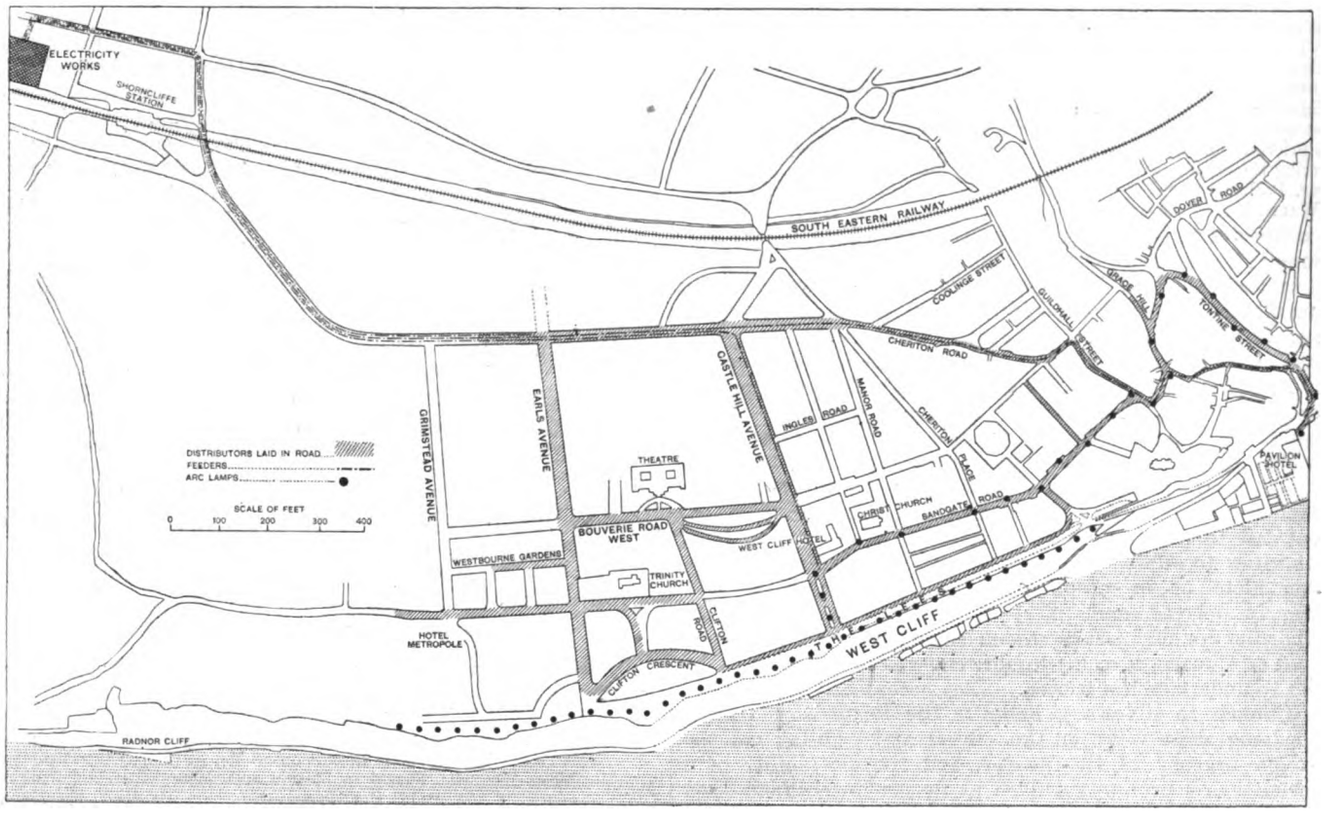

FIG. 1.—Map of District, showing Position of Electric Supply Station and Mains.

capable of evaporating 6,000lb. of water per hour at 150lb. pressure. Two of the boilers, which were used for a time with a temporary chimney, are fitted with Meldrum forced-draught furnaces. No economiser has been put in at present, but space has been left in case one is desired later. The contractors doubt, however, whether an economiser would be of much use with this type of boiler and a feed heater. Water is at present obtained from the town mains, but a 7½in. steel tube well is being sunk to a depth of 180ft., from which sufficient water will be supplied. As the water is very hard an exhaust "heater detartoriser" of Mr. William Boby's make is employed. This is capable of dealing with 12,000lb. of water per hour. The water enters at the top and flows downwards till it reaches the suction pipe of the feed pumps, which it enters at a boiling temperature. The apparatus consists of a number of circular trays set one upon another so as to form a column. Each tray is always nearly full of water, and the exhaust steam from the engines, entering near the bottom of the apparatus, bubbles through the water, raising it to boiling temperature, while the amount of back

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pressure caused in the exhaust pipe is said to amount only to a few inches on the water gauge. The heating of the water causes the carbonates of lime to be deposited, and the sulphates are dealt with by means of a small quantity of

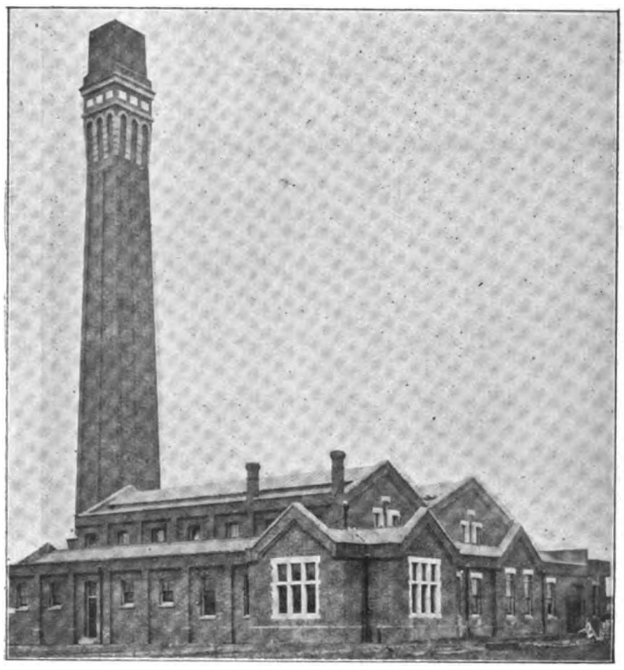

FIG. 2.—External View of Supply Station.

common soda solution, which is automatically injected at the top of the detartoriser, in exact proportion to the amount of water passing through the machine. No attempt is made to remove the sediment by blowing out, but when cleaning is required the trays are lifted down and cleaned—a by no means lengthy operation, as the deposit, though compact, is soft. As there is practically no pressure in any part of the apparatus when at work, the joints are made by the weight of the parts without bolting, by simply employing ordinary glazier's putty. The apparatus is stated to reduce the hardness of the water to not exceeding three grains per gallon, and it possesses the advantage that its efficiency as a heater does not diminish as load is added to the plant.

Up to last week Worthington centrifugal feed-pumps were used as a temporary expedient, but these have now been replaced by two three-throw pumps with gun-metal plungers, made by Messrs. Hayward, Tyler and Co., driven by Parker two-polar shunt motors. The pumps will deliver 12,000lb. of water per hour when running at 43 revolutions per minute, this low speed being attained by the use of double-reduction gear with raw-hide teeth to the pinions. Switching apparatus is provided to allow a supply of 210 or 420 volts, thus giving two speeds, and further regulation of the speed is obtained by inserting resistance in the field and armature circuits of the motors. The feed piping is arranged in duplicate with two connections to each boiler, with the requisite number of Hopkinson's valves to isolate any pump or any portion of the piping in case of failure. The pumps can either be supplied with cold water from the supply tank or with hot water from the feed heater.

The usual ring main system is used to supply the engines. The mains are of 7in. steel with copper bends, with 5in. steel connections to the boiler and 2½in. and 3½in. copper connections to the engines. The main piping is drained at the ends of the ring to Geipel steam traps, and connections for drains are also fitted at the foot of the separators on the engine beds to similar drains. Steam being continually connected to these separators, dry steam is always available for starting up any engine.

A good view of the engine room is given in Fig. 4. Three generating sets are installed up to the present, one of 246 B.H.P. and the other two 120 B.H.P., when running at 375 and 480 revolutions per minute respectively, with steam at 140lb. at the stop valve. A second engine of the larger size is on order and is expected to be in place by the end of the year. All are of the Peache type coupled to Parker dynamos. They are single-acting three-crank six-cylinder engines, and they were running very silently at the time of our inspection. There appears to be nothing exceptional in the construction of the dynamos. They are of Messrs. Parker's two pole type with steel magnets and Eickemeyer windings. They are designed to give from 420 to 460 volts pressure, and to be connected across the outers of the three-wire system; the smaller ones give 160 amperes, and the larger ones 380 amperes. The booster and balancer set is also of Messrs. Parker's make. There is an eight-ton overhead crane travelling the whole length of the engine room.

Two views of the switchboard are given in Figs. 6 and 7. It is made of enamelled slate supported on a steel frame with a wooden moulding round the edge. The greater part of the

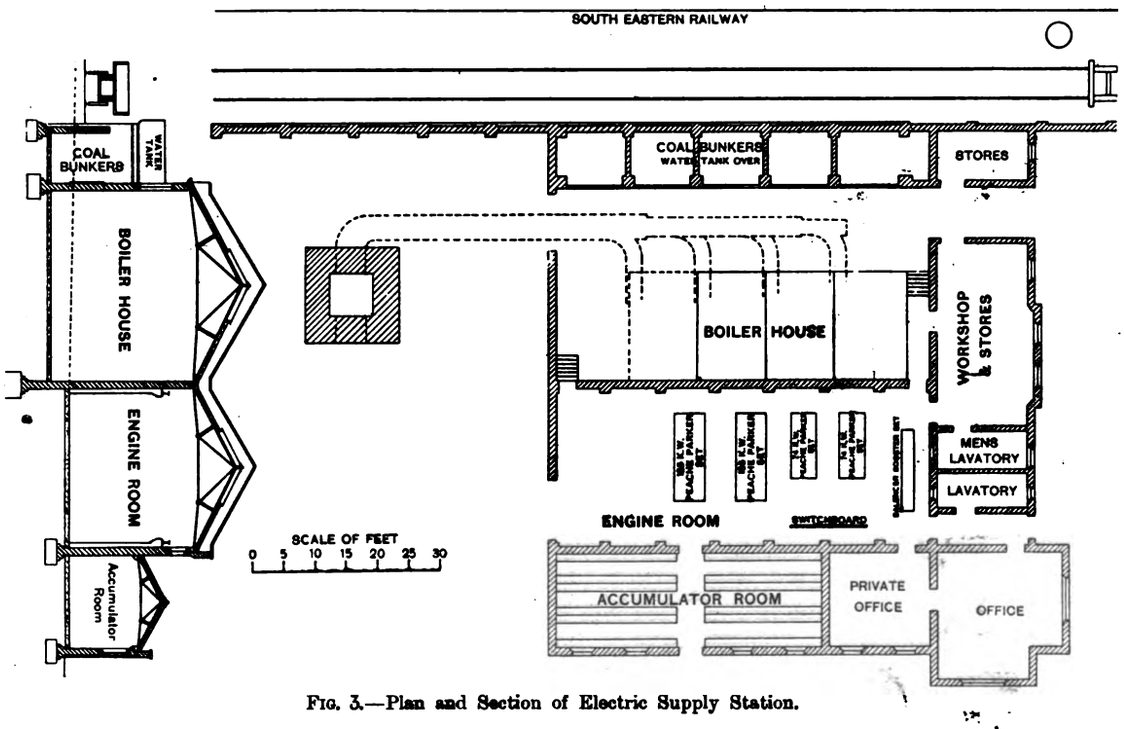

FIG. 3.—Plan and Section of Electric Supply Station.

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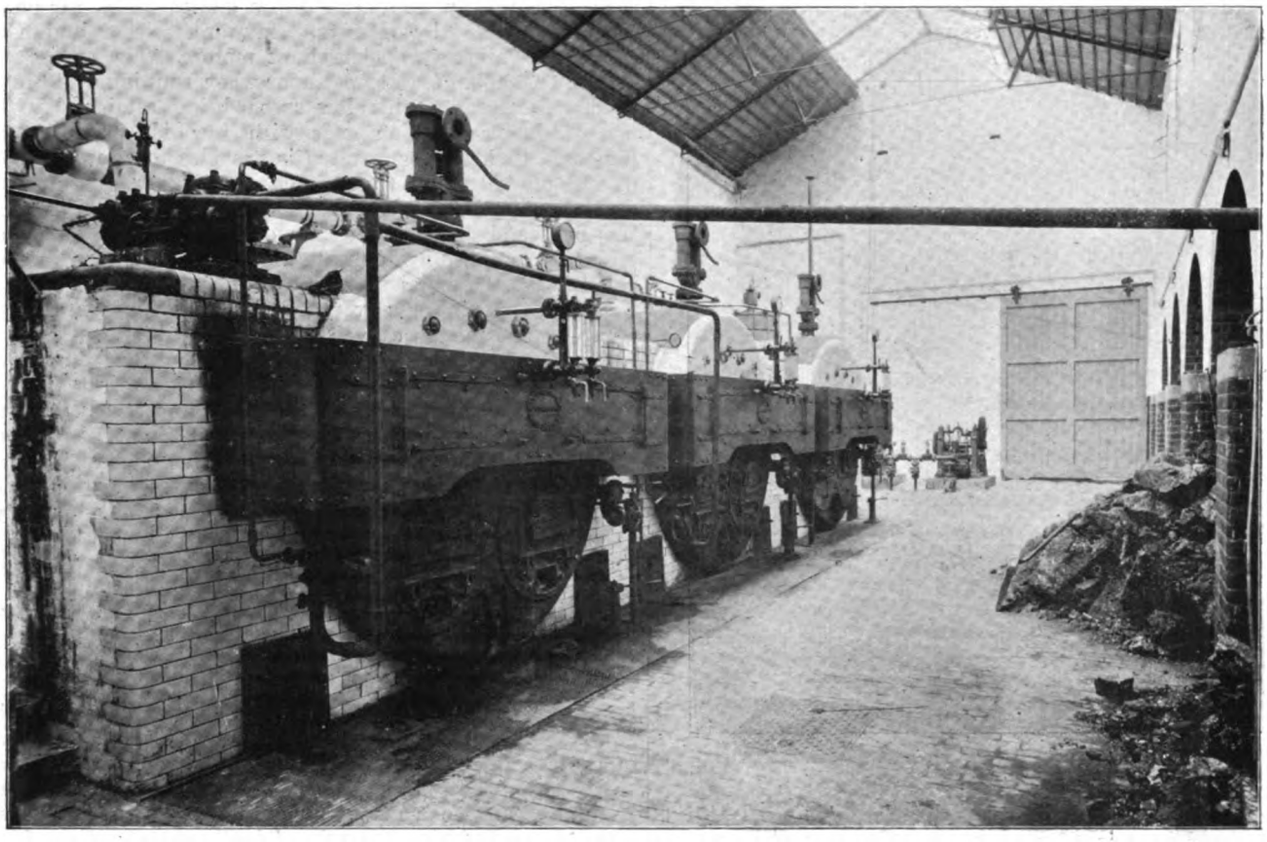

FIG. 4.—View of the Boiler House.

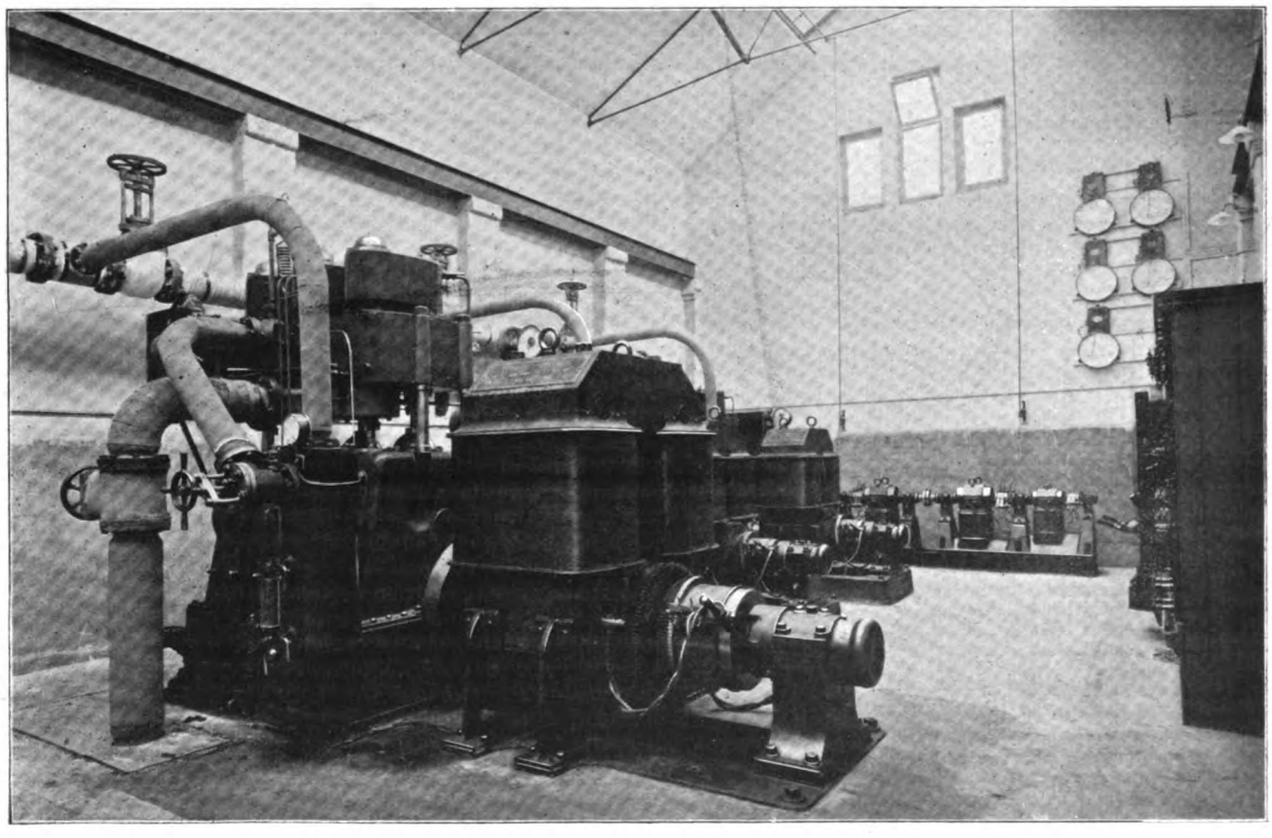

FIG. 5.—View of the Engine Room.

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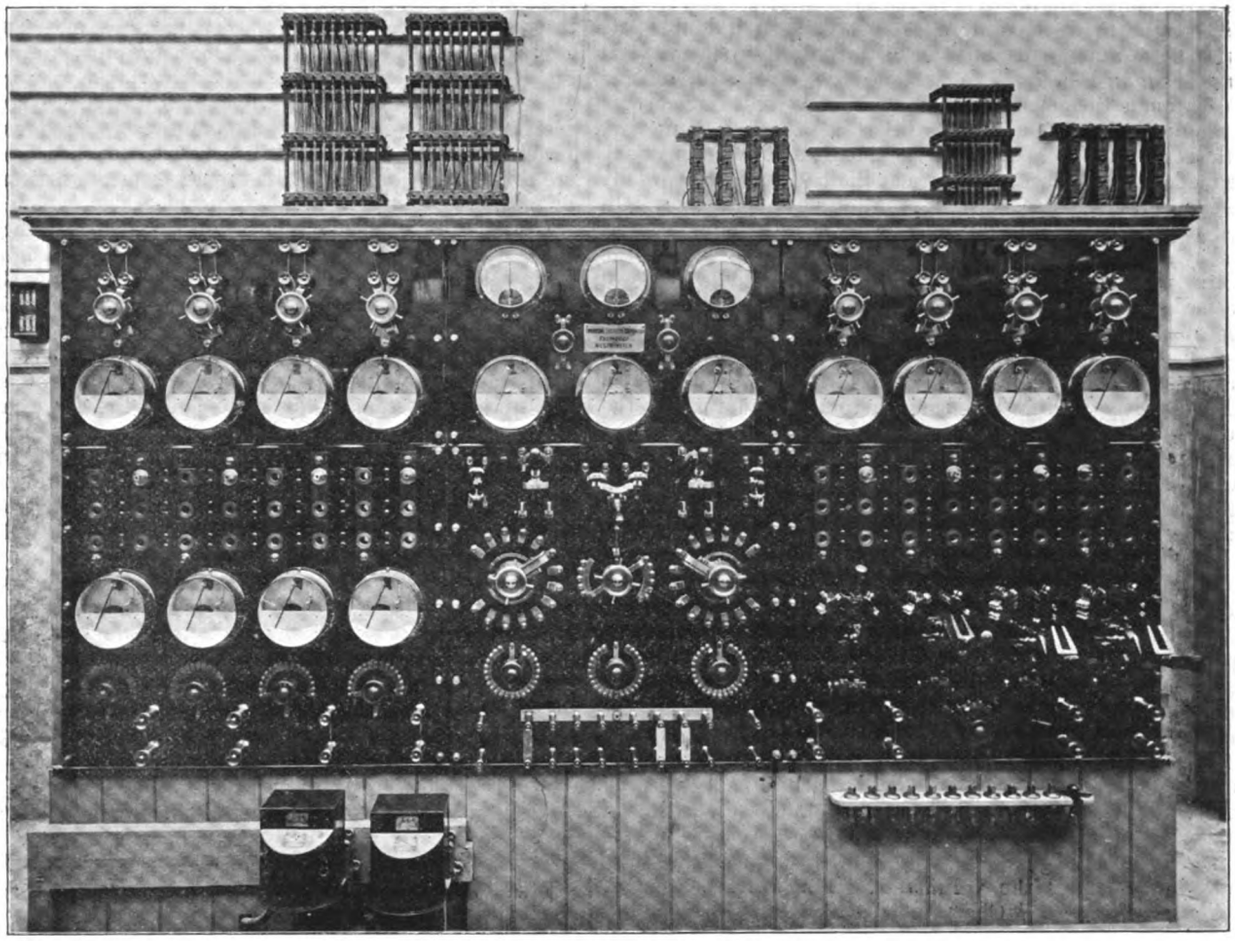

FIG. 6.—The Switchboard.

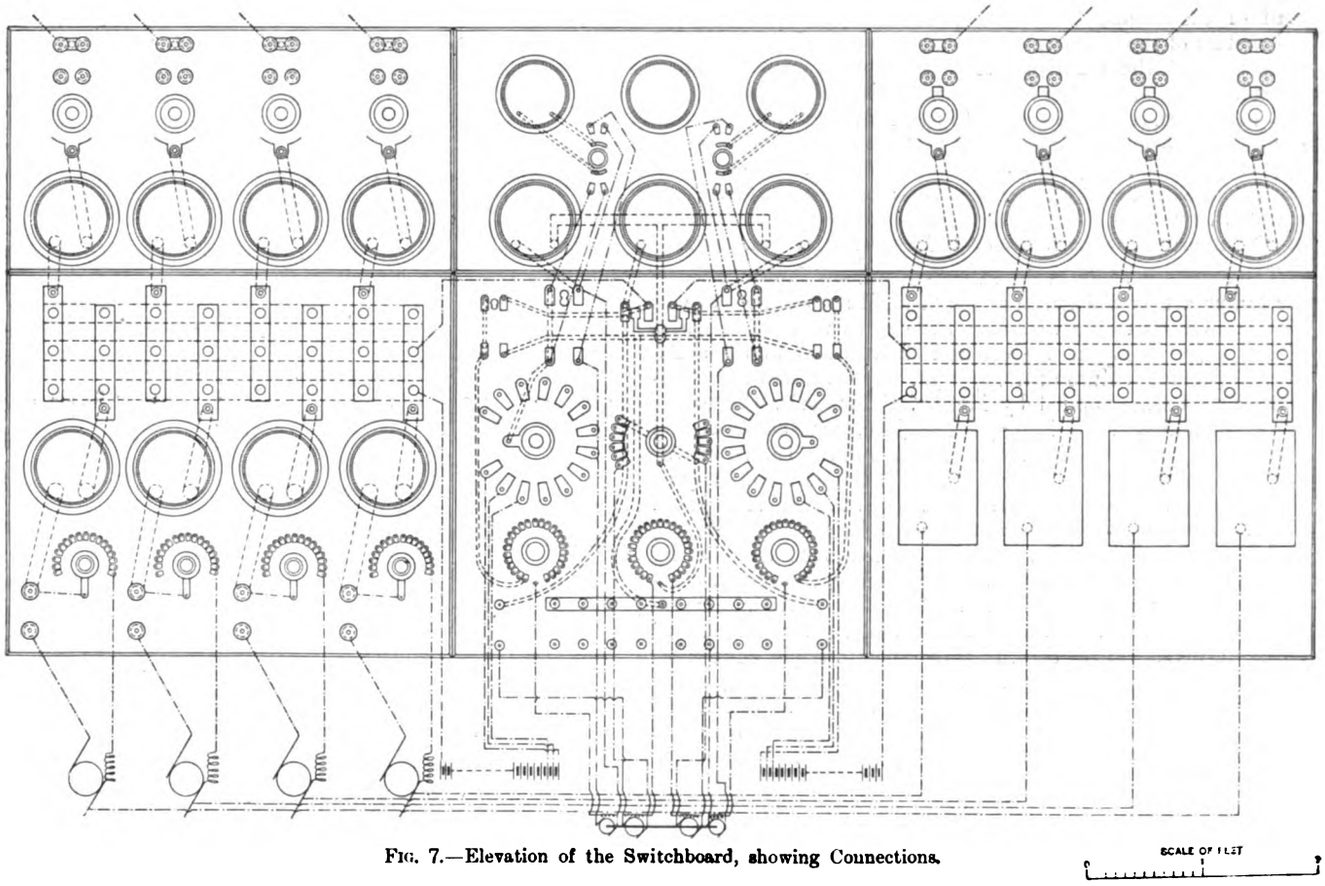

FIG. 7.—Elevation of the Switchboard, showing Connections.

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woodwork seen in Fig. 6 is shortly to be removed. As usual the three panels are for each of the three wires. The feeders are brought in at the top of the board through double-pole fuses to the ammeters and thence to the alternate vertical bars shown in Fig. 7. The dynamos are connected, on one side through Siemens minimum cut-outs (shown merely as rectangles in Fig. 7), and on the other side through ammeters, to the remaining four pairs of vertical bars, and the connections are made through three 'bus bars at the back of the board by means of brass plugs screwed into the holes by a special key. On the left-hand panel are the rheostats for the field circuits. As already stated, the dynamos are not directly connected to the central panel of the board, to which the middle wire of the feeders, the centre cells of the storage battery, and the "booster" connections are brought. On this panel is a 14-way regulating switch for each side of the battery, and a throw-over switch, by means of which the cells are connected either directly to the 'bus bars or to the armature of the booster. Two other throw-over switches are provided for the purpose of exciting the field of the boosters and short-circuiting them immediately the circuit is broken, thereby preventing an abnormal rise of pressure in their windings. The remaining double-pole switch is for starting the balancer, and it is interlocked with a resistance switch. On the upper part of this panel are the battery ammeters, the middle-wire ammeters, and the zero indicators for putting the dynamos or boosters in parallel. These zero indicators, which are of the Kelvin type, made by Mr. James White, are really low-reading voltmeters, but they are designed to withstand high pressures, and have their zeros in the middle of the scale. They are connected to the poles of the switch it is desired to close, and when the indication is zero it is known that the two machines are at the same pressure, and the attendant can close the switch. This forms a very simple and effective method of paralleling. The ammeters are all Lord Kelvin's sector pattern ampere gauges, likewise supplied by Mr. James White, who also furnished the voltmeters. The switchboard was made by Mr. Edmund Charrington to Messrs. Edmundson's design.

It will have been noticed that, with the exception of the zero indicators, there are no voltmeters on the switchboard. The only voltmeters employed are those seen on the left hand wall of the engine room in Fig. 5. They are electro-static voltmeters of the standard Kelvin engine room type and are connected at the ends of the pilot wires from the feeding points. The large open scales are visible from every part of the engine room. Thomson-Houston meters are fitted on each dynamo circuit, and Aron meters with Miller's single dial attachment are used for the accumulators. These latter are 230 cells of the D.P. type in glass boxes erected on wooden stands in two tiers. They are guaranteed to give a discharge of 80 amperes for nine hours or 119 amperes for four hours.

The supply is at 210 volts at the consumers' lamps, and the arc lamps are connected in series of eight across the 420 volt mains. Owing to the distance of the station from the centre of the supply area the feeders and distribution mains are a very important feature of the system. The whole of the network has been supplied by Messrs. Callender's, the cables being insulated with impregnated jute, lead-covered and armoured, and laid directly in the ground. Tarred boards are laid over them for protection from workmen who may be making excavations in the neighbourhood at some future time. The feeders are triple concentric with heavy lead-covering and steel-tape armouring, being connected to the distributing network at large feeder boxes. The configuration of the network is clearly shown in Fig. 1. The pilot wires are three-core, lead-sheathed, steel-taped cables laid in the same trench as the feeders. Three core, in preference to triple concentric cables, has also been used for the distributors owing to its convenience for connecting the house services. It may be mentioned that there are a number of Callender's standard type of network boxes fixed at the junctions, and so constructed that it is a simple matter to disconnect the mains at different sections for testing purposes. The feeders are in two sizes; 0·2 sq. in. and 0·4 sq. in. in area respectively. The section of the third wire is half that of the others. The largest distributors are of 0·1 sq. in. sectional area, their third wires being of 0·06 sq. in. Each of the wires of the three-core pilot cables have a sectional area of 0·008 sq. in. Sixty-eight arc lamps of Messrs. Johnson and Phillips' make are being erected at present. They take a current of 10 amperes and burn for 14 hours with single carbons. On each post are two incandescent lamps of 25 c.p. for use after 11:30 p.m. The circuits of the arc and incandescent lamps are connected to main circuits tapped from the network boxes by means of four-core non-hygroscopic cable, which is lead-sheathed and steel-armoured, two of these wires being for the arc lamps and two for the incandescent. The designs of the posts selected by the Corporation have very small chambers in their bases, so that there is only room for the isolating switches and substitutional resistances in them. The circuit switches and resistances are contained in pillar boxes similar in appearance to those frequently used for the line switches of a tramway system. There are five of these switch pillars, each arranged for three circuits.

Mr. J. C. Wigham has superintended the work on behalf of Messrs. Edmundson's, and Messrs. Lacey, Clirehugh and Sillar advised the Folkestone Company upon the contract and supervised the execution of the work on its behalf. Mr. Thomas Hesketh was the resident engineer for Messrs. Edmundson's, and his services have now been secured by the Folkestone Company as their engineer and manager.

CURRENTS IN BRANCHED AND IN MUTUALLY INDUCING CIRCUITS PRODUCED BY HARMONICALLY VARYING ELECTROMOTIVE FORCES.

(*Continued from page 818, Vol. XLI.*)

BY PROF. THOMAS R. LYLE.

I will now give a few examples of the application of the foregoing principles to alternate current problems.

Example I.—The Transformer.

Let $R_1L_1C_1E$ refer to the primary circuit, $R_2L_2C_2$ to the secondary, and let M be the coefficient of mutual induction. Applying Kirchhoff's extended laws, we get

$$E + mC_2 = r_1C_1,$$
$$mC_1 = r_2C_2.$$

Eliminating C_2, we have

$$E = \left(r_1 - \frac{m^2}{r_2}\right)C_1, \text{ or } E = r_1'C_1,$$

which shows that the primary current is the same as if the secondary coil were absent, and the constants of the primary changed to R'_1 and L'_1 where

$$R'_1 = R_1 + \frac{\omega^2M^2}{I_2^2}R_2,$$

$$L'_1 = L_1 - \frac{\omega^2M^2}{I_2^2}L_2,$$

$$(I_2^2 = R_2^2 + \omega^2L_2^2).$$

Hence if $E = e \cos \omega t$

$$C_1 = \frac{e}{I'_1}\cos(\omega t - \phi_1),$$

where $I'^2_1 = R'^2_1 + \omega^2L'^2_1$

and $\tan \phi_1 = \frac{\omega L'_1}{R'_1}$.

Since $C_1 = \frac{r_2}{m}C_2 = \frac{I_2e^{i\phi_2}}{\omega Me^{-i\pi/2}}C_2,$

where $\tan \phi_2 = \frac{\omega L_2}{R_2}$ and $I_2^2 = R_2^2 + \omega^2L_2^2$.

$$\therefore C_2 = \frac{\omega M}{I_2}e^{-i(\pi/2+\phi_2)}C_1,$$

or $$C_2 = \frac{\omega M}{I_2}\frac{e}{I'_1}\cos(\omega t - \phi_1 - \pi/2 - \phi_2).$$

$\pi/2 + \tan^{-1}\frac{\omega L_2}{R_2}$ being the difference of phase of C_1 and C_2, we

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see that for light loads (R_2 large) this difference approximates to $\pi/2$, or the currents are nearly in quadrature, while for heavy loads (R_2 small) it approximates to π, or the currents are nearly in opposition. The magnetic flux B through the core being equal to $(n_1C_1+n_2C_2)\sigma$, where n_1 and n_2 are the numbers of windings and σ the flux through the core due to 10 ampere-turns, we find, since $L_1=n_1^2\sigma$, $L_2=n_2^2\sigma$ and $M=n_1n_2\sigma$ if we neglect magnetic leakage,

that
$$B=n_1\sigma\left\{1+\frac{n_2}{n_1}\frac{m}{r_2}\right\}C_1,$$
$$=n_1\sigma\left\{1-\frac{n_2}{n_1}\frac{\iota\omega M}{R_2+\iota\omega L_2}\right\}C_1,$$
$$=n_1\sigma\frac{R_2}{I_2^2}(R_2-\iota\omega L_2)\,C_1,$$

as
$$\frac{n_2}{n_1}=\frac{L_2}{M_2}\ q.p.,$$

i.e.,
$$B=n_1\sigma\frac{R_2}{I_2}e^{-\iota\phi_2}C_1,$$
$$=n_1\sigma\frac{R_2}{I_2}\frac{e}{I'_1}\cos(\omega t-\phi_1-\phi_2),$$

where $\tan\phi_2$ as before $=\dfrac{\omega L_2}{R_2}$.

From the above expressions for C_1 C_2 and B the behaviour of the transformer under varying conditions can be immediately deduced.

The power drawn from the mains being the average value of EC_1, that is, $\frac{1}{2}ec\cos\phi_1$ is
$$=\tfrac{1}{2}e^2\frac{R'_1}{I'_1{}^2}.$$

The power supplied to the external secondary circuit being the average value of $S'C_2^2$, that is $\frac{1}{2}S'c^2$ (where S′ is the external resistance of the secondary, S being the internal and $R_2=S+S'$), is equal to
$$\tfrac{1}{2}S'\frac{\omega^2M^2}{I_2^2I'_1{}^2}e_2.$$

The efficiency of the transformer is therefore
$$\frac{S_1}{R'_1}\frac{\omega^2M_2}{I_2^2},$$
which is a maximum (S′ variable) when
$$S'^2=S^2+\omega^2L_2{}^2+\frac{S}{R_1}\omega^2M^2,$$
and the maximum value is
$$\frac{1}{1+2\dfrac{R_1R_2}{\omega^2M^2}}.$$

The values of the currents and of the powers drawn from the mains and supplied by the transformer can, for the case of maximum efficiency, be at once got by substituting in the expressions for these quantities the corresponding value of R_2, that is, $S+\sqrt{S^2+\omega^2L_2{}^2+\dfrac{S}{R_1}\omega^2M^2}$.

In the simple case, when the internal resistance S is neglected, R_2 for max. efficiency $=\omega L_2$, and if we assume in addition $M^2=L_1L_2$,
$$C_1=\sqrt{2}\frac{e}{\sqrt{R_1^2+(R_1+\omega L_1)^2}}\cos(\omega t-\phi_1),$$
where $\tan\phi_1=\dfrac{\omega L_1}{2R_1+\omega L_1}$,
$$C_2=\frac{M}{L_2}\frac{e}{\sqrt{R_1^2+(R_1+\omega L_1)^2}}\cos\left(\omega t-\phi_1-\frac{3\pi}{4}\right),$$
$$B=n_1\sigma\frac{e}{\sqrt{R_1^2+(R_1+\omega L_1)^2}}\cos\left(\omega t-\phi_1-\frac{\pi}{4}\right).$$

Power drawn from mains
$$=\tfrac{1}{2}\frac{R_1+(R_1+\omega L_1)}{R_1^2+(R_1+\omega L_1)^2}e^2.$$

Power supplied by transformer
$$=\tfrac{1}{2}\frac{\omega L_1}{R_1^2+(R_1+\omega L_1)^2}e^2.$$

It is also worth pointing out that if $R_2=0$,
$$C_1=\frac{e}{R_1}\cos\omega t,$$
and if $R_2=\infty$,
$$C_1=\frac{e}{I_1}\cos(\omega t-\phi_1).$$

In the case of a transformer supplying power there will be inductance in the external secondary circuit, and the formulæ applying to this case can be at once got from those already established {when L_1L_2 is not $=M^2$} by substituting $L_2+L'_2$ for L_2, where L_2 now represents the internal and L'_2 the external inductance of the secondary. The effect on the action of the transformer of varying L'_2 can be at once deduced, and an interesting case is presented when L'_2 becomes negative, that is, when capacity predominates in the external secondary circuit.

All the discussion already given about a transformer treats of the case when the energy supplied is at constant pressure, but an obvious modification of the results already obtained will make them apply to the case of a constant current supply.

I will now give an example on the general theory of the transformer, having inductance (or capacity) in its external secondary circuit, taking account of leakage and hysteresis when the impressed E.M.F. is harmonic and of constant amplitude, and assuming that the forced variations of the other quantities are also harmonic. If we represent by a vector (M, say) in the diagram the magnetomotive force applied to any iron circuit, then the resulting magnetic flux N will not, on account of hysteresis and Foucault currents, be in phase with M, but will lag behind it, and will be, from the same causes, slightly diminished in amplitude, so that the

vector equation
$$N=\kappa e^{-\iota\theta}\frac{M}{p},$$

(where p is the magnetic reluctance of the circuit, κ a number very little less than unity, and θ a small angle generally) will represent very approximately the relation between M and N. Now, if n_1 and n_2 be the primary and secondary turns, σ_{11} the magnetic flux through the primary due to 10 ampere-turns of the primary, σ_{22} a similar quantity for the secondary, and σ_{12} the magnetic flux through the secondary due to 10 ampere-turns of the primary ($\sigma_{12}=\sigma_{21}$), N_1 and N_2 fluxes through primary and secondary, then

(I.)
$$N_1=\kappa e^{-\iota\theta}(n_1\sigma_{11}C_1+n_2\sigma_{12}C_2),$$
$$N_2=\kappa e^{-\iota\theta}(n_1\sigma_{12}C_1+n_2\sigma_{22}C_2),$$

C_1 and C_2 being the primary and secondary currents (vectors on the diagram). But

(II.)
$$E-n_1\frac{dN_1}{dt}=R_1C_1,$$
$$-n_2\frac{dN_2}{dt}=(R_2+\iota\omega L'_2)C_2,$$

where L'_2 is the external inductance of secondary, and remembering that if any vector V on the diagram represent

$v\cos\omega t$, $\quad -\dfrac{dv}{dt}=r\omega\cos\left(\omega t-\dfrac{\pi}{2}\right)=\omega e^{-\iota\frac{\pi}{2}}V.$

Hence, substituting from I. into II., we get

$$E+\kappa n_1\omega e^{-\iota\left(\frac{\pi}{2}+\theta\right)}(n_1\sigma_1C_1+n_2\sigma_{12}C_2)=R_1C_1,$$
$$\kappa n_2\omega e^{-\iota\left(\frac{\pi}{2}+\theta\right)}(n_1\sigma_{12}C_1+n_2\sigma_{12}C_2)=R_2+\iota\omega L'_2)C_2, \quad \text{or}$$

(III.)
$$E+mC_2r_1=C_1,$$
$$mC_1r=C_2,$$

where if we put $\kappa n_1{}^2\sigma_{11}=L_1$, $\kappa n_2{}^2\sigma_{22}=L_2$, and $\kappa n_1n_2\sigma_{12}=M$,
$$r_1=R_1+L_1\sin\theta+\omega L_1\cos\theta,$$
$$r_2=R_2+\omega L_2\sin\theta+\omega(L_2\cos\theta+L_2{}^1),$$
$$m=\omega Me^{-\iota\left(\frac{\pi}{2}+\theta\right)}.$$

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So that this general case of the transformer is reduced practically to the simple case solved in Example I.

Eliminating C_2 from equations III. we get (as in Example I.),

$$E = \left(r_1 - \frac{m^2}{r_2}\right)C_1,$$

showing that the current in the primary is the same as if the secondary were removed and the constants of the primary changed to ρ and λ where

$$\rho = R_1 + \omega L_1 \sin\theta + \frac{\omega^2 M^2}{I_2^2}\{R_2 \cos 2\theta - \omega L'_2 \sin 2\theta - \omega L_2 \sin\theta\},$$

$$\omega\lambda = \omega L_1 \cos\theta - \frac{\omega^2 M^2}{I_2^2}\{\omega L_2 \cos\theta + \omega L'_2 \cos 2\theta + R_2 \sin 2\theta\},$$

where $I_2^2 = (R_2 + \omega L_2 \sin\theta)^2 + \omega^2(L_2 \cos\theta + L'_2)^2$.

Hence, if $E = e\cos\omega t$,

$$C_1 = \frac{e}{I}\cos(\omega t - \phi_1)$$

where $I^2 = \rho^2 + \omega^2\lambda^2$; and $\tan\phi_1 = \frac{\omega\lambda}{\rho}$.

Again, as $C_2 = \frac{m}{r_2}C_1$, we find at once,

$$C_2 = \frac{\omega M}{I_2}\frac{e}{I}\cos\left(\omega t - \phi_1 - \frac{\pi}{2} - \theta - \phi_2\right),$$

where $\tan\phi_2 = \omega\frac{L_2\cos\theta + L'_2}{R_2 + \omega L_2 \sin\theta}$.

From the above values for C_1 and C_2 any quantity involved in the theory of the transformer can be at once obtained, and with a slight modification, the above theory may be made to apply to a constant current transformer. L'_2 may be positive or negative.

As in Example I., the power drawn from the mains, the power supplied to the external secondary circuit, the copper losses per second in primary and secondary, and the efficiency can be at once written down.

The power absorbed by hysteresis and Foucault currents will be found to be equal to

$$\frac{1}{2}\frac{e^2}{I^2 I_2^2}\omega\sin\theta[L_1(R_2^2 + \omega^2 L'^2_2) + \omega(L_1L_2 - M^2)(\omega L_2 + 2R_2\sin\theta + 2\omega L'_2\cos\theta)],$$

in which the term in $L_1L_2 - M^2$ represents the loss due to hysteresis, &c., of the lost or leaked magnetic lines, while the other term represents that due to the hysteresis, &c., of the lines looped on both primary and secondary circuits.

It must be remembered that L_1L_2 and M are not the inductance coefficients of the coils as usually understood, but κ times them where κ (the hysteresis amplitude factor) is a number slightly less than unity. The amplitude of the flux actually produced by a given current is the same as if κ were taken = 1, and the permeability of the iron diminished in the ratio $1:\kappa$.

If a coil n turns per centimetre is wound on a long rod of iron of unit cross-section, and of permeability μ, then $H = 4\pi nC$ where C is the current $= c\cos\omega t$ in the coil. B, therefore, if harmonic, $= \mu\kappa e^{-i\theta}H = 4\pi n\mu\kappa c\cos(\omega t - \theta)$, but at any instant the back E.M.F. per centimetre of the rod is

$$n\frac{dB}{dt} = n\omega e^{i\frac{\pi}{2}}B = 4\pi n^2\omega\mu\kappa c\cos\left(\omega t - \theta + \frac{\pi}{2}\right),$$

hence the power absorbed per cubic centimetre of the iron of the rod, being the average value of $nC\frac{dB}{dt}$, is $4\pi n^2\omega\mu\kappa c^2\sin\theta$, or $2\nu n^2c^2\mu\kappa\sin\theta$, where ν is the number of alternations per second ($\omega = 2\pi\nu$).

Hence the work done per alternation per cubic centimetre

$$= 2n^2c^2\mu\kappa\sin\theta,$$

$$= \frac{h^2}{8\pi^2}\mu\kappa\sin\theta,$$

where h is the amplitude of the magnetising force. As this hysteresis loss can be determined for any sample of iron $\kappa\sin\theta$ can be found, and as κ is very nearly unity, $\sin\theta$ can be found to the first order. The preceding discussion involves the assumption that if C be harmonic so will be B. This is not a correct assumption, but the result arrived at will be a fair approximation to the truth.

(To be concluded.)

ELECTRICITY WORKS ACCOUNTS.

Ayr Municipal Electric Supply Works.

Municipal electric supply in Ayr was commenced on January 8, 1896, so that the first of our tables this week refers to the two completed years of working. The authorised capital is £40,000, and the received capital £40,827, borrowed at 3 per cent. A sum of £1,750 has been repaid, and £36,920 expended, representing £59 per kilowatt capacity of generating plant installed. We are unable to give the separate items of capital expenditure, as they are not rendered in the accounts issued.

Last year's output was 161,093 units sold, showing an increase of about 29 per cent. over that of the previous year; the accruing revenue was £2,445 being an average price of 3·64d. per unit. A great improvement has been made in the ratio of the costs to the revenue in that by a reduction in the total costs per unit of 0·88d. this ratio has been reduced from 105 per cent. to 80·4 per cent. All the items of cost, except that of wages at the station, have fairly contributed to this satisfactory economy, which has resulted in a working profit of £478 being made. £581 has been paid into the Sinking Fund, and £1,052 as interest on loans, resulting in a deficit of £1,155, which has been carried to the police account, to be met by the rates.

Walsall Municipal Electric Supply Works.

Our second table covers the accounts of the two completed years of working of the Walsall undertaking. The authorised capital stands at £23,400, of which £21,500 has been received, borrowed at 3 per cent.

The expenditure to capital account at Dec. 31 last had reached £20,959, representing £87. 6s. per kilowatt of generating plant in the station.

Last year saw 24 additional consumers and an equivalent of 1,900 8 c.p. lamps connected to the mains. The output was 96,376 units sold, representing an increase of about 44 per cent. over the output for 1896. As a result of the introduction of the maximum demand system of charging, with 2d. per unit charge after 1½ hours, the average price per unit sold has dropped from 5·6d. to 5·1d. The total costs per unit have been reduced by 0·3d. through a reduction in the management and property charges; works costs have remained steady.

The financial results are a working profit of £547, a payment of £524 towards redemption of stock issued, and £555 interest, leaving a deficit which, with that of the previous year, amounts to £977.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared :—

Bedford (Municipal)	Mar. 4	Kensington & Knightsbridge (Co.)	Sept. 30
Belfast (Municipal)	Sept. 23	Kingston-upon-Hull (Municipal)	Aug. 19
Blackpool (Municipal)	Oct. 7	Kingston-upon-Thames (Mun.)	Mar. 25
Bournemouth (Company)	June 3	Lancaster (Municipal)	Oct. 21
Bradford (Municipal)	May 20	Leeds (Company)	April 8
Brighton (Municipal)	May 6	Leyton (Municipal)	Sept. 23
Bristol (Municipal)	July 29	Liverpool (Municipal)	Aug. 12
Burnley (Municipal)	Sept. 16	Manchester (Municipal)	July 29
Burton-upon-Trent (Municipal)	April 15	Newcastle-upon-Tyne (Co.)	April 29
Cambridge (Company)	June 17	Northampton (Company)	April 15
(Central) Kensington (House-to-House (Company)	Sept. 30	Notting Hill (Company)	Mar. 11
Charing Cross (Company)	April 22	Nottingham (Municipal)	Oct. 28
Chelsea (Company)	May 20	Oxford (Company)	April 1
Cheltenham (Municipal)	Oct. 7	Portsmouth (Municipal)	Nov. 4
Chester (Municipal)	Oct. 14	Preston (Company)	Oct. 28
Clerkenwell (Company)	Mar. 18	Reading (Company)	Sept. 16
Dover (Company)	Mar. 11	Richmond (Company)	Mar. 4
Dundee (Municipal)	Nov. 4	Scarborough (Company)	April 1
Eastbourne (Company)	July 22	St. James' & Pall Mall (Company)	July 1
Edinburgh (Municipal)	Oct. 14	St. Pancras (Vestry)	May 13
Exeter (Municipal)	Aug. 5	Shoreditch (Vestry)	May 27
Glasgow (Municipal)	Aug. 12	Southampton (Municipal)	June 3
Guildford (Company)	May 13	Stafford (Municipal)	Oct. 21
Hammersmith (Vestry)	June 10	Sunderland (Municipal)	Aug. 19
Hampstead (Municipal)	Sept. 9	Taunton (Municipal)	Aug. 5
Hanley (Municipal)	April 8	Tunbridge Wells (Municipal)	July 22
Harrow (Company)	Sept. 9	Wandsworth (Company)	Mar. 18
Hastings & St. Leonard's (Co.)	April 29	Westminster (Company)	April 22
Hove (Company)	May 6	Wolverhampton (Municipal)	July 15
Huddersfield (Municipal)	Mar. 25	Worcester (Municipal)	May 13
Islington (Vestry)	June 24	Yarmouth (Municipal)	June 17

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	AYR.		WALSALL.	
Undertaking Worked by	Ayr Corporation.		Walsall Corporation.	
Date of Commencement of Supply	1896.		1895.	
System of Supply	Alternate-current transformer sub-stations.		High-pressure con.-cur. with transformers and [storage batteries.	
Chief Engineer	Arthur J. Fuller.		Alexander Wyllie.	
YEAR ENDED	MAY 31, **1897.**	MAY 31, **1898.**	DEC. 31, **1896.**	DEC. 31, **1897.**
QUANTITIES—				
Units generated	191,886	264,233	110,491	145,606
„ **SOLD (TOTAL)**	**124,924**	**161,093**	**67,170**	**96,376**
„ sold to consumers	54,924	73,693	56,133	74,556
„ sold for public lighting, &c.	70,000	87,400	11,037	21,820
„ used on works	9,200	11,720	7,174	9,136
UNITS SOLD PER 8 C.P. LAMP CAPACITY	**17·8**	**8·26**	**9·33**	**12·85**
Maximum supply demanded	129	146	94 kilowatts	155 kilowatts
Number of public lamps	25 arc	28 arc, 55 glow	14 arc	14 arc
Number of consumers	—	—	76	100
Connections to mains in 8-c.p. lamps	7,530	9,000	5,600	7,500
CAPACITY OF PLANT IN 8-C.P. LAMPS	**7,030**	**19,500**	**7,200**	**7,500**
CAPACITY OF PLANT IN KILOWATTS	225	625	230	240
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	**£40,000** / **£178**	**£40,000** / **£64**	**£21,500** / **£93·5**	**£23,400** / **£97·5**
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	40,000 / 178	40,000 / 64	21,500 / 93·5	23,400 / 97·5
RECEIVED (TOTAL)	**31,531** / **140**	**40,827** / **65·3**	**18,900** / **82·1**	**21,500** / **89·6**
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	31,531 / 140	40,827 / 65·3	18,900 / 82·1	21,500 / 89·6
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	**8,469** / **37·6**	— / —	**2,600** / **11·3**	**1,900** / **7·92**
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	8,469 / 37·6	— / —	2,600 / 11·3	1,900 / 7·92
REPAID (TOTAL)	**4,284** / **19·1**	**1,750** / **2·8**	**841** / **3·66**	**841** / **3·50**
RESERVE OR SINKING FUND	**564** / **2·51**	**1,154** / **1·85**	— / —	— / —
DEPRECIATION FUND	— / —	— / —	— / —	— / —
EXPENDED (TOTAL)	**29,103** / **129**	**36,920** / **59·1**	**19,357** / **84·2**	**20,959** / **87·3**
Lands and buildings	— / —	— / —	2,703 / 11·75	2,856 / 11·9
Plant	— / —	— / —	11,094[a] / 48·2	12,142[a] / 50·6
Mains	— / —	— / —	5,530 / 24·0	5,931 / 24·7
Miscellaneous	— / —	— / —	30 / 0·130	30 / 0·125
BALANCE OF CAPITAL ACCOUNT	**+2,428** / **10·8**	**+3,907** / **6·25**	**−457**[b] / **−1·99**	**+541** / **2·25**
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	**£1,882** / **3·620d.**	**£2,445** / **3·640d.**	**£1,568** / **5·608d.**	**£2,048** / **5·100d.**
Revenue from supply	1,305 / 2·510d.	1,734 / 2·580d.	1,354 / 4·840d.	1,646 / 4·100d.
„ meters, &c.	— / —	— / —	31 / 0·111d.	42 / 0·105d.
„ public lighting	500 / 0·961d.	629 / 0·937d.	184 / 0·658d.	360 / 0·897d.
„ sale of lamps, &c.	— / —	— / —	— / —	— / —
„ miscellaneous sources	77 / 0·148d.	82 / 0·122d.	— / —	— / —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	**£1,983** / **3·810d.**	**£1,967** / **2·930d.**	**£1,130** / **4·040d.**	**£1,500** / **3·735d.**
WORKS COSTS	**1,462** / **2·810d.**	**1,483** / **2·210d.**	**663** / **2·370d.**	**954** / **2·374d.**
Generation of electricity	*1,202* / *2·310d.*	*1,280* / *1·906d.*	*558* / *1·995d.*	*805* / *2·003d.*
Fuel (including cartage, &c.)	480 / 0·922d.	456 / 0·679d.	178 / 0·636d.	279 / 0·695d.
Oil, waste, water, stores	104 / 0·200d.	61 / 0·091d.	57 / 0·204d.	87 / 0·217d.
Wages at station	519 / 0·997d.	691 / 1·030d.	196 / 0·701d.	221 / 0·551d.
Repairs and maintenance at station	100 / 0·192d.	71 / 0·106d.	127 / 0·454d.	218 / 0·543d.
Distribution of electricity	*155* / *0·298d.*	*130* / *0·194d.*	*64* / *0·229d.*	*67* / *0·167d.*
Wages, &c.	81 / 0·156d.	80 / 0·119d.	58 / 0·207d.	50 / 0·125d.
Repairs, renewals of mains, &c.	74 / 0·142d.	50 / 0·075d.	6 / 0·021d.	17 / 0·042d.
Public lighting	*105* / *0·202d.*	*73* / *0·109d.*	*41* / *0·147d.*	*83* / *0·204d.*
Attendance	22 / 0·042d.	73 / 0·109d.	} 41 / 0·147d.	82 / 0·204d.
Renewals	83 / 0·160d.	— / —		
MANAGEMENT AND PROPERTY CHARGES	**521** / **1·001d.**	**483** / **0·723d.**	**466** / **1·666d.**	**547** / **1·362d.**
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*68* / *0·131d.*	*78* / *0·116d.*	*169* / *0·604d.*	*179* / *0·446d.*
Management	*453* / *0·871d.*	*405* / *0·604d.*	*297* / *1·062d.*	*368* / *0·916d.*
Salaries	274 / 0·527d.	260 / 0·387d.	237 / 0·847d.	270 / 0·672d.
Stationery, &c.	40 / 0·077d.	36 / 0·054d.	23 / 0·082d.	24 / 0·060d.
Establishment charges	43 / 0·083d.	36 / 0·054d.	26 / 0·093d.	62 / 0·154d.
Law charges, &c.	96[a] / 0·184d.	73[d] / 0·109d.	11[c] / 0·039d.	12[c] / 0·030d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	**−£101**[b] / **0·405%**	**£478** / **1·45%**	**£438** / **2·26%**[d]	**£547** / **2·71%**
Sum carried to Depreciation Fund	— / —	— / —	— / —	— / —
Sum carried to Reserve or Sinking Fund	484 / 1·94%	581 / 1·76%	424 / 2·19%[d]	524 / 2·60%
Net interest on loans (incl. Debenture charges)	741 / 2·97%	1,052 / 3·19%	459 / 2·37%[d]	555 / 2·75%
BALANCE FROM LAST ACCOUNT	— / —	— / —	— / —	−445 / 2·21%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	— / —	— / —	— / —
Deficit	*1,327* / *5·32%*	*1,155* / *3·50%*	*445* / *2·50%*[d]	*977* / *4·85%*
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	105%	80·4%	72%	73%
Expenditure per kilowatt capacity	£8. 16s. 5d.	£3. 3s. 0d.	£4. 18s. 2d.	£6. 5s. 0d.
REVENUE PER KILOWATT CAPACITY	**£8. 7s. 5d.**	**£3. 18s. 3½d.**	**£6. 16s. 5d.**	**£8. 10s. 7d.**
Expenditure per 8-c. lamp capacity	5s. 7¾d.	2s. 0¼d.	3s. 1¾d.	4s. 0d.
REVENUE PER 8-C.P. LAMP CAPACITY	**5s. 4¼d.**	**2s. 6d.**	**4s. 4½d.**	**5s. 5½d.**
REVENUE PER 8-C.P. LAMP CONNECTED	**5s. 0d.**	**5s. 5½d.**	**5s. 7¾d.**	**5s. 5½d.**
Price charged for lighting, per unit	} 6d. to 4d.[e]	6d. to 4d.[e] {	6d.[e]	} 6d. to 2d.[f]
Price charged for power, per unit			4d.	
Price charged for public lighting	£20 per arc per ann.	£20 per arc per ann.	—	—

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SHAFTING *VERSUS* DIRECT-DRIVING.

The Paper recently read by Mr. Langdon before the Institution of Mechanical Engineers has once again brought to the front the vexed question of large motors and shafting *versus* separate motors for each machine in connection with the electrical transmission of power in works. The Paper also, of course, raised the whole question of the advantages of electricity as a motive power; but with this we do not here propose to deal, further than by once again pointing out that, where a number of shops have to be driven, there can be no question of the advisability of employing electricity distributed from a single efficient centre, in place of long lines of shafting, or of a number of separate engines with numerous boilers or long steam pipes. Granted the employment of electricity as the means of bringing power to a shop, we propose to discuss the merits of the two possible methods of distributing the power in the shop itself.

Mr. Langdon has shown us that in the case he was dealing with 72 per cent. of the energy supplied to the main shafting was lost in transmission to the work on the machine-tools, and in the discussion on the Paper it was made clear that losses of this magnitude were of frequent occurrence. *Primâ facie*, therefore, there would seem to be a great gain in using motors coupled direct to the machines. But it must be remembered that loss of energy in itself is no bad thing; it is the cost of the loss that is objectionable, and if by the employment of direct-driving motors the interest, &c., on increased capital expenditure amounts to more than the cost of the energy lost in shafting, then it will be economy to put up with the loss. Let us take the figures Mr. Langdon gives. With all the 15 machines at work the loss in transmission was 1,778 watts, or 2·4 H.P., which at £10 per horse-power gives a loss of £24 per annum. But this does not include the loss in the driving motor, which at 80 per cent. efficiency would bring the loss up to £32 per annum. On the other hand, employing separate motors at, say, 50 per cent. efficiency, including the loss in the driven tool, the loss of energy would be at the rate of about 1 H.P., representing £10 per annum. Owing, however, to the fact that the

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machines would, on the average, be idle during one-third of each working day, during which time current could be switched off if separate motors were employed, we must, for purposes of comparison, reduce the £10 to £7. On the other hand, the extra cost of fitting the 15 machines with their own motors would be roughly £200, and allowing 5 per cent. interest and 10 per cent. depreciation on this sum, we arrive at £30, which, together with £7, makes £37 per annum. Thus, by the use of shafting, and in spite of its low efficiency, there would be a net gain of £5 per annum. But this is not all. The motors required for separate driving would be of very small size (½ H.P. and less), running at speeds over 1,000 revolutions per minute, and such small motors give much trouble from brushes, &c.; and their number being great the total attention required would be considerable. On the whole, then, we may say that in those shops in which the machines are all small it will be advisable to adopt larger motors driving shafting. Since, however, a motor becomes much cheaper per horse-power as its size increases—a 5 H.P. motor, for instance, costing approximately but three times one of ½ H.P.—a point is reached at which it becomes economical to employ a single motor driving a group of tools through a single short line of shafting. Just exactly where this point occurs is a matter for consideration in each individual case, but as a general rule we would suggest that something like 5 H.P. will be found a suitable unit. By the employment of such units counter-shafting, with its attendant losses, could be done away with, and the tools might be so grouped that when the shop happened to be slack whole units could be cut out, and the loss from running idle saved.

The above remarks, however, only apply to a case such as that taken by Mr. LANGDON, in which a number of small machines have to be driven. In a large shop, with heavy tools, it would undoubtedly be more economical in power to do away with shafting altogether. Each machine, being of large size, would then be equivalent to one of the groups above mentioned; and as large machines have to stand idle during longer periods than small ones, owing to the difficulty of getting the work into position, and to the fact that large work is scarcer than small, the gain by cutting off power altogether except just when wanted would be very marked. Further, the saving effected in other ways by driving each machine separately would be very great. In the first place, being self-contained, machines having separate motors can be placed in such positions relatively to one another that the foreman can keep his eye on all or most of his men at once; and a machine can be moved about just as it may be desired. Secondly, owing to this flexibility of the system, drilling and other tools may be brought up to heavy castings, instead of the castings being taken to them, and with great difficulty fixed in position. Indeed, two or more tools may be brought to work upon the same casting at one time. Thirdly, the speed of the motor can be very easily and delicately adjusted to suit the work in hand; and, if desired, the speed of all the machines can be increased with very little trouble. In addition to this, the absence of belting makes the installation of overhead travellers and cranes a very simple matter, and in such machines and many others, two or three separate motors may be employed to work the various motions. Last, though by no means least, the employment of a number of motors makes the stoppage of a whole shop of very unlikely occurrence. In one or two cases it may, however, be advisable to employ a single motor and shafting; as, for instance, where two or more wall-planers are to be driven, which require an extra amount of energy at a certain portion of the stroke. It will be extremely unlikely that all the planers will require the maximum energy at one and the same time, and consequently the size of the single motor may be reduced and a saving so effected. On the other hand this principle must not be carried very far, or the great loss in the shafting will again necessitate a large motor; and though it is true that a large motor is cheaper than a number of little ones of equivalent power, there still remains the prohibitive loss of energy in the shafting.

The result we arrive at, then, is that machine tools should be grouped into units when small, and separately driven when large, and yet that this principle must not be applied too rigidly. Often it will be advisable to drive small machines (such, for instance, as winding lathes) separately, each by its own motor, for the sake of compactness; while, as we have seen in the case of wall-planers, it may be best here and there to employ short lengths of shafting even in shops for heavy work. But the present state of chaos, in which we find every combination of motor and shafting used without rhyme or reason, certainly ought to be brought to an end. The question of the arrangement to be adopted is entirely one of principle, and that principle should be fully understood before the plant is laid down. It will, of course, be said that much of the present haphazard work is due to the fact that most shops now fitted with electrical power were originally driven by steam, and that the best has been done under the circumstances; but we think that where it is considered profitable to introduce electricity at all, it will in the long run be found more economical still once and for all to apply it in the most satisfactory manner. On the other hand, the rage for very small motors exhibited by some people in their enthusiasm for electric working, and nothing but electric working, we hold to be a mistake. At present, at least, the small continuous-current motor with its troublesome commutator and more or less exposed cotton-covered wire is not suitable for the knockabout work of the shops; and though in these respects the polyphase motor has the advantage, yet, when of small size, its speed cannot be easily and efficiently regulated. This difficulty has been met in some cases by employing two tri-phase circuits of different frequency, on to either of which the motor can be switched; but even with this complication the regulation cannot be called satisfactory. A gradual variation of speed over a considerable range is what is required. But the whole question of separate driving *versus* shafting concerns only the small motor; with large machine tools there can be little doubt that separate motors ought to be employed.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Continuity of Wave Theories.—Lord Kelvin's fascinating communication to the British Association, at Bristol, which has just been published, throws a flood of light on the connections which exist between all types of wave motion, from those of sound to Hertzian and heat waves, and to luminous and ultra-violet waves. Lord Kelvin pictures an ideally rigid globe of solid platinum of 12cm. diameter, hung inside an ideal rigid massless spherical shell of 13cm. internal diameter, and of any convenient thickness. This shell is hung in air or under water by a very long cord, or is embedded in a great block of glass, or rock, or other elastic solid. By proper application of force between the shell and the nucleus the two are made to vibrate in opposite directions with a simple harmonic motion, and an amplitude of, say, 10^{-3}cm. If the shell is in air, and the period 32 vibrations per second, a humming sound will be heard, audible to an ear a short distance away. On increasing the frequency the loudness will increase eventually to an intolerable shriek. Maintaining the same expenditure of energy, and increasing the frequency to 500×10^{12},

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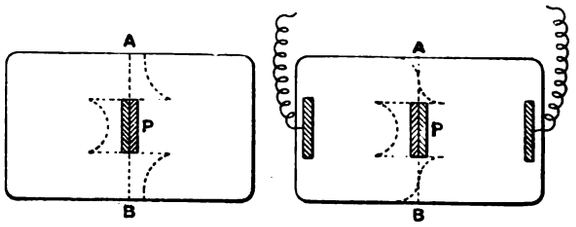
there will be no sound, but from all points of view not in the line of vibration a luminous point of homogeneous yellow polarised light will be seen proceeding, as it were, from the centre of the sphere. If the ether is absolutely incompressible no condensational-rarefactional waves will be sent out beyond frequencies of 4×10^{12}, and only the distortional waves will remain. Lord Kelvin points out two other lines along which such a transition may be looked for. In one of them oscillatory rotations are imparted to the sphere and the shell in opposite directions, and in the third the massless shell is replaced by an infinitely massive shell, and the platinum sphere by an electrified non-conductor. But for these the reader should study the original Paper.

[KELVIN, *Phil. Mag.*, November, 1898.]

Intermediate Conductors.—J. Stark has devised an elegant method of representing the occurrences at the surface of a metallic plate immersed in an electrolyte through which an electric current is passing. In the accompanying illustrations (*see* diagram) P represents a double plate, consisting of two different metals joined together. They form, of course, a closed circuit, and a current circulates from one to the other through the liquid. The path being shortest just round the edges the current is strongest there. The strength and direction of the current at any point in the plane A B may be represented by an ordinate on that plane. In Fig. 1 the double plate alone is active, and the current intensity at the edges is well illustrated by the dotted curves. In Fig. 2 a feeble current from the electrodes interferes with the current due to the double plate, and where the curves intersect the



plane A B there is no current at all. Almost any distribution of current may thus be brought about. A single plate of any metal is practically equivalent to a double plate, since it immediately takes a metallic deposit from the anode on passing the current. A beautiful gradation of zinc-copper alloys may be thus produced.

[STARK, *Wied. Ann.*, No. 10, 1898.]

Potential Gradients in Vacuum Tubes.—E. Wiedemann and G. C. Schmidt communicate the results of a lengthy investigation of potential gradients in vacuum tubes as influenced by the choice of a source of current, by heat, magnetism, ultra-violet light and photo-luminescence of the gas itself. They found that as soon as the same appearances were presented by a discharge from an influence machine, and that from a battery of accumulators, the potential gradients were equal to within 10 per cent. at all events. Even this difference may have been accompanied by differences of appearance, since the discharge of the influence machine was not steady. Hence, generally speaking, the luminous appearances are characteristic of the discharge potential. As regards methods of studying potential gradients, it is found that probes are unsuitable for discontinuous discharges and for discharges in narrow tubes. The discontinuity in the potential gradients in passing from wide to narrow parts of a tube explains the production of cathode rays at the points of transition. The potential gradient in the positive light column is largely independent of the width of the tube and the type of the discharge. This is somewhat analogous to the fact that in ordinary conductors the resistivity is independent of the dimensions and of the current intensity. Ultra-violet light and photo-luminescence are practically without effect upon the potential gradient. The heating effects in the glow light are quite out of proportion to the potential gradient there, probably owing to the fact that some rays are produced at the cathode and absorbed in the glow light. In the positive light, the whole of the energy given out by the discharge is converted into heat. A magnet brought near the positive column only increases the potential gradient indirectly by compressing the column.

[WIEDEMANN and SCHMIDT, *Wied. Ann.*, No. 10, 1898.]

Point Discharges with Oscillating Currents.—Experiments with Tesla apparatus have proved that rapidly alternating currents of high potential, when passing a pointed terminal, are capable of charging an insulated plate in the vicinity of the point positively, and not, as might have been expected, negatively. K. Wesendonck repeated the experiment with a Blondlot exciter with the same result. He now describes a very simple arrangement by which he is able to demonstrate and study the same phenomenon. One terminal of a Voss influence machine is put to earth, while the other leads to a spark gap, beyond which a fine needle is attached to the wire, which is also put to earth. Opposite the needle point is mounted a plate connected with an electroscope, the outer cover of which is put to earth. On working the machine the plate is always charged positively, whichever of the terminals of the influence machine is connected with the needle. On introducing a suitable self-induction, however, the plate is charged with the same charge as that of the terminal used. The difference between the two cases may be strikingly shown by introducing a closely wound coil of wire as a self-induction, and then pulling out the coil to a greater length, thus lessening its inductance. The author does not look for any explanation of this phenomenon to Pflüger's damping theory, but to a retardation which is greater for the negative than for the positive discharge.

[WESENDONCK, *Wied. Ann.*, No. 10, 1898.]

Polarised Electromagnetic Waves.—The observations made by Latrille (see *The Electrician*, Vol. LXI., p. 518), concerning the polarisation of electric waves by a metallic slit, had been previously made by K. Waitz, who did not, however, publish any account of them. The latter now proceeds to describe his own results in detail. They differ from those of Latrille in one important particular. In Latrille's experiments the transmitted energy always increased with the length of the slit, though not in proportion to that length. Waitz, on the other hand, found that the energy transmitted by the slit undergoes a periodic increase and diminution as the length of the slit is steadily enlarged. The minima are very pronounced, and closely approach zero. A maximum transmission occurs when the stationary wave at the slit has the same length as the resonator and electrometer combined. The first minimum occurs at a length of slit which is double that of the first maximum. The slit vibrates in two halves, and there is a node at the centre. When the resonator is displaced towards the ends of the slit, so as not to be at the node, the deflection of the electrometer increases.

[WAITZ, *Wied. Ann.*, No. 10, 1898.]

Low-Temperature Properties of Metals.—The anomalous behaviour of metals at very low temperatures is not confined to their resistivity. U. Behn has carried out some measurements of their specific heat, which have yielded interesting results. The method he adopted was that of mixtures, as being the handiest, and, on the whole, the most trustworthy. The metals dealt with were lead, platinum, iridium, palladium, copper, nickel, iron, and aluminium. The lowest temperatures were obtained by means of liquid air, and those between 0deg. and −80deg. by means of the usual mixture of solid carbonic acid and absolute alcohol. It was found that the lower the temperature the more was Dulong and Petit's law departed from. Between −80deg. and −180deg., the atomic heats, instead of ranging in the close neighbourhood of 6·3, varied from 6·0 (lead) to 4·0 (iron). The specific heats all diminished with decreasing temperature, and the more rapidly the higher their initial values. The author supposes that near the absolute zero they all have the same value, which is very small, and probably itself zero.

[BEHN, *Wied. Ann.*, No. 10, 1898.]

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Temperature Coefficient of Dielectric Constants.—H. Pellat and P. Sacerdote have determined the dielectric constants of such substances as paraffin and ebonite at various temperatures. To ensure a uniform and known temperature in the specimens, which is a notoriously difficult task, they only made measurements at room temperatures, and varied the latter by suitable ventilation and other means. After keeping one such temperature constant for 24 hours it could be fairly assumed that the specimens had assumed the same temperature throughout their mass. The dielectric constant of paraffin diminishes as the temperature increases, at the rate of $3{\cdot}6 \times 10^{-4}$ per degree. The dielectric constant of ebonite, on the other hand, increases at the rate of $8{\cdot}8 \times 10^{-4}$ per degree. It follows that in charging a condenser at constant temperature the charge is not simply $\frac{1}{2}$ CV², but must be multiplied by a factor depending upon the temperature. If the dielectric is ebonite, the actual energy of the charged condenser exceeds by more than a quarter the value hitherto ascribed to it. If rapid the charges and discharges will be adiabatic, and variations of temperature are produced, amounting to about 0·001°C. These are two small to be placed in evidence.

[Pellat and Sacerdote, *Comptes Rendus*, October 17, 1898.]

Incandescent Safety Lamps.—To show that an incandescent filament is incapable of producing a gas explosion, H. Couriot and J. Meunier filled such a lamp with a 9·5 per cent. mixture of marsh gas and air, that mixture giving the greatest explosive power. The lamp was one of 10 c.p., and required 0·8 amperes and 45 volts. It was switched on and then filled with the explosive mixture. The effect observed was that the glow diminished rapidly, except at one point, and at that point the filament eventually broke. The fracture was only a fraction of a millimetre long, and the ends were pointed. No explosive effect was produced. Another lamp was then overfed with 53 volts. But the behaviour was the same, except that the life of the lamp was shortened to 20sec. No difference was observed in any other type of glow lamp. The explanation of this behaviour appears fairly simple. The marsh gas is gradually burnt up without explosion, and when the spark occurs at the rupture there is no longer an explosive mixture in the tube, but only water vapour and carbonic acid. The former collects in the bulb on cooling. In order to obtain an explosion, it is necessary to break the filament and produce a spark by shaking the broken ends till they collide. Even then the ends are sometimes welded together by the spark, and the lamp goes on glowing as if nothing had happened.

[Couriot and Meunier, *Comptes Rendus*, Oct. 17, 1898.

Addendum.—It appears that Wiedeburg's "New Electro-thermal Relation" between the emissivities and resistivities of metals (see these notes, Oct. 7, p. 772) was discovered by Lodge 22 years ago, and published in the *Phil. Mag.*, 1876, Vol. II., p. 524.

THE COMMERCIAL AND BUSINESS ASPECTS OF MUNICIPAL ELECTRICAL SUPPLY.

BY ALFRED H. GIBBINGS, M.I.E.E.

(*Continued from page 749, Vol. XLI.*)

Electric Motive Power (*continued*).

We have now dealt with the application of the electric motor to three important and useful purposes, viz., letterpress and lithographic printing, electric traction and cranes and hoists. Without specially considering the other applications given in Table VIII., it will suffice if we now enumerate, in the form of a summary, the general advantages of the electric motor. They are as follows :—

1. Speed practically constant under varying loads if required.
2. The cost in repairs is practically *nil* with a well-designed machine.
3. The smaller sizes may be fixed to a wall if necessary.
4. Occupies very small space, viz., about 4ft. square for any size up to 10 B.H.P.
5. Perfect silence in working, absence of smell and does not give off any gases.
6. Requires no attention, except oiling the bearings once or twice a week, and renewing the brushes occasionally.
7. Absolute freedom from vibration, thereby enabling the motor to be placed in any position in a building without expensive foundations.
8. The larger sizes can be readily adjusted to take up any slack in the belt, instead of cutting the belt and making a new joint.
9. A motor can be started and stopped by the simple operation of a switch. This arrangement obviates running the motor when not required, and, of course, effects considerable economy in the use of power.
10. As there is no reciprocating motion, the running is the steadiest that can possibly be obtained. The motors are therefore suitable for any kind of work.
11. Where a number of machines are used, and extensions are likely to be made, the use of additional motors is much cheaper and more adaptable to circumstances than extensions of shafting and counter-shafting. Odd and additional plant may be put down anywhere, doing away with the necessity of setting out with a line of shafting, and thus floor space can be utilised to greater advantage. The space above would also be free from open belts, cross-belts, pulleys, counter-shafting and other gearing. When these separately driven machines were not in use, there would be no long lengths of shafting being uselessly driven and wasting power.
12. Motors can be coupled direct to any class of machinery. They can be placed at any point where they will be least in the way, and in some cases an advantage may be derived from running two or three small machines from the one motor. For instance, bookbinders' stitching machines, of which a number are usually worked on one floor, might with advantage be coupled this way, as but small power is required, and not all being in operation at the same time, a single motor will be sufficient for the whole. Electric driving is the only system by which the *exact* power required to drive a machine can be accurately ascertained. Every other form of power, including steam engines, gas engines, oil engines and hydraulic engines, necessitates the use of a brake method in order to ascertain approximately the power required or developed. With electric power, and by means of an ammeter in the main circuit, the maximum and all variations of power is shown at a glance at any time, while the motor is actually working under its ordinary conditions.

Having dealt with the general advantages of electric motive power, we will now consider briefly the actual cost of working, instituting a comparison with the cost of gas, oil and steam. Hydraulic power may be omitted from the comparison, as the purposes to which it may be applied are very limited, the means of handling it and regulating it are very costly, and the repair and maintenance are serious items. In addition to these drawbacks, the service is liable to be affected by drought in summer and by frost in winter. It may, therefore, be dismissed as being by no means a competitor with electricity.

In order to make a fair comparison of the cost of power by steam, gas, oil and electricity respectively it must, first of all, be determined what we are to assume as the respective prices charged for these commodities. But there are other items which must also be taken into consideration, and these may be stated as follows :—

1. Horse-power of plant.
2. Average number of hours per annum during which the power is required.
3. Efficiency of plant.
4. The capital outlay of the complete plant.
5. The interest and depreciation on outlay.
6. Cost of repairs.
7. Rent, rates and taxes.
8. Wages for attendance.
9. Efficiency of gearing.

We will take these items seriatim, and assume the relative prices to be 12s. 6d. per ton for coal, 3s. per 1,000 cubic ft. for gas, 4d. per gallon for petroleum oil and 2d. per unit for electricity. In order to reduce these to a common basis for comparison, it is necessary to obtain the cost per brake horse-power per hour. In the best engines of each type respectively it has been found that 4lb. of coal for steam engines, 25 cubic ft. of gas for gas engines, 1½ pints of oil for oil engines and 830 watts for electric motors are each equivalent to one brake horse-power per hour. Hence in actual cost in pence per hour we get :—

Steam at 12s. 6d. per ton	0·26d.
Gas at 3s. per 1,000 cubic ft.	0·80d.
Oil at 4d. per gallon	0·75d.
Electricity at 2d. per 1,000 watt hours	1·66d.

These figures represent the brake horse-power (B.H.P.) on the pulleys of the engines and motors, and also (what is of equal and immense importance in making this comparison) they represent the result at the *full load* of the engine. With a *varying load* the efficiency of the engines rapidly decreases, while that of the electric motor remains practically the same, as will be shown further on.

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The next two items to be considered are (1) the horse-power of the plant and (2) the average number of hours per annum during which the plant is required. It may be admitted that as steam plant is never put down for less than about 30 H.P., and hence that may be taken as a basis. The number of horse-power hours per day may be taken as 8, 6 and 4 respectively, although the first is very rarely reached. A steam engine may, for instance, be running for 9½ hours, but the load will be constantly varying from ¼ to possibly ¾ load, sometimes reaching full load for short periods. Hence the average must be taken, and, allowing 300 working days per year, we get 2,400 hours, 1,800 hours and 1,200 hours for 8, 6, and 4 hours per day respectively, or for 30 H.P., 72,000, 54,000 and 36,000 H.P. hours per annum respectively,

This brings us to the third point, viz., the efficiency of the plant at the average loads, which is found to be as follows:—

Table XI.

Plant.	Cost of fuel per brake horse-power per hour on varying loads. Horse-power hours per annum.		
	72,000	54,000	36,000
Steam	0·26d.	0·34d.	0·46d.
Gas	0·80d.	1·00d.	1·20d.
Oil	0·75d.	0·94d.	1·12d.
Electric	1·66d.	1·66d.	1·66d.

The next items for consideration have a much more important bearing on the actual and comparative costs of running. They consist of (1) capital outlay, (2) interest and depreciation, (3) repairs and maintenance, (4) rent, rates and taxes and (5) attendance. For a 30 H.P. plant these may be estimated as follows:—

Table XII.

Items.	Cost per annum.			
	Steam.	Gas.	Oil.	Electricity.
Capital	£500	£250	£250	£300
Interest and depreciation, 10%	£50 0	£25 0	£25 0	£30
Repairs, 5%	25 0	12 10	12 10	(2½%) £7 10
Rent, &c., for space occupied...	10 0	5 0	5 0	Nil.
Attendance	100 0	50 0	50 0	Nil.
Total	£185 0	£92 10	£92 10	£37 10
Cost per B.H.P. per hour for 72,000 hours ..... =	0·61d.	0·30d.	0·30d.	0·13d.
Ditto for 54,000 hours... =	0·82d.	0·41d.	0·41d.	0·17d.
Ditto for 36,000 hours... =	1·22d.	0·61d.	0·61d.	0·26d.

Table XII., together with Table XI., provides us with the necessary data wherewith to ascertain the actual cost of a brake horse-power hour for the respective plants under similar conditions, but with varying loads. These combined results are given in Table XIII.:—

Table XIII.—*Average Cost per Brake Horse-Power Hour in Pence for Varying Annual Loads.*

Plant.		72,000 hours. Per hour.	54,000 hours. Per hour.	36,000 hours. Per hour.
Steam	Running costs...	0·26d.	0·34d.	0·46d.
	Capital costs ...	0·61d.	0·82d.	1·22d.
	Total	**0·87d.**	**1·16d.**	**1·68d.**
Gas	Running costs...	0·80d.	1·00d.	1·20d.
	Capital costs ...	0·30d.	0·41d.	0·61d.
	Total	**1·10d.**	**1·41d.**	**1·81d.**
Oil	Running costs...	0·75d.	0·94d.	1·12d.
	Capital costs ...	0·30d.	0·41d.	0·61d.
	Total	**1·05d.**	**1·35d.**	**1·73d.**
Electricity ...	Running costs...	1·66d.	1·66d.	1·66d.
	Capital costs ...	0·13d.	0·17d.	0·26d.
	Total	**1·79d.**	**1·83d.**	**1·92d.**

It will be seen that these figures as they stand in the table are not favourable to electricity as a motive power. This is due to two reasons. First, the comparison between the respective motors is that of brake horse-power, taken at the shaft of each machine; and secondly, the price for electricity for power purposes, viz., 2d. per unit, is high.

To take the first of the above causes, it must be admitted that in comparing the costs of running at the point where the power is delivered by each engine, viz., at the pulley of the crank or armature shaft, the electric motor is not much cheaper, and in this instance is dearer, than the other three. It is clear, however, that in actual practice that point is not where the comparison is either useful or needed. The point at which the comparison should be made is the point of application of the power to the machinery or object to be operated or driven. Unless the gas, oil or steam engine is to drive one machine only, the necessity arises in the case of these engines to use intermediate gearing in the forms of shafting, belting, ropes, spur wheels, bevel wheels, &c. This gearing forms a very much greater proportion of the power required *per machine* than would appear to be the case. It may be taken as varying from 25 per cent. to 100 per cent. above the actual power of the machines when all are in operation. It is no uncommon occurrence, however, for only a small proportion of the machines to be at work while the engine is driving the whole of the shafting. Electric motors, of course, do away with nearly all this complication and waste, because they can be coupled direct to each separate machine, and in addition are not required to run when the machine is not in use. We can go even further than this, and start and stop the motor in a moment as the work on the machine is varied. As regards steam, gas and oil, therefore, it will be necessary to at least double the figures given in Table XIV. before accepting them as representing the actual working cost.

There is also another important feature in connection with the economy of electric motors. I refer to the efficiency at varying loads. It may be taken for granted that no single piece of machinery maintains a full load for any considerable length of time, and hence the efficiency of the driving engine at quarter, half and three-quarter load, &c., becomes important. The efficiency of the electric motor is much higher at all loads than either steam, gas or oil engines. The cost, therefore, of running an electric motor will be represented by the actual resultant taken on the average of the varying loads. This feature is illustrated in the accompanying curve (Fig. 5), which has been taken from the most modern machines. It will be seen that the maximum horse-power was 6·4 and the duration of time 18min., which, if the maximum power had been a constant load, would represent two horse-power hours. But after the resultant has been carefully obtained with a planimeter, the actual horse-power hours are found to be 1·06. This difference between the maximum horse-power required and the mean horse-power used is rarely taken into account or even understood by many small power users. It is a most difficult thing to get them to appreciate.

The second reason of the unfavourable comparison of cost per brake horse-power hour for electric power, as given in Table XIII., and to which brief reference has already been made, is that the price of 2d. per unit is high. It will be shown later on in this section that electricity for power purposes can be supplied at 1d. per unit from a central electric lighting station, and that a considerable profit can be made at that price. There are very few instances in which any private steam or gas plant can compete with electricity at 1d. per unit. In some towns, however, the charge for electricity for motive power is as high as 3d. per unit. The figures in Table XIV. give the cost per brake or electrical horse-power per hour for varying prices per Board of Trade unit. This table should be referred to only in conjunction with Fig. 5 and the explanation thereto.

The Effect upon the Output and Costs of the Generating Station.—There is very little necessity to enlarge upon the beneficial effects from a financial point of view upon the works costs of the generating station of a good day load in the form of a demand for electric motive power. The reader is referred

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Table XIV.

Electrical horse-power, 80 % efficiency.	Cost per hour in pence at varying prices per Board of Trade unit.				
	1d.	1½d.	2d.	2½d.	3d.
½	0·46d.	0·69d.	0·92d.	1·15d.	1·38d.
1	0·93d.	1·39d.	1·86d.	2·32d.	2·79d.
2	1·86d.	2·79d.	3·72d.	4·65d.	5·58d.
3	2·79d.	4·18d.	5·58d.	6·97d.	8·37d.
4½	4·18d.	6·27d.	8·36d.	10·45d.	12·54d.
6	5·58d.	8·37d.	11·16d.	13·95d.	16·74d.
10	9·32d.	13·98d.	18·64d.	23·30d.	27·96d.

to the section on "How to Charge for Electrical Energy," pp. 8, 76 and 179, Vol. XLI. It can be readily understood that in many cases electric motors may be required for a very short time per day: such cases, for instance, as coffee-grinding, hair brushing, restaurant lifts, &c. It is found in practice, however, that the rate of charge which has to be made for electricity for lighting purposes, may be considerably modified in regard to motive power. This arises, of course, from the fact that electric motors are in use principally, and to a great extent, in the daytime, whereas the demand for the electric light forms the well-known "peak" at the time of dusk, when the sum of all the demands is simultaneous. It is often stated that during the winter months the respective sums of the demands for both lighting and power are also simultaneous, thereby necessitating the same initial charge per unit for the first hour's average daily demand in both cases. As a matter of experience and observation it is found that such is not the case entirely. A certain proportion of the power for motors is bound to overlap the maximum of the lighting load, but the greater proportion undoubtedly occurs before 5 p.m. throughout the year.

In Bradford the maximum charge for motive power is 2½d. per unit with the sliding scale, as in Table XV., reducing the price according to the average daily use. The calculations are based upon a working year of 300 days. Wright's Demand Indicator is used to ascertain the maximum horse-power, which serves the double purpose of also showing whether the consumer's motor has been applied to work beyond the capacity for which it was designed.

The charges for electricity for power purposes will be 2½d. per unit, for an average use for four hours and under per day of the maximum power actually required. If the power is used for an average of over four hours per day, the charge will be reduced in accordance with the scale on the next page.

From the statement given therein any number of units may be ascertained by taking the amperes that are multiples of 100, say, 125, thus :—

Over	Under						
97½ ...	100=30·83 ...	11,000 ...	13,000 ...	15,500 ...	19,000 ...	24,000
22½ ...	25= 7·70 ...	2,750 ...	3,250 ...	3,875 ...	4,750 ...	6,000
120 ...	125=38·53 ...	13,750 ..	16,250 ...	19,375 ...	23,750 ...	30,000

and so on.

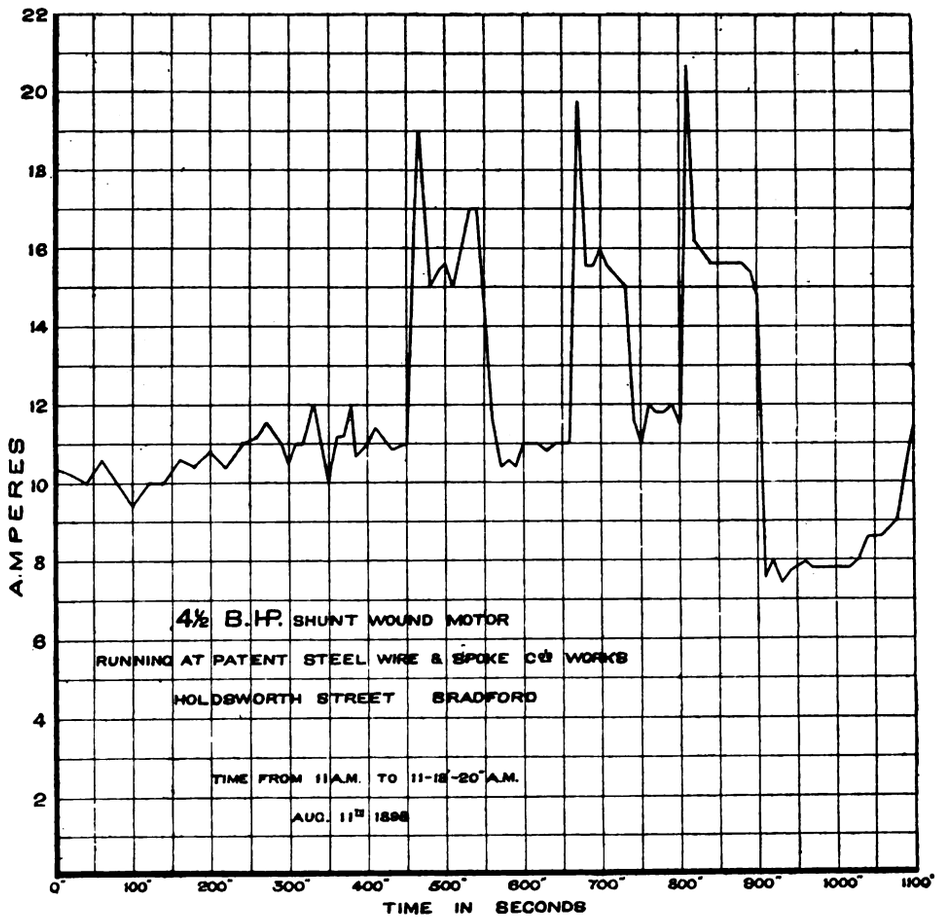

Fig. 5.

In addition to, and consequent upon the effect which the demand for motive power has upon the output and generating costs of the electricity works, there are sundry advantages from a generating point of view which have not yet been taken into consideration. There is less necessity for "banking" boiler fires, as the boilers are in more general use. This reduces the quantity of coal per unit sold, and in one municipal electricity works the saving effected in three years was ¼d. per unit, the cost being reduced from ½d. to ¼d. The radiation losses due to keeping steam pipes warm all day will remain practically the same, but per unit sold will, of course, be less with a day load than without. Another important effect occurs with the more continual running of the engines. The extra wear and tear will be neglible, indeed an advantage will accrue from their more frequent use. With an electric lighting load only, the greater portion of central station machinery is standing idle for long periods during the summer months, which, from an engineering point of view, is even more dele-

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Table XV.—*Sliding Scale of Charges for Electric Power, Calculated upon Six Months' Use.*

Max. demand of current. Amperes. Over	Under	Equivalent of current in H.P. required.	Average daily use: 4 hours. Units at 2d. Exceeding	5 hours. Units at 1½d. Exceeding	6 hours. Units at 1½d. Exceeding	7 hours. Units at 1¼d. Exceeding	8 hours. Units at 1d. Exceeding
...	5	1·54	550	650	775	950	1,200
5	7½	2·31	825	975	1,162	1,425	1,800
7½	10	3·08	1,100	1,300	1,550	1,900	2,400
10	12½	3·85	1,375	1,625	1,937	2,375	3,000
12½	15	4·62	1,650	1,950	2,325	2,850	3.600
15	17½	5·39	1,925	2,275	2,712	3,325	4,200
17½	20	6·16	2,200	2,600	3,100	3,800	4,800
20	22½	6·93	2,475	2,925	3,487	4,275	5,400
22½	25	7·70	2,750	3,250	3,875	4,750	6,000
25	27½	8·47	3,025	3,575	4,262	5,225	6,600
27½	30	9·24	3,300	3,900	4,650	5,700	7,200
30	32½	10·02	3,575	4,225	5,037	6,175	7,800
32½	35	10·79	3,850	4,550	5,425	6,650	8,400
35	37½	11·56	4,125	4,875	5,812	7,125	9,000
37½	40	12·33	4,400	5,200	6,200	7,600	9,600
40	42½	13·10	4,675	5,525	6,587	8,075	10,200
42½	45	13·87	4,950	5,850	6,975	8,550	10,800
45	47½	14·64	5,225	6,175	7,362	9,025	11,400
47½	50	15·41	5,500	6,500	7,750	9,500	12,000
50	52½	16·18	5.775	6,825	8,137	9,975	12,600
52½	55	16·95	6,050	7,150	8,525	10,450	13,200
55	57½	17·72	6,325	7,475	8,912	10,925	13,800
57½	60	18·49	6,600	7,800	9,300	11,400	14,400
60	62½	19·26	6,875	8,125	9,687	11,875	15,000
62½	65	20·04	7,150	8,450	10,075	12,350	15,600
65	67½	20·81	7,425	8,775	10,462	12,825	16,200
67½	70	21·58	7,700	9,100	10,850	13,300	16,800
70	72½	22·35	7,975	9,425	11,237	13,775	17,400
72½	75	23·12	8,250	9,750	11,625	14,250	18,000
75	77½	23·89	8,525	10,075	12,012	14,725	18,600
77½	80	24·66	8,800	10,400	12,400	15,200	19,200
80	82½	25·43	9,075	10,725	12,787	15,675	19,800
82½	85	26·20	9,350	11,050	13,175	16,150	20,400
85	87½	26·97	9,625	11,375	13,562	16,625	21,000
87½	90	27·74	9,900	11,700	13,950	17,100	21,600
90	92½	28·51	10,175	12,025	14,337	17,575	22,200
92½	95	29·28	10,450	12,350	14,725	18,050	22,800
95	97½	30·06	10,725	12,675	15,112	18,525	23,400
97½	100	30·83	11,000	13,000	15,500	19,000	24,000

terious than continual running. Standing machinery has a tendency to become rusty, and in order to avoid this each set has to be run for a few hours weekly with no load. The same applies to the generators, damp and dust doing greater harm than when they are frequently in use.

(*To be continued.*)

MR. W. H. PREECE'S PRESIDENTIAL ADDRESS TO THE INSTITUTION OF CIVIL ENGINEERS.*

(*Concluded from page 51.*)

Lighthouses.

The introduction of electricity into our lighthouses has not been such an unqualified success as into our ships. No new electric light has been installed on the coast of Great Britain since St. Catherine's (Isle of Wight) was fitted up in 1888. Other electric lamps are to be found at the South Forland, at the Lizard, and at Soutar Point; only four lighthouses in all upon our coasts. This is due chiefly to the great prime cost of its installation and to the annual expense of its maintenance. But the sailor himself is not enamoured of it. It does not assist him in judging distances. It is too brilliant in clear weather, while in bad weather it penetrates a fog no further than an ordinary oil lamp. Moreover, great modern improvements have rapidly followed each other in other apparatus, lenses and lamps. A third order light of to-day can be made superior to a first order light of ten years ago. Oils have improved, and gas has been introduced. Lord Kelvin proposed that lighthouses should signal their individuality to passing ships by flashing their number in the Morse alphabet. But the Morse alphabet, in 1875, was as unknown as Egyptian hieroglyphics to our nautical authorities. The same end was obtained with less mental exertion by occulting and group-flashing systems. A new and very promising plan has recently been introduced in France, called the "Feux-éclairs" or "lightning flash" system. It has been installed in many places, but especially at the two Capes dominating the Bay of Biscay. Nothing more brilliant or more effective is to be seen anywhere than the lights that rapidly sweep across the horizon, like well-directed flashes of summer lightning, with a motion that conveys the idea of a wave of some illuminated spirit-arm warning the navigator away from the rocky dangers of Ushant. Our Trinity House has not yet introduced this plan. Any change of our well-considered and deeply-important coast-lighting system is not to be hastily effected. We are very proud of our well-guarded shores. Every headland and landfall, every isolated rock, all dangerous shoals and banks and narrow channels in lines of trade are so illuminated that navigation by night is as safe and easy as by day. Lighthouses and lightships stud our channels. Most of them are placed in direct communication with our Post Office telegraph system, so that the speediest help can be secured in moments of difficulty and danger. We, however, want improvement in fogs and storms. Here electricity steps in. I wrote, in 1893, of wireless telegraphy:—"These waves are transmitted by the ether; they are independent of day or night, of fog or snow or rain, and, therefore, if by any means a lighthouse can flash its indicating signals by electromagnetic disturbances through space, ships could find out their position in spite of darkness and of weather. Fog would lose one of its terrors, and electricity become a great life-saving agency." We are nearing that goal.

Traction.

Electrically worked railways originated in Europe. The first experimental line was constructed by Dr. Werner Siemens, in Berlin, in 1879. When I visited America in 1884 there was only one experimental line at work in Cleveland, Ohio. Now there are more miles of line so worked in Cleveland alone than in the whole of the United Kingdom. The reason for this is not difficult to comprehend. The climatic influences of the States, the habits of the people, the cost of horseflesh, the necessity for more rapid transit, soon proved the vast superiority of electric over every other form of traction. Horses and cables will soon disappear. In England the Tramways Act of 1870 has been restrictive. It deferred the real solution of the question for 21 years. Its avowed tendency has been to throw the industry into the hands of the municipalities. Private enterprise has, therefore, not been encouraged, and municipalities have not taken it up. Local authorities have now been educated. The successful progress in the States and on the Continent has proved contagious, and everywhere our great cities are rising to the occasion. Indeed, to neglect to supply tramways where they would be useful, healthful and valuable is, to a certain extent, an abuse of the trust confided to the municipality by the Legislature. Rapid and convenient suburban transit is a social factor of great importance to the working classes, who can be readily transported from close quarters to pure air and healthy dwellings. Hamburg is one of the best trammed cities on the Continent. The trams were constructed by private enterprise under lease from the municipality. The latter supplies the electric energy. The tramway company is bound to take the current at a fair and reasonable price; but they have also to pay a tax on the gross receipts, which is set aside by the local authority as a sinking fund, so that on the expiry of the agreement the town will have the capital to purchase the tramways. Corporations in this country who have secured a provisional order for the installation of electric light have secured also legal powers to supply electric energy for all purposes. It is, therefore, their right, and it may become a very valuable property. The duplication and multiplication of central electrical stations is likely to become a serious evil. It is absurd to see two buildings erected where one only is needed, and two causes of nuisance perpetuated where none need exist. I have already pointed out the economy of combining electric lighting and tramway working. The relative merits of overhead and underground conductors, and the use of storage batteries, are practically the only important engineering questions under discussion. The underground conduit system has been materially helped by the practical object lesson to be seen in New York, where the tramways are being very successfully worked on this plan. The trolley system is much more economical. Its erection does not interfere with the traffic of the streets. The principal objection to it is its anti-æsthetic appearance, but it is wonderful how ideas of utility and the influence of custom make us submit to disfigurement. What is more inartistic than a lamp-post, or more hideous than the barn-like appearance of many a railway terminus?

The corrosion of water and gas pipes, the disturbances of telegraphs and magnetic observations, are serious questions arising from the introduction of powerful currents into the earth; but, fortunately, the remedies are simple, easily obtainable, and very effective.

I have alluded to the proposed working of our underground railways. The success of the Mersey Dock line and of the South London and Waterloo lines have placed the question beyond controversy. The problem to be solved is, How is the conversion from steam to electricity to be effected without interfering in any

*Abstract of an Address delivered by Mr. W. H. Preece, C.B., F.R.S., on November 1, 1898.

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Place.	Electric power generated.	Pressure on line.	Distance transmitted.	Remarks.
	Kilowatts.	Volts.	Miles.	
Eschdorf-Grünberg, Schleswig	225	10,000 (three phase).....	15	One 80 H.P. Siemens and Halske dynamo, driven from water-wheel; one 220 H.P. S. and H. dynamo, driven from turbines (above driven through counter-shafting); one 220 H.P. S. and H. dynamo, direct-coupled to engine.
Ogden, Salt Lake City, Utah.....	3,750	15,000 (three phase)..... ...	36	Plant consists of five 1,000 H.P. 24-pole three-phase generators, driven by Knight water-wheels running at 300 revolutions per minute.
Big Cottonwood, Utah	1,800	10,000 (three phase)..... ..	14	Plant consists of four 450 kilowatt three-phase general electric generators, each one directly coupled to a Pelton wheel.
Folsom-Sacramento, California	3,000	11,000 (three phase).....	22½	Plant consists of four 1,000 H.P. three-phase generators built by the General Electric Co., coupled direct to the turbine shafts.
San Antonio Creek to Pomona	480	10,000 (single phase	13¾	Plant consists of four 120 kilowatt 12-pole Westinghouse alternators, driven by a Pelton water-power plant.
To San Bernardino, California			28¾	
Rand Central Electric Works, Brakpan to Johannesburg, Transvaal	3,200	10,000 (three phase).....	18	Plant consists of four S. and H. rotary-phase machines, coupled direct to 1,000 H.P. to 1,200 H.P. engines.

way with the existing traffic or with the existing permanent way? This is not to be solved on paper. It must be determined by actual trial, and this is about to be done on the short line connecting Earl's Court and High-street, Kensington. Electric traction as an economical measure in all cases of dense traffic is so certain that every great railway company must consider, sooner or later, the working of their suburban traffic by electricity. This experiment on the Metropolitan Underground Railways, therefore, should interest them all. It is a question deeply affecting the interests and comfort of the public and the condition of the congested traffic of our streets.

The storage battery fulfils a very important function in the economical working of an electric railway. It equalises the pressure on the circuits. It meets the fluctuations of the load. It takes in current when the load is light; it lets out current when the load is heavy. It thus secures the continuous working of the engines at their full constant and most economical conditions, and it enables the engines to be shut down altogether when the load is very light as it is at night, in the early morning, and on Sundays. In Buffalo, the battery is charged by energy from Niagara, 21 miles away, and the local engines are shut down for 12 hours every day, and for 10 hours on Sunday. Electric traction is invading even our streets. When the real storage battery is produced, the automobile problem will be solved. At present, steam and oil are active competitors.

The Transmission of Power.

The energy wasted in waterfalls is enough to maintain in operation the industries of the whole world. Great cities as a rule are not located near great falls; nor has a beneficent Providence provided great cities with waterfalls, as, according to the American humourist, He has with broad rivers. There is but one Niagara, and we are seeing how industries are rather going to the falls than the energy of the falls is being transmitted to the industrial centres. The arbitrament of money is limiting the distance to which energy can be profitably transmitted. The cataracts of the Nile can be utilised in irrigating the waste lands of the upper regions of the river, but their energy cannot compete, at Alexandria, with that of coal transported in mass from England.

In mines electricity is invaluable. It is used for moving trams and for working hoists. It lights up and ventilates the galleries, and by pumping keeps them free of water. It operates the drills, picks, stamps, crushers, compressors, and all kinds of machinery. The modern type of induction motor, having neither brushes nor sliding contacts, is free from sparks and safe from dust. Electrical energy is clean, safe, convenient, cheap, and it produces neither refuse nor side products. It is transmitted to considerable distances. In mountainous countries the economical distance is limited by the voltage which insulation can resist; 40,000 volts are being practically used between Provo Canyon and Mercur, in Utah, in transmitting 2,000 H.P. 32 miles.

The above table records some interesting installations.

Conclusion.

I have touched lightly—I fear too lightly—upon some of the applications of electricity. I have confined myself, in a very general sense, to those with which I have been personally associated. I have shown how electricity began its beneficent career by protecting our lives and property from the disastrous effects of Nature's dread artillery, how it facilitates intercommunication between mind and mind by economising time and annihilating space. It

> "Speeds the soft intercourse from soul to soul,
> And wafts a sigh from Indus to the Pole."

By its metallic nerves it brings into one fold not only the scattered families of one nation, but all countries and all languages, to the manifest promotion of peace and general goodwill. Not only does it show us how to utilise the waste energies of Nature, but it enables us to direct them to the place where they are most wanted, and to use them with the greatest economy. It opens to our view Nature's secret storehouses, presenting us with new elements, new facts and new treasures. It economises labour and purifies material. It lightens our darkness in more senses than one, and by enabling us to see the unseen, it tends to aid the gentle healing art and to alleviate both suffering and pain. It aids us in the pursuit of truth, and it has exploded the doctrine that the pursuit of truth means the destruction of faith. I have occupied your time sufficiently I hope to impress upon you the universality of electricity. Its flood gates were opened when our good Queen ascended the throne, and during her glorious reign it has overflown all the fields cultivated by the engineer. Though its followers are now regarded as specialists, the period is not distant when it must cease to be a speciality. Its facts and tenets, its science and practice, must form the framework of the profession of the engineer. Every engineer must ultimately become an electrician; and electricity will be the most general, the most useful, and the most interesting form in which he applies the fundamental principles of energy to the wants, the comforts and the happiness of mankind.

TESTIMONIAL TO RICHARD COLLETT.

On Friday evening last, at the Trocadero Restaurant, London, took place one of those functions which mark most acutely the passage of time, and call attention to the gradual retirement from active service, one by one, of the early workers in electrical enterprise. Were it not for the severance of the old ties, such gatherings as that of Friday would leave nothing but pleasant memories, for it is undoubtedly the case that, at these "meetings for farewell," the pioneers of practical telegraph work are prone to give those intensely personal particulars of the trials and troubles of their early work, which at no other time can they be induced to dilate upon. The present occasion was no exception, and we heard from Mr. H. A. C. Saunders unrecorded incidents of Atlantic cable campaigns.

Mr. J. Denison Pender occupied the chair, and, in addition to Mr. Richard Collett, the company included Messrs. W. H. Axworthy, C. B. Barnes, W. Barnett, G. R. Birch, R. T. Brown, T. A. Bullock, W. H. Burman, S. Collett, F. Dawes, W. Dover, Geo. Draper, Ch. Gerhardi, W. P. Granville, Capt. Greey, F. E. Hesse, W. Hibberdine, E. Steer Hodson, W. W. Howell, G. C. Jack, J. Jack, W. Judd, F. Lucas, J. F. Mills, O. Moll, Dr. Muirhead, G. R. Neilson, F. C. C. Nielsen, Capt. Perkins, H. C. Plank, H. E. Popplewell, J. Rippon, H. A. C. Saunders, H. St. L. Smith, W. O. Smith, W. S. Smith, Geo. Tucker and Dr. T. Wholey.

After an excellent dinner, and a cordial reception of the usual loyal toasts,

The CHAIRMAN, in presenting the testimonial and proposing Mr. Collett's health, referred in kindly terms to the excellent services rendered by Mr. Collett to telegraphs. After briefly reviewing Mr. Collett's career in the Atlantic telegraph service, from 1857 to 1870, and to the fact that he was traffic manager of the first Atlantic cables opened to the public, he dwelt upon his association with the Brazilian Submarine Company, and pointed to the remarkable success which that Company had from the first attained having paid a 6 per cent. dividend from the commencement. This success was not, however, immediately reflected in the Stock Exchange, for the Company's shares were at a very low figure. But that was not for many years, and the £10 shares now stood about £16. He referred to the singularly few repairs which the Company's cables had required, and to the fact that from the first the policy of the Directors had been to have no property in cable ships. That might be termed a policy of pluck and ability, for it had proved a success, and had shown the wisdom and foresight with which the Brazilian Submarine Company had from the first been conducted. No small share of this success was due to the work of their guest, whose popularity in the service was shown by the fact that his friends in all parts of the world had contributed to the handsome and useful testimonial which they were able to present to Mr. Collett as a small evidence of their regard for him as a friend and associate. Mr. Collett had requested some time ago that he should be permitted to retire, but important negotiations were then in progress, and it was felt by the Directors that Mr. Collett should remain in active work until these negotiations had culminated in success. That period had now been reached, and

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the Directors felt that they could no longer withhold their consent to Mr. Collett's wish to retire while in full health and strength. He (the Chairman) and all who knew Mr. Collett intimately sincerely hoped that this period of well-earned repose would be a long and pleasant one. It was a wrench to their feelings to part in business with an old friend, but they looked forward to his friendship in the future as in the past.

The toast was drunk with musical honours.

Mr. RICHARD COLLETT, who was much affected by the enthusiasm with which the toast was received, spoke very feelingly of the uniform kindness and consideration he had always received from the Directors and his colleagues. He thanked everybody for this kindness and consideration, and he asked that his appreciation of the handsome and useful testimonial which they had been good enough to present to him might be conveyed to all the donors. Such a gathering for such a purpose as the present was a reward for a long and active career, and answered conclusively the query, "Is life worth living?"

Mr. H. A. C. SAUNDERS proposed the health of the Chairman, and associated with his remarks the subject of Submarine Telegraphy. He said those present knew their Chairman's intimate connection with the development of telegraph work, and how he had succeeded his father, the late Sir John Pender, who entered telegraphs as far back as 1854 as Director of the Magnetic Company, in the days of Whitehouse and Brett. At that period the length of submarine cable laid in all parts of the world was only 735 miles. He referred to his own early connection with telegraphic work, when associated with Whitehouse and Brett in carrying out experiments. It was, he said, remarkable how very early in the history of submarine telegraphs the American nation had shown an eagerness for rapid communication with the United Kingdom. The demand for news was so great that when the mail ships arrived at Cape Race, boats came out to meet them, and papers containing news were thrown into the water and were taken ashore by these boats. In order to obtain command of the lines when news was expected bogus messages were manufactured, so that uninterrupted possession of the lines might be secured. Meantime "subaqueous" and submarine lines were being laid in Europe, and experiments were being conducted in order to extract from these cables their utmost capacity in speed and accuracy. The longest deep sea cable in those days and up to 1856 was 110 miles of line laid in 500 fathoms of water. In 1856, when he joined the Atlantic Company, they had but limited knowledge and experience, and it was nothing short of audacity to make and attempt to lay an Atlantic cable with the extremely limited knowledge at command; it was, therefore, not surprising that, on October 20, 1858, that cable failed. In May, 1858, he commenced what proved to be a 15 months' expedition to Newfoundland, and returned to London in August, 1859, and again in the next month left Galway with a man whose name should not be left unrecorded in the annals of submarine cable work—Captain Kell, a retired mercantile marine man—with whom he arrived at St. John's, Newfoundland, after a nine days' passage. They then chartered a fishing boat, the "Hibernia," and he might mention that very remarkable craft were, in the early days of the expedition, drafted into the service. In October of the same year they encountered a great storm in Bull's Arm Bay, which badly damaged their boats, and played havoc with their electrical outfit, which, by the way, he would mention cost about £25. It was found by Nov. 5th that the weather was too bad to continue operations, and so they returned to England. In 1860 a more important expedition to recover the lost cable was organised, and a Deal lugger, the "Industry," was, on Capt. Kell's advice, engaged, and on April 28th of that year, his friend Richard Collett and he left Galway for Newfoundland, where they arrived in seven days. Very rough weather was subsequently encountered, and it was not until June that they were able to make a start. On June 12th they began to recover the lost cable, but the weather was so bad that their movements were greatly impeded. On June 26, 1860, Cromwell Varley joined them in a tug. However, on July 3rd of that year they abandoned the work and returned to England, and on the 27th of August terminated Richard Collett's and his own then engagement with the Atlantic Company. They were, however, together again in Messrs. Glass, Elliott and Co.'s service, and in the laying of the Malta-Alexandria cables. They drifted apart for some years after this, Mr. Collett joining the Anglo-American Company and he (the speaker) being at Malta. However, they were ultimately together again with the Eastern and associated companies, Mr. Collett having joined the Brazilian Submarine Co. on its establishment, and he taking service with what subsequently became the Eastern Telegraph Co. In all this great telegraph enterprise the late Sir John Pender had taken an active part, and his son, their chairman this evening, had followed and was following his father in this great national work. He had great pleasure in proposing the toast of their Chairman.

The toast was drunk with enthusiasm.

The CHAIRMAN, in reply, referred to his own long connection with telegraphs, and said that he looked upon his duties in the telegraph service as a trust handed him by his father. There was present that evening the representative of a company which had done a great pioneer work in connection with telegraphs—Mr. F. C. C. Nielsen, of the Great Northern Company. He could not refrain from associating with the name of his father that of the late Sir James Anderson, nor must they omit, in a gathering like this, to give due credit to the manufacturers of submarine cables and to the inventors and makers of the delicate instruments which were necessary in submarine cable work. They had a representative there that evening of the Telegraph Construction and Maintenance Co., and Dr. Muirhead was also present. With regard to the telegraph companies, there were at one time, no doubt, serious jealousies, but these had been and were being overcome, and they now represented a bond of strength and good feeling. For himself, what success he had achieved he attributed largely to the valuable assistance rendered by the staffs of the companies with which he was associated.

This concluded the toast list and the proceedings, which had been throughout of an enthusiastic nature, terminated.

The testimonial to Mr. Richard Collett consisted of a pair of handsome candelabra, a three-bottled spirit frame with cable design, a case of fish eaters and a pair of fish servers, a case of nut cracks, a double inkstand, and a salver, all of silver, designed and manufactured by Messrs. Mappin and Webb.

CORRESPONDENCE.

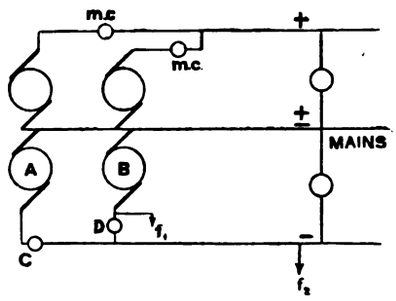
THE BREAKDOWN AT BRIGHTON.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Having followed closely the Notes, in the two last issues of *The Electrician* regarding the breakdown at Brighton, perhaps the following account of a similar occurrence may be interesting to your readers, and help to explain the cause of the minimum cut-outs opening.

About eight years ago (in the United States), whilst in charge of a large station, there were four 150 kilowatt machines running in two sets of two in parallel on the three-wire mains.

Each dynamo (in addition to other apparatus) was provided with a minimum cut-out. The four machines were nearly loaded, when suddenly the minimum cut-out D acted, the cause being due to a fault developing on the machine B, when a band came loose: a fault f_2 on the main short-circuited the cut-out f_1 to f_2, and the apparatus opened.



The machine A was now overloaded, the dynamo B running as a motor; then the field of A dropped, owing to the engine slowing down, and its minimum cut-out *c* also worked. An extinction of the lights on this side of the three-wire system then took place. The machines were self-excited, but later on were separately excited. The fault f_2 in the meantime, it should be added, had been completely burnt off, and it was afterwards found to have been caused by a subsidence of the pavement at a certain place.

A wholly different type of minimum cut-out was afterwards used with every success of a design that I have never seen employed in Europe, and which I feel sure would have prevented the trouble at Brighton.—Yours, &c.,

London, Nov. 6, 1898. J. D. DALLAS.

BOOKS RECEIVED.

"The Official Gazette of the United States Patent Office." Nos. 3 and 4. Vol. LXXXV. Published by authority of Congress. (Washington: Government Printing Office.)

"Istruzioni Pratiche di Servizio sulla Telefonia Intercomunale." By I. Brunelli. (Rome: Dell'Unione Co-operativa.)

"Experiments on the Pressures and Explosive Efficiency of Mixtures of Acetylene and Air." By F. Grover. (Leeds: Jowett and Lowry.) Price 1s.

"Catalogue of the Michigan College of Mines." 1896-1898. With statements concerning the Institution and its courses of instruction for 1898-1900. (Houghton, Mich., U.S.A.: Published by the College.)

"The Theta-Phi Diagram Practically Applied to Steam, Gas, Oil and Air Engines." By Henry A. Golding. (London: John Heywood.) Price 3s.

"Kalender für Elektrotechniker" for 1899. By F. Uppenborn. (Munich and Leipsic: R. Oldenbourg.) Price 5 marks.

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LEGAL INTELLIGENCE.

Kaye v. Croydon Tramways Co. and Others.

In the Chancery Division on Wednesday, before Mr. Justice Kekewich, Major-General G. F. Kaye brought an action, on behalf of himself and the other members of the Croydon Tramways Co., against the company, its directors, and the British Electric Traction Co. (Limited), for a declaration that an agreement dated Nov. 25, 1897, between the tramways company and the traction company for the sale to the latter company of the tramways company's undertaking, and a resolution approving the same purporting to have been passed at a meeting of the shareholders of the tramways company held on Dec. 14, 1897, in pursuance of a notice dated Nov. 26, 1897, were *ultra vires* and ought to be set aside, and for an injunction to restrain the defendants from carrying out the agreement, and also claiming relief against the Directors of the tramways company personally. This matter has been before the Courts previously, and now came on for trial.

Mr. Justice KEKEWICH said it was agreed that plaintiff must have an order for payment of his costs, so far as the action turned upon the question of insufficient notice to the shareholders of the date of meeting to consider the agreement. But the whole case of the plaintiff depended on the charge of fraud. Of course, if in the circumstances of the case fraud had been made out, it would have been a very grievous charge. The plaintiff had not based his case on negligence, saying that the Directors had too easily sanctioned this agreement, and had not brought in expert evidence, but he had put it distinctly on the ground of fraud. If fraud was charged it ought to be proved ; if it was not proved the usual consequences must follow. To his lordship's mind it had not been proved. He dismissed the action, so far as it alleged fraud, and made an order giving the defendants (the British Electric Traction Co.) the costs of the action and the defendants (the Directors) the costs of the action so far as they did not relate to the insufficiency of the notice and the invalidity of the resolution.

Boyce, French and Bulwer v. The Alexandra Palace Electric Railway Co.

At Wood Green (London) County Court, Judge Edge heard three actions for damages for personal injuries arising out of an accident on the electric railway established in the grounds of Alexandra Palace. The accident occurred on Whit Monday last, and a number of passengers were injured. Council explained that the railway car was descending the slope from the Palace to Wood Green when the car ran away at a great speed and collided with another car standing at the end of the track. The plaintiff Boyce claimed £20. 5s. and French £10, and judgment was given for these amounts with costs. Bulwer claimed £20 and obtained £10 and costs. The defendants in the action did not appear.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London :—

NOW READY.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. The Author hopes that, besides Telegraph and Telephone Engineers, it may, perhaps, also prove of service to those in charge of cables for the transmission of light and power. The localisation of faults has been very fully investigated, including the different degrees in which the various methods are affected by the presence of a second fault or of general leakage.—*Extract from Preface.* Demy 8vo, fully illustrated. 10s. 6d., post free ; abroad 11s.

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d.

"The Students' Guide to Submarine Cable Testing."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net ; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition ready in November.*

"Practical Notes for Electrical Students."—By Messrs. A. E Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s , post free.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free ; abroad, 11s.

"Laboratory Notes and Forms."—With the above title we have ready the New Edition of a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net ; in sets of any three, 1s. net ; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net ; or in handy portfolio, price 12s. net ; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"Wireless Telegraphy : Signalling across Space without Wires by Electric Waves."—By Dr. O. J. Lodge, with many original illustrations. *Enlarged Edition*, 2s. 6d. net, 2s. 9d. post free.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d. ; abroad, 8s.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"The Manufacture of Electric Light Carbons." — A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated. price 1s. 6d. ; post free, 1s. 9d.

"The Bibliography of X-Ray Literature and Research, 1896-97.' A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free ; abroad, 5s. 3d.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free ; abroad, 5s. 6d. Prospectus on application.

"Electrical Engineering Formulæ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour ; price 7s. 6d. ; by post, 7s. 9d. ; abroad, 8s. A fine large paper edition with wide margins for notes can also be supplied. Price 12s. 6d. ; post free, 13s. ; abroad, 13s. 6d. *New Edition in the press.*

"The Alternate Current Transformer," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *New Edition.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"The Electrician" Primers.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free ; cloth 2s. 9d. Single Primers, 3d. each, post free.

"Electromagnetic Theory."—By Oliver Heaviside. Vol. I., price 12s. 6d. ; post free, 13s. *Nearly ready.*

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth also ready. Price 7s. 6d. ; abroad, 8s. Prospectus on application.

"The Potentiometer and its Adjuncts" : A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s , post free ; abroad, 6s. 6d. Digest post free.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free; abroad 13s. 6d. Prospectus post free.

"Armature Windings of Electric Machines."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

IN THE PRESS.

"The Electric Arc."—By Mrs. Ayrton.

"The Manufacture of Carbons for all Electrical Purposes."—By Francis Jehl.

"Electromagnetic Theory." By Oliver Heaviside. Vol. II.

"Secondary Batteries, their Design and Manufacture."—By E. J. Wade.

"Primary Batteries : Their Construction and Use."—By W. R. Cooper.

"Practical Telephony."—By Dane Sinclair and F. C. Raphael.

"'The Electrician' Wireman's Pocket-book."

"The Electrician" Electrical Trades' Directory and Handbook.—An important announcement in connection with the 1899 issue of the "Big Blue Book" will be found in an advertisement on another page of the present issue, to which our readers will please refer.

TENDERS INVITED.

The Electric Lighting committee of the *Salford* Corporation invite tenders for the supply and erection of the following : (1) boilers, (2) engines, (3) dynamos, (4) boiler feed-pumps, (5) mechanical stokers, (6) superheaters, (7) economisers, (8) condensers, &c., (9) steam and water pipes, (10) cranes and weighing machines, (11) tanks, &c., (12) switchboards, and (13) booster. Further particulars are given in an advertisement in another

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column, and specifications, forms of tender, &c., may be obtained from the borough electrical engineer (Mr. C. L. Turner), Walness-road, Broughton. Tenders, addressed to the chairman of the Electricity committee, must be delivered at the offices of the town clerk (Mr. Samuel Brown), Town Hall, Salford, by Dec. 1.

As will be seen from our advertisement pages, the *Glasgow* Corporation invite tenders for providing and erecting switchboards and instruments at the new electricity works, Port Dundas. Copies of the specification, &c., may be had from Mr. W. A. Chamen, city electrical engineer, 75, Waterloo-street, Glasgow, and tenders must be lodged with the town clerk (Sir J. D. Marwick), City Chambers, Glasgow, not later than Monday, Dec. 5.

The *Glasgow* Corporation also invite tenders for the supply of about 800ft. of cast-iron pipes (21in. diameter) and certain cast-iron pipes (22in. and 29in. diameter), with special castings, for the Port Dundas electricity works. Tenders to town clerk, by 22nd inst.

The Corporation of *Blackpool* invite tenders for trolleys, trolley wire and other material in connection with the conversion of their present conduit system to the overhead system. Specifications may be obtained from the Borough electrical engineer, Mr. Robert C. Quin, and tenders are to be sent in not later than Tuesday, Nov. 22. Further particulare are given in our advertisement columns.

The *Dublin* United Tramways Co. invite tenders for the supply of general stores, including electrical supplies, car fittings, ironmongery, &c., for the year 1899. Tenders to the chairman of the Company, 9, Upper Sackville-street, Dublin, by the 5th prox. For some further particulars see advertisement on another page.

The Electric Lighting committee of the borough of *Middlesbro'* require tenders for the supply and erection of the following plant:—(*a*) Lancashire boilers and accessories, mechanical stokers, feed pumps, injector, economiser and electric motor; (*b*) slow speed steam dynamos and accessories; (*c*) condensing plant and pipe work; (*d*) overhead travelling crane; (*e*) switchboard and instruments; (*f*) accumulators; (*g*) trenching, cables, &c.; (*h*) meters. Tenders to Mr. Geo. Bainbridge, Municipal Buildings, Middlesbro', by Nov. 29.

The *Great Northern Railway Co.* (*Ireland*) invite tenders for (1) Lancashire boilers; (2) engines, dynamos, pumps, steam and exhaust pipes, &c., cranes, feedheaters and tools; (3) switchboards. Tenders to the Company, Amiens-street Terminus, Dublin, by 19th inst.

The *British Electric Traction Co.* require tenders for the supply of about 12,000 tons of granite setts required during the ensuing twelve months. Particulars from the company's permanent-way engineer, Donington House, Norfolk-street, Strand, London, W.C.

The Electric committee of the *Belfast* Corporation require tenders for the supply and erection of four 400-kilowatt steam dynamos. Specification, &c., from the city electrical engineer (Mr. Victor A. H. McCowen). Tenders to Sir Samuel Black, town clerk, Belfast, by noon of 17th inst.

The *Belfast* Harbour Commissioners require tenders for the supply of nine iron latticed-built electric light masts, 70ft. high from the ground lines with suitable base. Tenders to Mr. W. A. Currie, Harbour Office, Belfast, by Nov. 14.

The Corporation of *Barrow-in-Furness* invite tenders for the supply and erection of cast-iron lamp columns, arc and incandescent lamps, automatic switches and fittings. Tenders to Mr. C. F. Preston, Municipal Offices, Barrow-in-Furness, by noon of Nov. 14.

The *Edinburgh* Corporation invite tenders for the following plant for their electric lighting station in McDonald-road:—(1) Marine type boilers and mechanical stokers, (2) engines and dynamos. The engines must be of the Willans or Belliss type. Tenders to the offices of the town clerk (Mr. Thomas Hunter), Town Hall, Edinburgh, by Nov. 14.

The *Leatherhead* District Council invite offers from persons willing to take over their Electric Lighting Order (1898). Offers to Council Offices, Leatherhead, by Nov. 21.

Tenders are invited for the supply and fixing of two engines and dynamos at the *Southampton* County Lunatic Asylum, Knowle, near Fareham. Tenders to Mr. John R. Wyatt, Knowle, by Nov. 16.

The *East Indian Railway Co.*, Nicholas-lane, London, E.C., invite proposals for the supply of 18 instruments for nine blocks (for single line); 80 instruments for 41 stations (for double line), and six spare instruments. Tenders to secretary by 1 p.m. Nov. 23.

The *Midland Railway Co.* require tenders for stores, including telegraph instruments, stay rods and bolts, telegraph and signal wire, &c. Tenders to secretary, Derby, by 9 a.m., 15th inst.

The *Irish Board of Public Works* invite tenders for the hire of plant required for the electric lighting of the State apartments, Dublin Castle, during the next Castle season. Tenders to the secretary, by 10 a.m., 14th inst.

The horse tramways of *Rheims* are about to be converted to the electric trolley system. Proposals from firms prepared to contract for the equipment of the lines should be forwarded to La Compagnie de Tramways de Rheims, Sharbeeck, Brussels.

The *Shanghai* Municipal Council invite tenders for the construction and working of about 23 miles of electric tramways on the trolley system. Plans, &c., from Messrs. John Pook and Co., 8, Jeffreys-square, St. Mary Axe, E.C. Further particulars from Mr. Charles Mayne, whose cable address is "Dynamo Shanghai." Tenders to secretary by noon of March 15 next.

The Consul-General of the *South African Republic*, Nicholaas Witsenkade 9, Amsterdam, invites tenders for the supply of iron telegraph poles. Tenders by Nov. 19.

TENDERS RECEIVED AND ACCEPTED.

The *Aberdeen* Town Council have accepted the tender of Messrs. S. Z. de Ferranti (Limited) for the supply of electricity meters. The Penny-in-the-Slot Electric Supply Syndicate, General Electric Co., Venner and Co., British Insulated Wire Co. and the Premier Electricity Meter Co. also submitted tenders. As announced in our last issue, the tender for house service cable has been let to the Callender Company. The British Insulated Wire Co., the Western Electric Co., Siemens Bros. and Co., the Telegraph Manufacturing Co. and W. T. Henley's Telegraph Works Co. also tendered. For the house fuse boxes the tender of Mr. Alex. Spark was accepted, and tenders were also received from the British Insulated Wire Co., the General Electric Co., the Reason Manufacturing Co. and Ernest F. Moy (Limited).

The *Ipswich* Guardians have accepted the tender of Messrs. Crompton and Co. for the supply of an electric motor for the new workhouse at £159.

The tender of Messrs. Yates and Thom has been accepted by the *St. Helens* Town Council for the supply of additional boilers at the electricity works.

The *Leyton* District Council have given out the following contracts for the supply of additional electric lighting plant:—

Dowson Economic Gas and Power Co.—Gas plant.
General Electric Co.—Dynamos.
Wells Bros. and Co.—Gas engine, piping, &c.
Laurence, Scott and Co.—Switchboards.
Fuller-Wenstrom Electric Co.—Motor.
Western Electric Co.—Cables.

APPOINTMENTS VACANT AND FILLED.

Particulars are given in an advertisement on another page of the requirements of the electricity and public lighting department of the St. Pancras Vestry, who require (1) a prime cost and third assistant clerk at a salary of £100 per annum, increasing by £5 to £120 per annum; (2) a shorthand and correspondence clerk commencing at £90 per annum, increasing £5 annually to £120 per annum; (3) a boy clerk. Forms of application for (1) and (2) can be obtained at the offices, 57, Pratt-street, and have to be returned by Nov. 19. Forms of application for (3) can be had at the Vestry Hall, Pancras-road, London, N.W.

The National Boiler and General Insurance Co. require an electrical engineer for electrical machinery insurance and general engineering work. Salary £150 to £175 per annum. Further particulars are set out in our advertisement columns, and applications must be sent to the chief engineer (Mr. Edward G. Hiller), 22, St. Ann's-square, Manchester.

The Leyton District Council require an engineer-in-charge for their electric light works. Commencing salary 35s. per week, increasing by annual increments of 2s. 6d. per week to 50s. See advertisement.

Competent wiremen are also required at Leyton. See advertisement.

A junior assistant is wanted for the meter and testing department of the Brighton Electricity Works. See advertisement.

The St. Giles and Bloomsbury (London) Guardians require an engineer, with knowledge of electric lighting work. Salary £2. 10s. per week. Applications to 57, Broad-street, W.C., by 15th inst.

The Worcester Electric Light committee will recommend the City Council, on Wednesday next, to appoint Mr. F. Harman Lewis, late of Wolverhampton, to the position of borough electrical engineer, vacant by the resignation of Mr. E. T. Ruthven Murray, who has been elected to fill a similar position at Willesden. There were 29 applications, but this number was reduced to five by the committee, whose choice ultimately rested on Mr. Harman Lewis. The salary attached to the position is £350 per annum. Mr. Harman Lewis, who was born in 1863, was educated at Epsom College for the medical profession. In 1883, Mr. Lewis gave up his medical studies, and went through a course of training in electrical engineering at the Finsbury Technical College, obtaining the college certificate. In 1886 he entered the works of the E.P.S. Company. In 1889 he was for a time upon the staff of the Westminster Electric Supply Corporation, then for about two years an assistant engineer to the St. James's and Pall Mall Company's station, and in 1891 was appointed electrical engineer to the Corporation of Hull, for

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whom he designed and carried out an electricity works on the three-wire sytem at a cost of about £35,000. In 1893, Mr. Lewis went to Wolverhampton as borough electrical engineer, and has designed and laid down electricity works on the 2,000 volt direct-current system, for public and private lighting, at a cost of about £40,000.

The Liverpool City Council have appointed Mr. W. H. Collis assistant electric tramway engineer at a salary of £240 per annum. Mr. M. Pattern has been appointed motor inspector.

Mr. A. S. Black has been appointed assistant engineer at the Derby Corporation electricity works, in place of Mr. H. G. McHaffie resigned. Mr. Hugessen has been appointed mains superintendent.

BUSINESS NOTICES.

Messrs. Williamson and Joseph (Limited) have acquired the sole rights of the "Prentice" patent magnetic automatic cut-out. The firm have in preparation a revised list giving a description of these instruments, which can be obtained on application to Northampton Works, Northampton-grove, Canonbury, London, N.

The partnership business hitherto existing between Thomas Coombe Moore, George Warren and Charles Henry Mathews, electric light fittings manufacturers, &c., trading as T. C. Moore and Co., 2, Longford-street, Regent's Park, N.W., has been dissolved.

We are informed that, for the purposes of reconstruction, the British Incandescent Electric Lamp Co. has gone into voluntary liquidation, and the New British Incandescent Electric Lamp Co. has now taken over the business of the old company. The offices of the new company are at 55, Suffolk House, Laurence Pountney-hill, E.C., and the works are at Willesden, where new machinery is being put down.

It was resolved at a meeting on Oct. 17 to voluntarily wind up the Niagara Battery Co. (Limited) for purposes of reconstruction and to appoint Mr. F. Offor, 139, Cannon-street, as liquidator. This resolution has been confirmed.

BANKRUPTCIES, LIQUIDATIONS, &c.

The public examination of Jacob Gütman (otherwise Jacob Goodman), lately trading as J. Goodman and Co., was held at the London Bankruptcy Court last week. Particulars of this failure were given on p. 57 of our last issue. The bankrupt said he came from Germany in 1889, and commenced business in 1893—first at 3, Broad-street-buildings, E.C., next at 20, New Broad-street, and finally at 48, Commercial-street, E. His failure was due to loss on the trading, want of capital, and to the proposed arrangement for the discharge of his debts by the company having fallen through. Examination concluded.

A first and final dividend of 1s. 10½d. will be payable on the 17th inst. at 3, Grimshaw-street, Burnley, in the bankruptcy of J. Fletcher and J. A. Hirst, electrical and mechanical engineers, Bankfield Works, Curzon-street, Burnley, late Northgate Electrical Works, Chester, and 17, Full-street, Derby.

In the bankruptcy of E. H. Berry, electrical engineer, 22, St. Matthew-street and St. James's Hall, Burnley, the trustee (Mr. H. L. Price, 79, Mosley-street, Manchester) has been released.

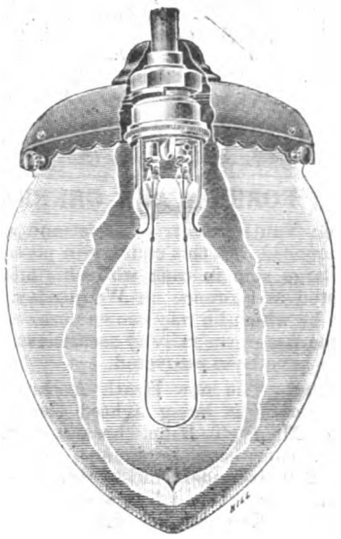
Messrs. C. S. Madan, Salford; E. C. Carter, St. Albans; and R. Stanton, the younger, London, have been appointed a committee of inspection to act with the Official Receiver and Liquidator of the Cox Thermo-Electric Co. (Limited).

In the Chancery Division, on Wednesday, Mr. Justice Wright made an order that the voluntary winding-up of the Apostoloff Automatic Telephone Parent Syndicate (Limited) be continued under the supervision of the Court.

In the Chancery Division, on Wednesday, Mr. Justice Wright said that he wished to state publicly (for the benefit of liquidators in voluntary liquidation which had been continued under the supervision of the Court), that steps would shortly be taken requiring them to make reports of what they had done. There had been about 143 cases of supervision orders since the winding-up registry had been established down to the end of 1897, and in most of these nothing had resulted. He was going to call on the liquidators in all these cases to make reports on affidavit as to the state of the liquidation and the funds in their hands, and by summonses require their attendance with reference to these matters.

Plant Catalogue.—We have received from Messrs. Drake and Gorham, 66, Victoria-street, London, S.W., their latest catalogue of electric lighting plant, which, in addition to plant, apparatus and accessories for lighting, deals with electric telephones and bells. The catalogue also contains prices of working cost and of initial outlay, specimen estimates, and a thumb index to the subjects in the book affords ready reference facilities. Before the list is sent out a charge of 1s. 6d. is made, which is refunded on receipt of first order. The demand for apparatus supplied by Messrs. Drake and Gorham has necessitated further extension to the offices in Victoria-street.

Ediswan Lamp Fitting.—We give below a sketch of a new fitting, introduced by the Edison and Swan Co. for high candle-power lamps. This fitting has been specially designed for use with incandescent lamps of 200 and 300 c.p., and is claimed to be



especially suited for outside and shop window illumination. The globe carrier is so arranged that the internal part of the fitting is not affected by damp or the weather, whilst the topmost hood of the carrier can be adjusted to admit of sufficient ventilation.

Code Telegraphy.—We have received from the Mercantile Publishing Co. (Limited), of 30, Walbrook, London, E.C., a copy of a work which has been prepared to assist those who, in the course of their business, have occasion to send and receive telegraphic messages in code. The work is called "The Official Vocabulary in Terminational Order." It will be remembered that some four years ago the International Bureau at Berne issued a not altogether satisfactory vocabulary of code words, and it was felt by many that the selected words were particularly liable to terminational error. Merchants and other code users will, therefore, welcome a work which will prove of great assistance in locating errors and mutilations where these occur in the terminational letters. In the book under review all words with similar endings are brought together. The price of the book is 40s., bound in cloth.

Society of Model Engineers.—Under this title a new society has been formed. The annual subscription is 10s. 6d., and applications for membership should be addressed to the secretary (Mr. H. Sanderson), "The Mount," Ealing, London, W.

The "Engineering Magazine."—The contents of the November issue of this magazine include "The Chinese and Recent Industrial Progress in China," by J. S. Fearon and E. P. Allen; "The Steel Foundations of the Shipbuilding Industry," by J. Riley; "Great Railway Stations of England," by T. Cargill; "Essential Elements of Economy in Steam Power Installation," by W. Cooper; "Effective Systems of Finding and Keeping Shop Costs," by H. Roland; "The Mining, Smelting and Refining of Nickel," by T. Ulke; "The Latest Improvements in the French Lighthouse System," by J. Boyer; "Continuous Operation in the Manufacture of Window Glass," by R. Linton; "The Evolution in Central Station Practice," by C. F. Scott; and "Sanitary Principles in the Construction of Isolation Hospitals," by G. A. Middleton. The usual review of the World's Engineering Press is also given. Copies of this number may be had at the offices of *The Electrician*, 1, 2 and 3, Salisbury-court, Fleet-street, London, E.C.

Enclosed Arc Lamp Patents.—We have received the following extract from the *Wall-street Journal* (New York) for publication:—"In the suit of the Marks Enclosed Arc Light Co., New York, *versus* Washington Mills Co., New York, a decision has just been rendered in favour of the complainant. The suit was begun in the United States Circuit Court, Sept. 10, 1897, and the decree granted to the Marks Company by Judge Coxe on Oct. 18, 1898. The patent infringed is No. 520,996, of Marks and Ransom, dated June 5, 1894. This patent broadly covers the method of operation used in all modern enclosed arc lamps. The Washington Mills Co. were users of the Kinsman lamp, sold by the Electric Construction and Supply Co., New York. The decision peremptorily stops the sale of unlicensed enclosed arc lamps by the Kinsman Company, and also involves the payment of damages by the defendant. This decision is understood to be unfavourable to General Electric."

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and tele-

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phone wire and material, but not including electrical instruments or machines, which are not separately specified) from Nov. 2 to Nov. 8, with the ports of destination :—

Argentina—Rosario, £239. *Australasia*—Adelaide, £1,148 ; Brisbane, £414 ; Launceston, £90 ; Perth, £301 ; Sydney, £655 ; Wellington, £942. *Belgium*—Ostend, £62. *Brazil*—Rio Janeiro, £65. *Canada*—Montreal, £123. *Ceylon*—Colombo, £20. *China*—Shanghai, £156. *France*—Boulogne, £17. *Germany*—Hamburg, £120. *India*—Bombay, £54 ; Calcutta, £255. Madras, £16. *Japan*—Yokohama, £2,216. *Malta*—£86. *Roumania*—Sulina, £63. *Russia*—St. Petersburg, £30. *South Africa*—Cape Town, £96 ; Durban, £775 ; East London, £351. *Sweden*—Gothenburg, £22 (telegraph material) ; Stockholm, £470. Total £8,786, against £11,464 in the corresponding week last year (Nov. 3 to Nov. 9).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Arrest.—Claude Vautin, electro-chemist and metallurgist, who, as previously announced, left this country in possession of valuable securities and a large sum in cash while his affairs are in bankruptcy, was arrested at Florence on Wednesday, travelling under one of the names by which he was known here—Charles Vaughan. It is stated that the American railway securities and a considerable portion of the cash have been recovered.

Asylum Lighting.—The new Heath Asylum, Bexley, of the London County Council is being lighted electrically under the superintendence of Mr. G. T. Hine, the architect, and Mr. A. A. Campbell-Swinton, consulting engineer. The contract, which includes about 3,200 incandescent lamps, generating plant of 300 kilowatt capacity, and two 1,500 ampere-hour batteries, has been placed with the Edmundson's Electricity Co. The lamps will be of 200 volts, connected on the three-wire system.

Barrow-in-Furness.—Applications for electric current are coming in so rapidly that already the question of extensions of the plant is being considered.

Battersea (London).—The Vestry have received a notification from the County of London Company of intention to apply for a provisional order for the district.

Brierley Hill.—The District Council has resolved to oppose all applications for provisional orders for this district, and the Lighting committee has been authorised to consult an electrical expert as to the Council itself applying for an order.

Brigg.—The District Council, which is considering the question of purchasing the gas works, has instructed a committee to report fully upon the subject of erecting electricity supply works.

Brighton.—The West Pier is to be lighted electrically, current being taken from the Corporation mains.

Bury St. Edmunds.—The Town Council have decided to adopt a modified electric lighting scheme, estimated to cost £16,000. This step has been taken owing to the attitude of the Local Government Board, who refused to sanction the original scheme.

Carlisle.—At the meeting of the Town Council last week the appointment of Mr. C. D. Burnet as borough electrical engineer was approved. The commencing salary is £250 per annum, and Mr. Burnet is to have liberty to take not more than two pupils. On the tramway question, Prof. Kennedy wrote that the alternative to horse haulage was overhead electric traction, and advised the latter.

Cheltenham.—A Local Government Board inquiry was held here on Friday into the application of the Town Council to borrow £17,000 for electric lighting purposes. The town clerk (Mr. E. T. Brydges) stated that the amount already borrowed was £68,152, and in consequence of the demand for current further extensions were necessary. The Mayor (Alderman Norman) said that in 1895-6 47,700 units were sold, the gross receipts being £1,050 ; in the following year 90,300 units (£2,040) ; in the next 140,600 units (£3,215) ; and a moderate estimate for the current year gave 204,200 units and £5,020 as the receipts. After allowing rebates and for the street arc lighting, he put the receipts for the current year at £6,600 net. There was a deficit of £622 on the first year's trading ; in the following year a surplus of £54 ; in the next a surplus of £1,262, and he put the figure this year at £3,300, sufficient to pay the whole of the interest and the annual sinking fund. The borough electrical engineer (Mr. Hamilton Kilgour) gave technical particulars, and, there being no opposition, the inquiry closed.

China.—Like the Moslems in Morocco, the Chinese are beginning to look kindly upon the developments of civilisation. Following on the establishment of a number of railways and other engineering works, we learn that the Westinghouse Electric Co., of America, has obtained a contract for the equipment of a large woollen mill at Tientsin with plant and apparatus for electric lighting and driving.

Chorley (Lancs.).—The Town Council have created a special committee to formulate an electric lighting scheme for the district.

City of London.—The Court of Common Council have referred the application of the Metropolitan Electric Supply Co. for a provisional order for the supply of electricity within the City to the Streets Committee.

The Streets Committee have been asked to consider and report upon the desirability of applying to the Postmaster-General for a licence to establish and work a telephone service either solely or in conjunction with the County Council.

From the annual report of the city electrical engineer and inspector (Mr. A. A. Voysey) it appears that, during the past year, 78 meters were submitted by consumers to the engineer for testing, and of these 34½ per cent. were slow, 22½ per cent. fast, and 43 per cent. approximately correct. The total number of arc lights in the City is 500. The lamp failures (1,468) is more than double what was the case in the previous year. The proportion of group failures and single lamp failures is reported to have increased during the year. The company has taken steps to remedy these defects. An improvement in the continuity of the supply to private customers is reported. At the end of 1896 there was the equivalent of 247.785 8-c.p. lamps connected to the company's mains, at the end of 1897 296,012.

Colliery Lighting.—Messrs. Kenneth and Co. have put down an electric lighting plant at their Mongomeriefield Colliery, Dreghorn, N.B., to provide current for lighting their brickworks, colliery, and other works and offices.

Constantinople.—The *Financial News* of the 9th inst. states that a company is being formed to acquire a concession for supp'ying electric current for light and power in Constantinople.

Derby.—The new borough electrical engineer (Mr. T. P. Wilmshurst) entered upon his duties on the 31st ult.

Diss.—The District Council has authorised the Suffolk Electricity Supply Co. to employ overhead wires in the distribution of electric current.

Dundee.—The receipts from the electricity department for the six months ended October amounted to £2,051. 8s. 7d., an increase of £467 on the corresponding period last year.

Durham.—At a special meeting of the Town Council on Monday the question of obtaining electric lighting powers was discussed. From a report by the Council's engineer (Mr. W. C. C. Hawtayne) the total cost of plant of 200 kilowatts capacity is given as £17,350 and of 350 kilowatts £2,000 additional. The gross revenue was estimated at £2,956. 12s., current being supplied at 5½d. per unit. The working costs would be £1,767. 10s., leaving a gross profit of £1,189. 2s. If the larger plant were installed, the working expenses would be £1,820, and the net profit £112. 17s. It was decided to obtain a provisional order.

Enfield.—The committee recently appointed by the District Council to consider the advisability of obtaining a provisional order has reported in favour of the proposal.

Formby (Lancs.).—A proposal to form a company for supplying electric current for both public and private lighting has been referred by the District Council to the Lighting committee for consideration and report.

Fulham (London).—The County of London Company and the House-to-House Company have notified the Vestry of their intention to apply for provisional orders for this district. The Electric Light committee is considering the notices.

Glasgow.—Electric lighting competition has, evidently, very little effect upon the consumption of gas in this city, as the Corporation are about to spend £1,000,000 in new gasworks. The electricity works were opened in 1893, but still the consumption of gas continues to increase at a rapid rate, as is shown below :—

Minimum Consumption of Gas per 24 hours in Cubic Feet.

1874	9,162,000	1894	22,853,000
1884	13,700 000	1898	31,354,000

The annual consumption has increased from 1,305,000,000 cubic ft. in 1874 to 4,800,000,000 in 1898.

Owing to the extreme satisfaction which the Mitchell-street and Springburn tramway has given, resulting in a saving of 3d. per mile on the working expenses, the Tramways committee decided on Wednesday to recommend the Council to construct an electric tramway from Glasgow Cross to Govanhill. The electric line between Parliamentary-road and the Cross is approaching completion and is to be continued to Govanhill.

Glossop.—The Town Council are to apply for a provisional order, but it has been decided to enter into negotiations with a company for a transfer of the order as soon as obtained.

Great Grimsby.—There was a further discussion by the Town Council last week of the conditions for re-leasing the tramways to the local tramways company. The lines are to be re-laid and equipped electrically, and the Corporation are to supply electric current. Subject to some slight modifications the seal of the council is to be affixed to the agreement with the company.

Halifax.—The Town Council have been petitioned to extend the electric tramways into the Greatland district. In the course of his address on Wednesday the Mayor said that the electric tramways recently instituted were proving very satisfactory, the profit for the quarter amounting to £1,336.

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Hampstead (London).—The report of the Lighting committee on the formation of a special reserve fund in connection with the Vestry's electricity undertaking was presented at the last meeting. The report favoured the creation of a fund, and the committee further stated that they were strongly of the opinion that the whole of the profits arising from the undertaking should be set aside to form this fund. The recommendations were agreed to unanimously. The receipts from the sale of current for the Michaelmas quarter amounted to £3,620. 10s., compared with £2,446. 11s. 8d. in 1897.

Hastings.—The Town Council have decided to apply for powers to construct and work electric tramways. It is not, however, proposed to put down a line on the front, a proposal which has, so far, met with considerable opposition.

Heckmondwike (Yorks.).—The District Council, which has decided to engage an electrical expert to prepare an electric lighting scheme for the district, has asked three engineers to wait upon and be interviewed by the Board.

Hull.—The City Council have authorised the Works Committee to take over from the present contractor the work of constructing the new electric tramway system. The Council's works department will complete the contract.

Hythe.—The Town Council will apply for a provisional order to prevent a company from obtaining electric lighting powers for the district.

Imperial Penny Post.—The Indian Government has decided to join in the scheme for Imperial penny postage.

Islington (London).—A motion will be submitted at the next meeting of the Vestry recommending that the cost of extending the street lighting to the Shoreditch boundary be ascertained.

Killarney (Ireland).—Our readers will probably remember the long and acrimonious contest which took place two or three years ago between the electric lighting and gas interests in this town. For six months the town had the advantage of electric and gas lighting; but, owing to an informality in the contract with the Electric Lighting Company, its supporters on the Township Commission were surcharged with the cost of electric lighting. Negotiations are now proceeding for the amalgamation of both concerns and the formation of a new company to undertake both electric and gas lighting in the district.

Kingstown (Dublin).—The question of formulating an electric lighting scheme will be taken up by the new Town Commission. A provisional order was obtained by the Commission in 1896, but no attempt has been made to comply with its provisions. Notice has now been given by Messrs. Porte, Sykes and Co., of Dublin, to obtain an order. This application is to be opposed by the Commission.

Leeds.—At the meeting of the City Council on Wednesday it was reported that the negotiations for the purchase of the undertaking of the Yorkshire House-to-House Electricity Co. had been completed.

Leyton.—The electric light mains are to be considerably extended. The Electric Light committee reported at the last meeting of the Council that the additional battery of Hart accumulators had been laid down, and was now working; also that the new engine was being erected, and would be working in about a fortnight.

Light Railways.—The Tyldesley, Atherton and Leigh Rural District Councils and Lowton Parish Council have approved the proposal to connect Liverpool, St. Helens, Leigh, Wigan, Bolton and intermediate towns by means of an electric tramway system. The Leigh Urban Council have appointed a sub-committee to consider the matter.

A project for the construction of a light electric railway between Camborne and Redruth has been submitted to the Camborne and Redruth District Councils.

The Board of Trade have confirmed the order of the Light Railway Commissioners to construct a light (electric) railway between Dudley and Stourbridge.

The Board of Trade on Tuesday heard the objections to the order of the Light Railway Commissioners authorising the British Electric Traction Co. to construct a light (electric) railway between Coatbridge and Airdrie. Sir Courtenay Boyle presided. The objectors were the North British and the Caledonian Railway Companies who were legally represented. Mr. Littler, Q.C., for the Caledonian Co., said that the promoters' proposals raised a very serious question for the main line companies throughout the kingdom generally, as, in the view of the objectors, the Light Railways Act was never intended to apply to schemes like the present which was of a highly competitive character with existing railways. He took the preliminary objection that the Commissioners at the local inquiry had wrongfully refused to hear the opposing railway companies on the question of competition, and he wished the Board of Trade's decision on the matter before going fully into the merits. After discussion, it was agreed that, inasmuch as decision in favour of the company's contention would involve the remission of the order to the Light Railways Commission for rehearing, which was not desirable, the objection should be waived. Mr. Littler pointed out that the Light Railways Act was not intended to apply where the existing communications were sufficient. Communications in the Airdrie and Coatbridge districts were, he held, sufficient, for both railway companies had a large number of stations in it—the Caledonian no fewer than five, and the North British as many as six. When the act was passing through Parliament, Mr. Ritchie had stated that the proposals had reference to railways whose cost would be under £3,000 a mile, while Lord Dudley in the House of Lords had pointed out that the bill was proposed in the interests of agricultural districts, and emphasised the fact that it provided that the Board of Trade required that schemes affecting existing railways should be submitted to Parliament by bill. Mr. Littler argued that the present was a case that came clearly within section 9 of the Light Railways Act, particularly within sub-section 3 of that Act. He went on to point out that the order proposed to give the company power to carry goods, and as the line was laid out the promoters would be in a position to form connections with public works now served by the existing railway companies. For the North British Co. Mr. Balfour Browne pointed out that their line directly paralleled the proposed line for a considerable distance along the canal, and that between the North British line and the proposed line there were situated works that yielded many thousands of pounds per year to the North British. If this light railway were made, it would be possible for the promoters to abstract much of that traffic. He went on to contend that to all intents and purposes the present proposals were tramway proposals under the Act of 1870, and as such ought to come before Parliament. Evidence was given by prominent residents that a feeling existed in the district in favour of the tramways and that a considerable portion of the present traffic could not be accommodated by the facilities provided by the railway companies. Provost Sharp, of Coatbridge, said there was a strong feeling in the district in favour of the light railways scheme. Ex-Provost Connor said he had called a meeting in connection with the opposition of the railway companies to the order, and he had never in the whole of his public experience seen a more unanimous feeling in support of any proposal. Mr. Sidney Morse, for the British Electric Traction Co., addressed Sir Courtenay Boyle in support of the order. He contended that what was proposed was a light railway, which would serve traffic which was not at present accommodated, and could not be accommodated, by the existing railways, and consequently could have no effect on these railways. Mr. Littler and Mr. Balfour-Browne maintained that the application was one for a tramway in the guise of a light railway, and they asked that the order should not be confirmed by the Board of Trade, because, as an application for a tramway, it should go before Parliament in the shape of a bill or provisional order. Sir Courtenay Boyle intimated that he would take time to consider, and would report to the Board of Trade on the preamble. The decision will rule the Broughty Ferry and other orders, which the railway companies object to on the ground of competition.

Liverpool.—The inquest upon the lad William Strong, who was killed in jumping off an electric trailer car at Liverpool last week, resulted in a verdict of accidental death, the jury adding a rider as follows:—"We think that it would be advisable to have lifeguards in front of the wheels of the trailer cars as well as in front of those of the motor cars."

London County Council.—At Tuesday's meeting the Finance committee reported on an application from the Hampstead Vestry for a loan of £51,343 for electric lighting purposes for the parish. It was agreed to advance £10,491. It was also agreed to loan the Islington Vestry £6,785 for similar purposes.

The telephone question was then discussed, to which reference is made on another page. In reply to the discussion which followed, in which reference was made to the success achieved by Glasgow in its application for a licence, Mr. J. W. Benn said he could only deplore the fact that Glasgow had succeeded in getting its licence, while, as far as London was concerned, they were unfortunately no forwarder. It was now five years since the Council first took up the question of the telephone service, and the delay in the settlement of the question was a very serious matter for London. The cities in the provinces were mostly getting the service for 10 guineas a year, and if they took £12 as the average rate for London, it would be found that the citizens of the metropolis were paying £50,000 or £60,000 more a year for the telephone than they ought to be doing. The National Company, in order to secure the monopoly it now enjoyed, had to purchase some 13 other companies, and upon going into figures he found that London had to pay the dividend on the watered capital consequent upon those purchases. The purchase of those 13 companies cost the National Company £3,000,000, and after carefully dividing the expenditure into what he might call the constructional part, and that which represented the watered section he found that the former represented £1,800,000 and the latter £1,400,000. In order to pay 6 per cent. upon that watered capital the company had to raise

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£83,000 a year, and if justice was done London only ought to be called upon to provide £17,000 out of that sum, but as a matter of fact London had to find no less than £76,000 every year to pay dividend on watered capital. A large number of persons were anxious to get upon the telephone in London even at the present price, but they were told that they could not have the service because the Council had refused to give the National Company facilities in respect to underground wires. That, however, was not the fact. The real truth was that they were prepared to give consent in all such cases provided that the company would place them upon like terms with Manchester, Leeds, Liverpool or other places in respect to charges. He could only hope that the block which at present prevented a fuller use of the telephone in London would shortly be removed, and if that recommendation were passed all possible pressure would be put upon the Postmaster-General in order that London might not much longer be placed at such a serious disadvantage with provincial cities.

On the subject of electric tramways Mr. Benn said a letter had been received from the London United Tramways Co. in which the Directors said that, provided they could obtain the consent of the Board of Trade, they would be prepared to carry out, as an experiment, an underground electric system on the Hammersmith section, if the Council would enlarge the scope of its resolution so as to include the working of the Goldhawk-road section by the overhead system, and would extend for seven years the purchase period with respect to the lines. They further suggested that the Council might sanction the use of the overhead system on the Goldhawk-road section, in addition to Uxbridge-road, leaving the Hammersmith branch entirely out of the question for the present. This letter would be taken into consideration at the next meeting of the Highways committee.

Llanelly.—The District Council have received a communication from the Local Government Board pointing out that, as nothing has yet been done to comply with the terms of the Llanelly provisional order (1891) it devolves upon the Board to say whether the order shall be allowed to remain any longer in force. Before taking action they invite the Council's explanation of the delay.

Maidstone.—The Town Council have engaged Messrs. Kincaid, Waller and Manville to prepare a report on the electric lighting and refuse destructor project, at a fee of 50 guineas.

Manchester.—A special meeting of the City Council is to be held on the 16th inst. to approve the proposed omnibus bill to be promoted next session, in which powers are sought for the better lighting of culs de sac, the development of the electric light undertaking and the working of telephones under licence from the Post Office.

Marylebone (London).—Last night the Vestry discussed a special report from the Electric Lighting committee, which stated that they had good reason to believe that the Board of Trade would not grant them a provisional order to supply the parish with electric light, and they therefore recommended that the committee have power given to it to obtain a private bill to enable the Vestry to supply the parish with electricity. Mr. Brooke Hitching, C.C., moved the adoption of the report, and Mr. White pointed out that the Vestry could not instruct its solicitor to take preliminary steps to obtain the act until, first of all, the Vestry had discussed the question and decided whether they would go for the proposed act or not. They could not decide such a question without 28 days' notice being given that such a question was to be discussed. Several members urged that action should be taken at once, or else the Vestry would have to wait another twelve months. The report was ultimately adopted by 40 to 7.

Mill Lighting.—Messrs. Alexander Cowan and Sons, papermakers, Valleyfield, Penicuik, N.B. (and London) have recently put down new plant for the electric lighting of the whole of their large establishment. The installation, which has been carried out by Messrs. Lowdon Bros., is said to be the largest in any papermaking works in Scotland. The plant consists of a 100 H.P. engine and three shunt-wound continuous-current dynamos. The lighting is effected by means of 36 2,000 c.p. arcs and about 1,000 incandescents of from 16 to 50 c.p.

Municipal Honours.—In the published list of mayors for the year 1898-9 the names of the following gentlemen connected with electrical and engineering enterprise (either municipal or private) appear :—Ald. Geo. Norman, chairman of the Electric Lighting committee at Cheltenham ; Ald. W. Bruce (re-elected), chairman of the Electric Lighting committee at Sunderland ; Ald. H. Coltman, of H. Coltman and Co., engineers, Loughborough ; F. T. Garrett (re-elected), of F. T. and A. Garrett, Dunstable ; W. Oulton, chairman of the Electric Tramways committee at Liverpool ; Sir W. Crundall, chairman of the Dover Electricity Supply Co. ; and H. M. Julian, of H. M. Julian and Sons, Basingstoke.

Nelson.—The Town Council have decided to apply for power to construct a light (electric) railway from the terminus of the Burnley and district tramways to the boundary of Colne.

Northallerton (Yorks).—A company has been formed for the purpose of erecting electricity supply works in this town. The question of public electric lighting is to be considered by the District Council.

Paisley.—The Town Council have authorised the Electric Lighting committee to enter into negotiations for the acquisition of additional land for the extension of the electricity supply works.

Police.—At the Westminster (London) Police Court on Friday, John Limbrey Higgs, of Delahay-street, Westminster, appeared to an adjourned summons charging him with having committed perjury in his examination in respect to the liquidation of the I.E.S. Accumulator Co., of which he was a director. Further formal evidence was submitted, and the summons was adjourned for a fortnight.

Provisional Order Notices.—Official notice of intention to apply for provisional orders has been given by the Bermondsey and Plumstead (London) Vestries, the Hartlepool and Longton Corporations, the Runcorn and Walker District Councils, and the Weston-super-Mare and District Electric Light and Power Syndicate for Weston-super-Mare.

Rathmines (Dublin).—A Local Government Board inquiry was held on Monday into the application of the Township Commissioners to borrow £50,000 for electric lighting purposes. The secretary (Mr. F. P. Fawcett) appeared in support of the application, and gave particulars of the scheme and of the expenditure involved. The consulting engineer (Mr. Robert Hammond) gave technical details. There was no opposition.

The Township Commissioners have received Mr. Robert Hammond's report on the electric lighting tenders.

St. Helens.—As announced in another column a new company entitled the New St. Helens and District Tramways Co. (Limited) has been formed for the purpose of acquiring the tramways in St. Helens. The lines are to be equipped electrically by the Corporation, and are to be worked on lease by the new company.

St. Pancras (London).—The Vestry has decided to increase the salary of the chief electrical engineer (Mr. Sydney W. Baynes) from £600 to £700 per annum. This figure is to be afterwards increased to £800 by two annual increments of £50. The question of revising the salary of the chief clerk of the electricity and public lighting department is at present under the consideration of the Electricity committee. The Vestry has also decided to make some additions to the clerical staff, and particulars of the requirements of the department are set out in an advertisement elsewhere.

Sale.—Some time ago the Electric Lighting committee applied to the Manchester Corporation for terms for supplying current in the Sale district. Apparently matters have drifted, and the policy of the committee does not commend itself to some members of the Council. Mr. Wells, the chairman of the committee, however, recently defended the course that had been adopted. Great strides were, he said, being made in electrical engineering, and the committee were anxious to move forward with caution. He thought the wisest course was to consult an expert and obtain estimates for a scheme of their own. The chairman of the Council thought that, if they were to wait for every possible improvement in electric plant and apparatus, they might wait for ever. The committee's proposal was approved.

Sleaford (Lincs.).—The District Council have complied with the request of the Tradesmen's Association and have appointed a committee to arrange with the Association for the erection of electricity supply works.

Southport.—The Town Council are applying for a provisional order enabling them to adopt electric or other form of mechanical traction on the local tramways. The scheme involves an expenditure of about £60,000.

Tanfield (Yorks).—At the meeting of the District Council last week it was decided to enter into an agreement with a company for the electric lighting of the district.

Telephone Municipalisation.—In their applications to Parliament for power to establish and work a telephone system, the Glasgow Corporation are seeking powers, not only for the City of Glasgow, but also for the neighbouring burghs and districts comprised within the counties of Lanark, Renfrew, Dumbarton and Stirling, as far west as Paisley and Renfrew, as far south as Mearns, as far north as Kirkintilloch and Kilsyth, and as far east as Rutherglen.

The Lord Provost's Committee of the Edinburgh Town Council resolved on Wednesday to recommend the Council to apply for Parliamentary powers to equip and work a telephone exchange system.

Waterloo (Liverpool).—The District Council have entered into an agreement with the Liverpool Overhead Railway Co. for constructing and working a system of electric tramways in this district. The Council will obtain the necessary Parliamentary powers, construct the permanent way, and lease the lines to the company. The company will pay the cost of obtaining the order, and will provide the electrical equipment.

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Watford.—In a report by Mr. W. C. C. Hawtayne on the progress of the electricity supply works it is stated that the station will not be completed before the end of January, and the Council will probably be in a position to undertake the supply of electric current continuously by the end of February. High-street, Queen's-road, and St. Albans-road are to be lighted by means of 40-c.p. incandescents on columns, placed 50 yards apart, and two arc lamps are to be erected in the market place and one in the station-yard as an experiment.

Wath (Rotherham).—A provisional order is to be obtained by this District Council.

West Hartlepool.—The Mayor has announced that, as the plans for the electricity supply works had not given satisfaction, it had been decided to invite Prof. Kennedy to visit the borough, and prepare plans for a scheme, similar to that at Sunderland and at a similar cost. It was also reported that the General Electric Tramways Co. had consented to the use by the Council of the tramway poles for supporting arc lamps.

Whitechapel (London).—The Electric Lighting committee recommend the District Board of Works to purchase Messrs. Ind, Coope and Co.'s premises in Osborn-street, for £10,000, as a site for electricity supply works.

Workhouse Lighting.—The Islington (London) Guardians have decided to put down an independent electric lighting installation at their infirmary in St. John's-road, Holloway.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom all information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

October 27, 1898.

22,578. E. RUSHTON and R. E. GRIFFIN. Cleethorpes. A new or improved method of bonding or connecting rails used for electrical traction and the like.

22,599. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in electric meters. (C. D. Haskins, United States.)*

22,600. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in incandescent electric lamps. (G. B. Painter, United States.)*

22,601. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in electric arc lamps. (H. C. Spinney, United States.)*

22,603. F. M. LONG and E. SCHATTNER. London. Improvements in prepayment electricity meters.

22,622. Q. MARINO. London. Improvements in or relating to electrolytic baths.

October 28, 1898.

22,664. E. M. MUNRO, H. BRECKNELL and H. J. ROGERS. Bristol. New or improved appliances for use in securing the copper bonds or conductors in electric tramway rails.*

22,683. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in couplings for electric conductors. (F. E. Case, United States.)*

22,697. H. D. WIBRATTE and A. F. LANASPÈZE. London. Improvements in apparatus for regulating the intensity of electric currents.

22,699. W. B. SAYERS, H. A. MAYOR and MAYOR AND COULSON (LIMITED). London. Improvements in dynamo and electric machines.

22,700. H. EDMUNDS. London. Improvements in the manufacture of tubes or conduits, or the like, more especially intended for containing electric cables or conductors.

October 29, 1898.

22,728. B. H. THWAITE. London. Improved means for effecting the collection and transmission of high-potential electricity.

22,729. B. H. THWAITE. London. Improvements in methods having for their objects the electrical propulsion of tramway cars and other vehicles, and in apparatus therefor.

22,762. C. E. B. HOLT and A. J. TAYLOR. Bradford. Improvements in the method of and apparatus for indicating and arresting the speed of electric tramway cars and the like vehicles.

22,777. C. FELDMANN. London. An improved light distributor or reflector for electric incandescent lamps.

22,794. J. D. F. ANDREWS. Fulham. Improvements in electric railways or tramways.

22,799. F. H. DAVIES and R. S. DRAYCOTT. London. New or improved method of and means for switching on and off the electric current in surface contact systems for electrically-propelled vehicles, and safety "cut-out" for same or other surface contact systems.

22,802. L. J. STEELE, Sir J. B. MAPLE, BART., and J. VERITY. London. Improvements in or connected with reflectors for incandescent electric and other lamps.

22,803. L. J. STEELE, Sir J. B. MAPLE, BART., and J. VERITY. London. Improvements in or connected with incandescent electric lamps.

October 31, 1896.

22,820. J. ENRIGHT. London. Improvements in the means of propelling tramcars by electricity.

22,836. H. SIMON. Manchester. Improvements in electric switches.

22,858. E. E. PRESTWICH and L. N. BURT. London. Combined apparatus for regulating the supply of electricity to lamps, motors, and other electrical apparatus.

22,870. S. B. APOSTOLOFF. London. Improvements in electricity meters.

22,872. J. LOISELET. London. Improvements in electrolytical apparatus.

22,884. E. ANDREAS. London. Improvements in or relating to means for making electrical connections.

November 1, 1898.

22,936. BAIRD and TATLOCK. Glasgow. An arrangement to act as a meter for one or more electric lamps, the object being to register the time during which the lamp or lamps burn.

22,964. A. VANDAM and T. H. MARSH. London. Improvements in plug switches or wall contacts for electric circuits.*

22,987. A. STUTTMANN. London. Improvements in electric arc lamps.

23,000. C. D. ABEL. London. Automatic regulator for electric currents. (F. Back, Austria-Hungary.)

November 2, 1898.

23,043. J. A. FLEMING. London. Improvements in the construction of electrical resistance balances or bridges.

November 3, 1898.

23,143. W. BUCK. London. Improvements in electrical warming pans and like articles.

23,155. H. H. LEIGH. London. Improvements in electric rail brakes and electromagnets therefor. (Gesellschaft zur Verwerthung elektrischer und Magnetischer Stromkraft (System Schiemann and Kleinschmidt) Ad Wilde and Co., Germany.)

23,160. A. SCHLATTER. London. Improvements in transformer switches.*

November 4, 1898.

23,183. W. H. STURGE. Birmingham. Improvements in electrical switches.

23,207. W. H. LOCK, J. PLACE and M. BARR. London. Improvements in electrical heating and melting, specially applicable to the metal pots of linotype machines.

23,233. J. WETTER. London. Improvements relating to electric railways and tramways provided with sectional conductors or surface contacts. (The Elektrizitäts-Aktiengesellschaft-vormals Schuckert and Co., Germany.)*

23,234. J. WETTER. London. Improvements in or connected with electric railways and tramways provided with sectional conductors or surface contacts. (The Elektrizitäts-Aktiengesellschaft-vormals Schuckert and Co., Germany.)*

23,243. P. RIBBE. London. Improvements in and relating to electric accumulators.*

23,249. C. H. PRESTON. London. An improved primary battery for generating electricity.

November 5, 1898.

23,265. E. J. PRESTON. London. Improvements in glow lamps and holders.

23,306. C. LEVETUS. Leeds. Improvements in or relating to galvanic batteries.

23,307. C. LEVETUS. Leeds. Improvements in or relating to galvanic batteries and the like.

23,320. F. W. GOLBY. London. Electromagnetic safety apparatus for lifts, mining cages and the like. (W. Suermondt, Germany.)

23,334. A. PELOUX. London. Improvements in electricity meters for continuous and alternating currents.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1897.

16,220. BELL. Electrically-illuminated signs, advertising media, or the like.

16,428. WHITE and WHITE. Method of and means for employing electric traction on ropeways, railways and like means of transit.

23,267. BRYANT. Apparatus for the electro-deposition of one metal on another.

23,304. WOOD. Magnetic circuit arrangements for dynamo electric machines and other purposes.

23,530. STUART and FORD-MOORE. Bicycle holders or stands and their combination with electrical contact makers.

23,625. WHEATLEY, JAMES and BROWNE. Electrical time-switch.

24,829. SIMPSON. Coin-freed mechanism applicable to gas, electricity and like meters.

25,403. BOULT. (Anderson and Anderson.) Current-collectors for electric railways.

26,646. THE BRITISH THOMSON-HOUSTON CO. (LIMITED) and HOLDEN. Watt-hour meters and in the means for damping in same.

27,261. PRICE and JOHNSON. Covers, caps and lids for closing the entrances of gas, sewer, telephone and electrical supply shafts and holes, gullies and the like.

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27,380. SELLICK. Electrical cut-outs and fittings.
27,387. MARTIN. Electro-therapeutic exercising apparatus. (Date applied for under International Convention, May 10, 1897.)
27,725. LEITNER. Construction of accumulators or secondary batteries.
27,805. WATSON. Electric lamp-holders.
27,806. WATSON. Electrical switches.
27,807. WATSON. Manufacture of switches for electrical purposes.
27,875. SOAMES. Electric lifts, hoists, capstans and the like.
28,458. HOFFMANN. Electrically-controlled submarine mines.
28,839. WOOD. Trolleys used on overhead wires for electric traction.
28,960. STAVELEY and PARSONS. Pushes for electric bells and the like.
29,062. SMITH and GRANVILLE. Apparatus for the manufacture of electric cables.
29,390. SIEMENS BROS. AND CO. (LIMITED), and HOLDEN. Electrical apparatus for transmitting and receiving predetermined messages.
29,676. BLACK. Union box for electric mains for lighting, traction power or other purposes.
30,447. SIEMENS BROS. AND CO., LIMITED (Siemens and Halske Actien Gesellschaft). Supplying electrical energy to railways worked by alternating currents.

1898.

3,806. SWOBODA. Apparatus for making and breaking electric circuits at predetermined times.
8,441. JÄGER. Electric recording system for navigational purposes.
9,466. BRANT. Electric switch.
11,604. STASSANO. Electro-metallurgic production of iron, steel and their alloys with chronium tungsten, nickel, manganese and the like.
13,274. THE BRITISH THOMSON-HOUSTON CO, LIMITED (Steinmetz) Generators for use in systems of electrical distribution.
17,161. MCMILLAN. Automatic electric switches.
17,583. BUGG and DARLING. Electric batteries.
18,137. STENDEBACH. Contact apparatus for electric railways with underground current feed and partial conductors.

COMPANIES' MEETINGS AND REPORTS.

Venezuela Telephone and Electrical Appliances Co. (Limited).

A meeting of this Company was held on Friday, at 28, Victoria-street, Westminster, Sir DOUGLAS FOX presiding. The CHAIRMAN expressed the satisfaction of the Board in being able to announce that the Company had been making good progress. For the twelve months ended June 30 the accounts showed a profit of £9,942, to which had to be added £744 brought forward. After providing the interest on the First and Second Debentures, &c., and the dividend on the Preference shares, there remained £5,499, and the Directors recommended a dividend on the Ordinary shares for the year to June 30th at the rate of 4 per cent. per annum, absorbing £2,800; that the balance of the discount and expenses of the First Debenture issue, amounting to £1,500, should be written off; that £500 be put to reserve and £699 be carried forward. The capital outlay for the year was £1,754 against £8,423 for the previous year. At June 30, the number of subscribers to the Company's instruments was 2,640. The Preference dividend of 8 per cent. and the Ordinary of 4 per cent. were approved.

Western and Brazilian Telegraph Co. (Limited).

The report of the Directors of this Company for the half-year ended June 30, to be presented at the thirty-sixth ordinary general meeting to-day (Friday), states the total earnings for the period amount to £72,692. 13s. 10d., against £59,754. 17s. 8d., an increase of £12,937. 16s. 2d. compared with the half-year to June 30, 1897. The working expenses were £39,376. 7s. 9d., against £44,575. 12s. 4d., a decrease of £5,199. 4s. 7d. Including the amount brought forward (£1,428. 5s. 11d.), and the dividend received upon the shares held in the "Platino" Company, the balance to credit of revenue is £44,914. 2s, from which has been deducted £8,041. 12s. 5d. interest on Debentures and Debenture Stock, £2,016. 3s. for tax, and £1,078. 17s. 8d. has been invested on account of the Debenture Stock redemption fund, £8,000 has been placed to reserve, leaving a balance of £25,777. 8s. 11d. The Directors now recommend the payment of 5s. per share, free of tax, for the half-year on the Ordinary shares (at the rate of £3. 6s. 8d. per cent. per annum), against 3s. per share (£2 per cent. per annum) for the corresponding period of last year, leaving a balance of £1,427. 18s. 11d. to be carried forward. In the case of shares divided into "preferred" and "deferred," this 5s. per share will be payable, 3s. 9d. to the preferred and 1s. 3d. to the deferred shareholders.

The shareholders of this Company having consented to exchange more than the number of shares required under the agreement between this company and the Brazilian Submarine Telegraph Co., the agreement has become operative as from June 30 last. In consequence, directors of the Brazilian Submarine Company have become directors of this Company and *vice versâ*, and Mr. W. S. Andrews, chairman of this company, has been elected chairman of the Brazilian Submarine Company. Mr. W. H. Axworthy has been appointed manager of the company, and Mr. E. Steer Hodson, formerly traffic accountant, has been named secretary in place of Mr R. M. Cunningham, who has retired. The arrangement now made will conduce to the more harmonious and efficient working of the companies, and will prove advantageous to the Governments and the public.

NEW COMPANIES, STATUTORY RETURNS, &c.

BUTE ELECTRICAL MANUFACTURING CO. (LIMITED).—This company was registered on Nov. 2, with a capital of £5,000, in £1 shares, to enter into an agreement with the Electrical Insulation Syndicate (Limited), and Augustus J. Marquand, and to acquire, develop, work and deal with certain inventions. The first subscribers (each with one share) are:—H. B. Marquand, T. McM. Heywood, F. G. Treharne, A. J. Marquand, engineer; E. Jenkins, G. Chitham and T. H. Owen, engineer. The first directors are:—H. B. Marquand, T. McM. Heywood, F. G. Treharne and A. J. Marquand.

DRUMMOND ART METAL WORKS (LIMITED).—This company was registered on Nov. 2, with a capital of £5,000, in £1 shares, to acquire and carry on the business of electrical engineers and metal workers carried on by Whitehouse and Thomas (Limited). The first subscribers (each with one share) are:—C. J. Toy, J. A. Campbell, T. H. Toy, W. A. Low, L. E. Reitz, A. J. Woods and F. C. Collyer, jun.

DUTTON AND CO. (LIMITED).—This company was registered on Nov. 7, with a capital of £21,000, in £1 shares, to acquire the business of Dutton and Co. (Limited), incorporated in 1889, and to carry on the business of mechanical engineers, electricians, and manufacturers of and dealers in railway and other signals, locking, safety and detecting apparatus, electrical and other lamps, dynamos and all kinds of electrical and magnetic apparatus. The first subscribers (with one share each) are: Ralph H. C. Nevile, J.P.; Charles Dutton, signal engineer; William Buck, engineer; S. T. Dutton, engineer; S. G. Corkran, G. W. Bull and Mrs. M. F. Nevile. The first Directors are: C. A. S. Murray, S. G. Corkran, Ralph H. C. Nevile and S. T. Dutton.

HAMILTON, MOTHERWELL AND WISHAW LIGHT RAILWAYS CO. (LIMITED).—This company was registered on Nov. 3, with a capital of £20,000, in £10 shares, to construct, lease, or otherwise acquire any light railways or tramways in Hamilton, Motherwell and Wishaw, in the county of Lanark, and to equip, maintain and work by electricity, or any other power, all light railways or tramways belonging to the company. The first subscribers (each with one share) are: N. J. Ferdinand, Ernest Lazarus, John T. Merz, H. F. Charles, A. Clements, W. Martindale, and A. R. Monks.

NEW ST. HELEN'S AND DISTRICT TRAMWAYS CO. (LIMITED).—This company was registered on Nov. 4, with a capital of £150,000, in £5 shares, to acquire the undertaking of the St. Helen's and District Tramways Co. (Limited), to construct, maintain, and work any tramways and railways, to carry on the business of cable and wire mauufacturers, electricians, mechanical engineers, suppliers of electricity, and to carry on the business of an electric light company in all its branches. The first subscribers are: Sir J. A. Willox, M.P., T. Evans, Jacob Atherton, D. L. Chalmers, H. Martin, J.P., James B. Atherton and F. J. Leslie. The first directors are: Sir J. A. Willox, M.P., T. Evans, H. Martin, James B. Atherton and Jacob Atherton.

SMITH, THOMSON AND CO. (LIMITED).—This company was registered on Nov. 3, with a capital of £2,000, in £1 shares, to carry on the business of electrical, gas and general engineers, machinists, millwrights, manufacturers of machinery, boilers, dynamos, engines, &c.

WEST KENT ELECTRICITY SUPPLY CO. (LIMITED).—This company was registered on Nov. 2, with a capital of £20,000, in £1 shares, to construct, lay down and fix all necessary cables, wires, lines, accumulators, lamps and works, and to carry on the business of electricians, mechanical engineers, suppliers of electricity and manufacturers of electrical apparatus. The first subscribers (each with one share) are:—W. W. Pritchard, J. T. Rockett, H. G. Pulham, G. H. Davies, G. W. Sutton, H. M. Carpenter and W. May.

DRAKE AND GORHAM ELECTRIC POWER AND TRACTION (PIONEER) SYNDICATE (LIMITED).—The statutory return to Aug. 30 gives the nominal capital as £20,000, in £10 shares, of which 1,107 have been taken up. £3 per share has been called.

ELECTRIC LIGHT AND POWER CO. (LIMITED).—The statutory return to Aug. 10 has been filed. The capital is £6,000, in £1 shares (of which 5,000 are Deferred). Seven shares have been taken up and the full amount paid.

ELECTRIC RAILWAY AND TRAMWAY CARRIAGE WORKS (LIMITED).—According to the statutory return to Sept. 7, the capital is £150,000, in £5 shares, of which 16,087 have been taken up. £2 per share has been called, and £32,174 received. £11,079 has been paid in advance of calls.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Oct. 13, 1898). Price of silver 28¾d. per oz. (Nov. 10). Consols (2¾ per cent.) 109⅞—110 for money, 110—110¼ for account; 2½ per cent. 104½—105 (Nov. 10). Stock Exchange Settling Days: Consols, Dec. 1; Stocks and Shares Continuation Day, Nov. 28; Ticket Day, Nov. 29; Pay Days, Nov. 11 and 30; Mining Share Carry-over Day, Nov. 26.

BORDEAUX TRAMWAYS AND OMNIBUS CO. (LIMITED).—A meeting of this company will be held on the 17th inst., to confirm the special resolution relative to the sale of the undertaking to the Cie Française des Tramways Electriques et Omnibus de Bordeaux and to the agreement with the French Thomson-Houston Co.

CARBON MANUFACTURE IN RUSSIA.—In Lyons the Banque Privée Rüsse has formed a company, entitled the Société Française pour la Fabrication des Electrodes, with a capital of 1,000,000fr. This is the first

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French works for manufacturing carbons for electrical purposes, which have hitherto been imported, notwithstanding exorbitant duties.

CHELSEA ELECTRICITY SUPPLY CO. (LIMITED).—During the week this company invited subscriptions for £40,000 Four and a-Half per Cent. Debenture Stock at £108. 10s. The lists opened at 10 a.m. on Tuesday, and (owing to the large number of applications) were closed at 2 p.m. on Tuesday instead of 4 p.m. on Wednesday.

COMBINATION OF GERMAN ELECTRICAL FIRMS.—It is reported that an arrangement has been made for amalgamating the undertakings of the Ludwig Loewe Aktien Gesellschaft (of Berlin) and the Elektricitäts Aktien Gesellschaft vormals Schückert and Co. of Nuremberg. The arrangement is, however, subject to the approval of the shareholders of both companies. The Loewe company increases its nominal capital from 7,500,000 marks to 40,000,000 marks (from £375,000 to £2,000,000), and offers to the shareholders of the Schückert company in exchange for each 2,000-mark Schückert share one 1,000-mark Loewe share and 100 marks in cash, The Schückert shareholders have also an option over one Loewe share at par. The shares of the subsidiary Schückert Company (the Continentale Gesellschaft für Elektrische Unternehmungen) amounting to 26,000,000 marks (£1,300,000) will be exchanged into shares of the subsidiary Loewe Co. (the Gesellschaft für Elektrische Unternehmungen.) The latter will increase its capital from 30,000,000 to 50,000,000 marks (£1,500,000 to £2,500,000), and the project of increasing the capital of the Union Electrical Company, which is also controlled by the company will be abandoned. The Disconto-Gesellschaft, the Dresdner Bank, the Bank für Handel und Industrie, and the firm S. Bleichröder are all said to be interested in the combination.

CUBA SUBMARINE TELEGRAPH CO. (LIMITED).—A dividend at the rate of 6 per cent. per annum and a bonus of 2s. per share on the Ordinary shares, both free of tax, for the half-year ended June 30, is declared.

ELMORE COPPER COMPANIES.—"A Poor Shareholder," having written to the papers complaining of the outlook for shareholders in the Elmore companies, has drawn the following characteristic reply :—

"'A Poor Shareholder' has taken the altogether unnecessary trouble of calling himself an utter fool. Surely the very fact of his having addressed so absurd a letter to the press at a time when he knows, or could very readily know by applying to the officials of the companies, that a large sum of money is about to be put into the business by a particularly strong group of financiers, is amply sufficient to proclaim him chief of the tribe he so much aspires to. One might be more inclined to believe in the *bona fides* of this 'Poor Shareholder' did he but have courage enough to attach his name and address to his letter. Might I ask if he does not hope to convert the poverty he advertises into comparative affluence by acting as the cat's-paw of those whose only object is to frustrate the amalgamation of the Elmore companies."—A. S. ELMORE (Leeds).

Another correspondent ("W. O.") complained of the delay in calling a meeting and placing the true position of affairs before the shareholders, and of a great waste of the capital of the company. To this Mr. J. Shurmer (a director) replies :—

"The letter of 'W. O.' would not have drawn a reply from the directors were it not that some shareholders might suppose that the statements it contains have some foundation in fact. It is simply monstrous to talk of the directors having 'wasted' between £150,000 and £200,000 of the company's money, when the utmost that can be truly said is that the securities held by the company have depreciated to a large extent, these securities being shares or debentures in other companies with the management of which the directors of the Foreign Elmore company have nothing to do. The assets of the company at December, 1893, stood at £52,783, of which £18,879 is due to the fact that the share capital of the German company has been reduced from £2 to £1 shares, and £39,864 has been written off the investments, subject to which it follows that there has been a gain during the above period over and above the working expenses ; moreover, the liabilities have been reduced by £5,221. How preposterously reckless, then, are 'W. O.'s' misstatements ! But I suppose it is not the object of 'W. O.' and his colleagues to state the truth. No promises have been made by the Directors of 'great things in store ;' but they adhere to their belief that the position of their securities is improving steadily, and that the future of the Elmore process is assured."—J. SHURMER (London).

A Mr. T. H. Butt lets further light upon the latest developments in Elmores. He writes (from Headingley, Yorks), that :—

"If 'A Poor Shareholder' had taken the trouble to have written to the secretaries of the companies he would doubtless have been informed that an agreement exists between the directors of the various Elmore companies to complete the amalgamation which has been in contemplation for some time past, and, further, that an agreement exists under which one of the most influential financial houses in London and Paris guarantees the new amalgamated Elmore company a total subscription of £300,000 in cash. From my knowledge of the matter I am convinced that when worked with the ample capital which is now being provided the Elmore process will prove at least as great a commercial success in this country as it has proved in France since sufficient capital has been available there for the purchase of raw material."

"A Poor Shareholder" and "W. O." appear to have succeeded in extracting some information which will interest many besides themselves. How is it that the Elmore shareholders find it necessary to "extract" their information in this way ? Some boards of directors keep their shareholders informed of negotiations likely to improve the value of their property.

STOCK EXCHANGE NOTICE.—Application has been made to the Stock Exchange committee to appoint a special settling day and to grant a quotation to the Four per Cent. Preferred Ordinary "A" shares of £10 each, and Five per Cent. Deferred Ordinary "B" shares of £10 each of the Great Northern and City Railway Co.

WESTERN AND BRAZILIAN TELEGRAPH CO. (LIMITED).—This company's traffic receipts for the week ended Nov. 4 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Co., Limited) were £2,876.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended		Amount.	Inc. or Dec.		No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.	
	1898		£	£			£	£	
*Birmingham Tramways.	Nov.	5	3,867	+	350	...	...	...	
Blackpool Corporation...	"	3	166	−	7	31	15,263	+	2,203
Blackpool and Fleetwood Co.	"	5	192	...		17	13,135	...	
*Bristol Trams & Carriage	"	4	2,567	+	22	18	56,441	+	7,300
City & South London Ry.	"	6	1,027	−	14	19	18,304	+	724
Dover Corporation	"	5	165	+	62	31	5,989	...	
Dublin United (Southern)	"	4	743	+	249	18	18,474	+	5,761
Liverpool Overhead Rly.	"	6	1,451	+	110	19	30,244	+	2,814
*Sheffield Tramways......	"	6	1,086	+	150	...	...	...	
*South Staffs. Trams......	"	4	663	+	8	44	27,887	−	245

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Nov. 2.		Price Wednesday, Nov. 9.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Week Ending Nov. 9. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.					£ s. d.		Highest	Lowest
6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	10	10½	10	10½	—	—	..	—
6,000	10	4/3 1/10	Do. 4½ per Cent. Cumulative Pref.	10¾	11½	10¾	11½	4 0 0	—	..	—
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	11½	12½	11	12	2 18 4	February & August	11⅞	11½
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6½	6	6½	3 9 3	" "	..	—
£34,000	5	2/6	Chelsea Electricity Supply Ordinary	8	9	8	9	3 6 8	March	8½	—
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	113	115	113	115	3 18 3	June and December	—	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red)	103	105	103	105	4 15 3	..	..	..
50,000	10	5/0	City of London Elec. Lighting Ord. 40,001 to 90,000	23½	24½	23½	24½	5 2 0	February & August	24½	24
10,000	10	1/9	Do. Ordinary 90,001 to 100,000	23	24	23	24	..	..		—
40,000	10	6%	Do. 6% Cumulative Pref.	15½	16½	15½	16½	3 11 9	January and July	15 9/16	—
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	127	132	127	132	3 16 1	June and December		..
30,000	10	—	County of London & Brush Prov. Ord. (fully paid)	12½	13½	12½	13½	—	—	13½	12¾
10,000	10	..	Do. (£8 paid)	10	11	10	11	..	..	..	—
20,000	10	6/0	Do. 6% Cumulative Preference	14½	15½	14½	15½	4 0 0	March & September	15	14⅝
15,660	5	2/6	House-to-House Electric Lighting Supply Ord.	9	10	9	10	2 0 0	..	9 7/16	9½
17,000	5	3/6	Do. 7 per Cent. Preference	9½	10½	9½	10½	3 6 8	March & September	..	—
15,000	5	10%	Kensington and Knightsbridge Ord.	13	14	13	14	3 18 7	..	..	—
10,000	5	6%	Do. 6% 1st Pref.	7¾	8¼	7¾	8¼	3 12 9	January and July	..	—
111,000	3	—	London Electric Supply Ordinary	3½	4	3½	4	—	—	..	—
50,000	5	..	Do. Preference	6	6½	6¼	6¾	—	—	6½	—
62,400	10	5/0	Metropolitan Electric Supply Ordinary	15½	16½	15½	16½	3 2 6	April and October	16	15⅝
£230,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	121	117	121	3 14 9	June and December		—
6,452	10	6/0	Notting Hill Electric Ordinary	15	16	15	16	3 15 0	March	15½	15½
275,000	1	—	Rand Electric	⅞	1⅛	⅞	1⅛	—	—	—	..
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb	88	93	88	93	5 8 1	—	..	—
150,000	$100	$2	Royal Electric Company of Montreal Shares ...	155	160	155	160	5 0 0	—	..	—
130,900	100	4½%	* Do. 4½% 1st Mort. Debs.	104	106	104	106	4 5 0	April and October	105½	..
31,980	5	5/0	St. James and Pall Mall Electric Ordinary	16	17	16	17	4 14 2	February & August	16⅜	16
20,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	" "	..	—
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.)	105	108	105	108	3 15 6	June and December	..	—
65,000	5	..	South London Electric Supply Ordinary (£3 paid).	2⅞	3⅛	2⅞	3⅛	..	..	2 15/16	..
79,900	5	5/0	Westminster Electric Supply Ordinary	14½	15½	15	16	4 1 3	March & September	15⅝	15¼
18,848	5	5%	Yorkshire House-to-House	7¾	8	7¾	8	3 2 6	February and July	—	—
18,626	5	5%	Do. (£4 paid)	5¾	6⅛	5¾	6⅛	3 18 5	February and July	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Nov. 2.	Price Wednesday, Nov. 9.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 9. Highest	Lowest
			TELEGRAPHS			£ s. d.			
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	100 104	100 104	3 17 4	January and July	.. ..	.. ..
25,000	10	..	Amazon Telegraph	6 7	5 6	..	..	.. ..	.. ..
£125,000	100	5%	Do. 5 per Cent. Debentures	92 95	92 95	5 5 3	..	.. ..	.. ..
£805,560	Stock	15/0	Anglo-American	61 64	61 64	4 13 9	Feb., May, Aug., Nov.	63 61	
£3,047,220	Stock	30/0	Do. Preferred	112 113	112½ 113½	5 14 2	" "	113¾ 112¼	
£3,047,220	Stock	..	Do. Deferred	13⅜ 14½	14½ 14⅝	..	..	14⅞ 14	
130,000	10	5/0	Brazilian Submarine	15½ 16	15½ 15⅝	4 15 3	Mar., June, Oct., Dec.	15 13/16 15 7/16	
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	111 115	111 115	4 8 0	June and December	.. ..	
10,000,000	$100	$1½	Commercial Cable Capital Stock	180 190	180 190	4 4 3	Jan., Apr., July, Oct.	.. ..	
£918,297	Stock	4%	* Do. 4 per Cent. Debenture Stock	104 106	104 106	3 15 6	" "	105½ ..	
16,000	10	..	Cuba Submarine Ordinary (Deferred)	8½ 9½	8½ 9½	..	February and August	.. ..	
6,000	10	..	Do. Preference 10 per Cent.	15½ 16½	16 17	..	" "	.. ..	
12,931	5	2/0	Direct Spanish (Ordinary)	4 5	4 5	4 8 11	April and October	.. ..	
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10 11	10 11	4 12 10	" "	.. ..	
£30,000	50	4½%	Do. 4½ per Cent. Debentures	104⅞ 107⅞	104⅞ 107⅞	4 4 8	January and July	.. ..	
60,710	20	3/0	Direct United States Cable	11⅝ 12	11½ 12	5 8 4	Jan., Apr., July, Oct.	11⅞ 11⅝	
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	101 104	101 104	4 7 5	..	103 ..	
400,000	Stock	6/6	Eastern Ordinary	17½ 17⅝	172 177	3 19 4	Jan., Apr., July, Oct.	176½ 174	
£1,295,000	Stock	17/6	Do. 3½ per Cent. Pref. Stock	104 107	104 107	3 5 5	" "	106½ 104	
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	124 128	124 123	3 2 6	May and November	.. ..	
£89,900	100	5%	* Do. 5 per Cent. Debentures, 1899	100 103	100 103	4 17 1	February & August	.. ..	
£500,000	Stock	8/9	Do. Provisional Certificates 50% paid	52 55	52 55	..	..	.. ..	
250,000	10	2/6	Eastern Extension	17½ 17⅝	17½ 17⅝	3 18 11	Jan., Apr., July, Oct.	17⅝ 17⅝	
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125 129	125 129	3 2 4	February & August	.. ..	
£16,200	100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900 (reg.)	100 104	100 104	4 16 10	January and July	103 ..	
£64,400	100	5%	Do. (Bearer)	101 104	101 104	4 16 10	" "	103½ ..	
£35,100	100	5%	*Eastern and S. African 5 p. c. Mor. Deb., 1900 (reg.)	100 104	100 104	4 16 10	" "	.. ..	
£46,500	100	5%	Do, (Bearer)	101 104	101 104	4 16 10	" "	.. ..	
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102 105	102 105	3 16 4	February & August	.. ..	
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	102⅞ 105⅞	102⅞ 105⅞	3 16 2	May and November	.. ..	
180,227	10	1/9	Globe Telegraph and Trust	12 12½	12 12½	4 2 0	Jan., Apr., July, Oct.	12½ 12⅝	
180,042	10	6%	Do. 6 per Cent. Preference	16½ 17	16½ 17	3 10 7	" "	17 16½	
150,000	10	5/0	Great Northern of Copenhagen	28½ 29½	28½ 29½	3 7 10	January, April, July	.. ..	
£150,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B"	100 103	100 103	4 17 10	March & September	101 ..	
£97,800	100	4½%	Halifax and Bermuda Cable 4½% 1st Mort. Deb. (red)	101 104	101 104	4 7 0	June and December	.. ..	
17,000	25	12/6	Indo-European	52 55	53 56	4 9 3	May and November	55½ 53½	
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	109 112	109 112	5 7 7	March & September	.. ..	
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red)	105 108	105 108	3 14 3	June and December	.. ..	
11,889	8	4/0	Reuter's	7½ 8½	7 8	5 0 0	April and October	.. ..	
3,381	£100 Cert.	6%	Submarine Cables Trust	133 138	133 138	4 6 11	" "	.. ..	
15,609	10	..	West African Telegraph	.. ..	.. ..	..	..	.. ..	
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99 102	99 102	4 18 0	March & September	.. ..	
30,008	2½	..	West Coast of America	¼ ⅜	¼ ⅜	..	..	.. ..	
£150,000	100	4%	* Do. 4 per Cent. Debentures	104 107	104 107	3 15 2	June and December	.. ..	
88,321	10	0/6	West India and Panama	1⅛ 1⅜	1⅛ 1⅜	..	May and November	1 5/16 1 3/16	
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9¼ 9¾	9¼ 9¾	6 3 1	" "	9⅜ ..	
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7 9	7 9	6 13 4	" "	.. ..	
£80,000	100	5%	* Do. 5 per Cent. Debentures	106 109	106 109	4 12 10	January and July	.. ..	
64,269	15	6/9	Western and Brazilian Ordinary	12½ 12¾	12½ 12¾	3 16 6	May and November	12¾ 12 3/16	
33,129	7½	6/0	Do. 5 per Cent. Preferred Ordinary	8 8½	8 8½	4 8 2	" "	.. ..	
33,129	7½	0/9	Do. Deferred Ordinary	4 4½	4 4½	..	" "	.. ..	
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	107 110	107 110	3 13 1	June and December	.. ..	
1,168,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	.. ..	.. ..	6 7 10	Feb., May, Aug., Nov.	.. ..	
£158,100	100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	98 103	98 103	5 16 6	March & September	.. ..	
			TELEPHONES.						
44,000	£5	4/0	Chili Telephone (fully paid)	2⅜ 3½	2⅜ 3½	6 8 1	August	.. ..	
224,850	10/0	1½d.	Consolidated Telephone Const. & Manufacturing	1 1/16 1 3/16	1 1/16 1 3/16	6 7 0	July	.. ..	
28,000	5	4/0	Monte Video Telephone 6 per Cent. Preference	.. ..	.. ..	7 5 6	October	.. ..	
£84,597	5	3/0	National	5½ 5⅝	5½ 5½	5 9 1	February & August	5 7/16 5½	
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	12 14	12 14	4 5 9	" "	13½ 13	
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	12 14	12 14	4 5 9	" "	.. ..	
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	5⅛ 5⅜	5⅛ 5⅜	4 13 0	" "	5 7/16 ..	
1,229,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	100 105	100 103	3 8 8	June and December	102 101	
171,504	1	0/4	Oriental	⅜ ⅝	⅜ ⅝	6 13 4	April and October	.. ..	
58,000	5	6/0	United River Plate	4½ 4⅝	4½ 4⅝	6 6 5	July	4½ ..	
£151,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103 106	103 106	4 14 4	June and December	.. ..	
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
90,000	2	1/2⅝	Brush Electrical Engineering	1⅝ 1⅞	1⅝ 1⅞	3 4 0		1⅞ 1 11/16	
90,000	2	1/2⅝	Do. 6 per Cent. Pref. Non-Cumulative	2 2¼	2 2¼	5 6 8	..	.. ..	
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	109 113	109 113	4 0 4	February & August	112 ..	
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101 105	102 105	4 7 0	June and December	102 ..	
£20,000	5	5/0	Callender's Cable Construction	9½ 10½	9½ 10½	6 8 7	" "	9⅞ ..	
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	110 113	110 113	4 0 6	November and May	113 ..	
300,000	1	9/8	Castner-Kellner Alkali Co. (fully paid)	1⅛ 1⅜	1⅛ 1⅜	5 16 5	..	.. ..	
50,000	1	..	Chadburn's Ship Telegraph Ordinary	1⅛ 1⅜	1⅛ 1⅜	..	..	.. ..	
50,000	1	7½	Do. 6 per Cent. Cumulative Pref.	⅞ 1⅛	1 1½	4 16 0	..	.. ..	
32,098	3	..	Crompton and Co. (Nos. 1 to 32,098)	1½ 2	1½ 2	..	..	.. ..	
£82,850	100	5%	* Do. 5% First Mort. Deb. (red.)	91 96	91 96	5 5 10	January and July	94 92	
99,261	5	2/1½	Edison and Swan United ("A" Shares) (£3 paid)	2½ 2⅝	2½ 2⅝	6 10 5	February & August	2½ 2½	
17,139	5	3/1½	Do. (£5 paid)	4 5	4 5	6 0 0	" "	.. ..	
£194,023	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	101 103	100 102	3 19 10	June and December	103⅜ ..	
17,400	5	5%	Edmundson's Electric Corporation Ord (fully paid)	5 5⅛	5 5⅛	4 10 11	Half-yearly	.. ..	
110,000	2	1/2⅝	Electric Construction Co. (Limited)	2 2⅛	2⅜ 2⅝	4 16 10	February & August	9 7/16 ..	
25,000	2	2/9½	Do. 7 per Cent. Cumulative Pref.	2⅝ 3⅛	2⅝ 3⅛	4 6 2	August	3 2⅝	
£111,100	Stock	4%	Do. 4% First Mortgage Deb. (red.)	105 107	105 107	3 16 2	..	.. ..	
91,196	1	..	Elmore's Patent Copper Depositing	⅜ ⅝	½ ⅝	..	..	.. ..	
12,500	10	8/0	Henley's Telegraph Works Ordinary	20½ 21½	20½ 21½	6 0 11	February & August	21 2 3/8	
3,000	10	7/0	Do. 7 per Cent. Preference	18 19	18 19	3 13 8	" "	18½ ..	
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110 115	110 115	3 18 3	" "	.. ..	
60,000	10	5/0	India Rubber, Gutta Percha, &c., Works	22 23	22 23	4 7 0	" "	22½ 23⅛	
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	102 106	102 106	3 15 6	March & September	.. ..	
£7,350	12	12/0	Telegraph Construction and Maintenance	37 41	37 41	4 6 2	March and July	40 38⅜	
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	104 107	104 107	4 14 9	January and July	.. ..	
£50,000	5	4/0	Willans and Robinson Ordinary	7⅜ 8½	7⅜ 8½	4 17 0	April and October	8⅛ 8	
£30,000	5	3/0	Do. 6% Cumulative Preference	6⅞ 7½	6⅞ 7½	4 2 9	" "	7⅛ 6⅞	
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	108 110	108 110	3 18 8	May and November	109⅛ 109	
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	..	Blackpool and Fleetwood Tramways	15½ 16½	15½ 16½	..			
25,000	10	6%	Bristol Tramways and Carriage	21½ 22	21½ 22	2 14 7		.. ..	
25,000	10	6%	Do. (£7. 10s. paid)	18⅜ 18⅞	18⅜ 18⅞	1 14 1		.. ..	
£90,410	Stock	4%	Do. 4% Debenture	121 123	121 121	3 5 1		.. ..	
80,000	10	..	British Electric Traction Ordinary	16½ 17½	16½ 17½	..		17½ 17	
10,000	10	2/4 7/16	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm.pd.)	13 14	13 14	4 5 9		.. ..	
34,440	10	..	Calcutta Tramways	5 6	5 6	..		5 ..	
£35,250	10	3/0	Central London Ordinary	9⅜ 10½	10 10½	2 17 2	June and December	10½ 10 3/16	
178,303	10	1/9⅜	Do. (£6 paid)	5⅞ 6½	5⅞ 6½	2 16 6	" "	6½ ..	
£630,000	Stock	2½%	City and South London Railway Con. Ordy.	69 71	69 71	2 16 8	January and July	70½ 69½	
22,500	10	..	Do. Ordinary (£4 paid)	3½ 4	3½ 4	..	..	.. ..	
9,251	10	5%	Do. 5% Perpetual Preference	14½ 15½	14½ 15½	3 4 6	January and July	15 ..	
£137,701	Stock	4%	Do. 4% Perpetual Debenture	134 133	134 138	2 18 10	May and November	.. ..	
20,000	10	6%	Imperial Tramways Ordinary (old £6 shares)	16⅛ 16⅜	16⅛ 16⅜	2 3 9	March & September	.. ..	
10,000	10	6%	Do. 6% Preference	15 15½	15 15½	3 18 8	" "	.. ..	
37,500	10	3%	Liverpool Overhead Railway Ordinary	10 7/16 10 9/16	10 7/16 10 9/16	3 1 6	February & August	.. ..	
10,000	10	5%	Do. 5% Preference	15½ 16	15½ 16	3 2 6	" "	.. ..	
195,000	Stock	4%	Do. 4% Debentures	108 110	108 110	3 13 1	January and July	.. ..	
20,000	5	3/8½	New General Traction 6% Cumulative Pref	4⅜ 5½	4⅜ 5½	..		.. ..	
£540,000	Stock	3%	Waterloo and City Ordinary	106 111	106 111	2 15 1	June and December	.. ..	

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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CONTENTS OF THE CURRENT NUMBER.

NOTES	95	Reviews	120
Meetings of Scientific Societies.	98	An Electrically-Operated Foundry. Illustrated	121
Liverpool Corporation Electric Tramways. Illustrated	99	The New Electric Cranes at Southamton Harbour. Illustrated	123
Glasgow Corporation Electric Tramways. Illustrated	104	Rotatory Converters. By Prof. Silvanus P. Thompson. Illustrated	126
Chicago Metropolitan West Side Elevated Electric Railroad. Illustrated	110	Correspondence	128
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe	114	Legal Intelligence	128
The Theory of the Rotary Transformer. By G. Kapp. Illustrated	115	Present Position and Prospects of Electric Traction in the United Kingdom. Illustrated	130
Electricity Works Accounts	116	Trade Notes and Notices	134
THE SOCIAL INFLUENCE OF ELECTRIC POWER	118	Companies' Meetings & Reports	139
		City Notes	141
		Companies' Share List	142

NOTES.

Two so-called experimental electric tramways, viz., those of the Corporations of Liverpool and Glasgow respectively, are described in two illustrated articles in our issue this week. It is only in a special sense that these lines can be regarded as of an experimental nature. The overhead trolley system, *per se*, requires no further demonstration of its practicability; that has been abundantly proved by its success in tens of thousands of miles in other countries, and in considerably over a hundred miles in the United Kingdom. Nor was it necessary to show that the British contractor could supply efficient plant and equipment, or that the British public could appreciate his efforts. Wherein lies the experimental character might, then, be difficult to discover. It is undoubtedly to be found only in the hesitation of the local authorities to expend large sums of money on a general equipment of their tramway systems until they shall have first tried the overhead trolley for themselves on short lengths of their own lines. British caution is the sole explanation; and those who know well what the overhead system can do will have no doubt that these two experiments are the precursors of an immediate adoption of that system over the whole of the tramways of these two important cities. The example thus well set will speedily be followed by local authorities all over the United Kingdom.

MUNICIPAL tramway working may itself, however, be in the nature of an experiment, the success of which it may require many years to demonstrate; but that is not a matter of electric traction. Since truth and sweet reasonableness are often found in a happy medium, it is probable that the most suitable solution of the tramway problem may lie—not, on the one hand, in company ownership, nor, on the other hand, in municipal working—but in the form of ownership and management about to be given a trial at St. Helens. This particular solution, far from being new, however, has yielded some of the best results financially that has been obtained on tramways abroad. It consists in a species of dual control—the local authority owning and leasing the lines, and supplying electrical power, and a Company being granted powers to work the lines with rolling stock provided by that Company, and to control the operation and financial affairs of the system. At St. Helens a lease of 21 years has been granted to the Company, which will obtain electrical energy from the Corporation supply at 2d. per unit for the first 400,000 units per annum, and 1d. per unit exceeding this consumption.

AN instructive table showing the relative costs and profits of electric, cable and horse tramway traction in New York, for the year ended June 30 last, is published in the November number of the *Street Railway Journal*, of that city. The table is based on the official cost sheets of the Metropolitan Street Railway Co. It will be borne in mind by our readers that while horse and cable traction have been in extensive use in New York for many years, the introduction of the cable conduit system on the lines in question is of recent date. The long experience in handling cable and horse equipment, therefore, might render severe criticism of any shortcomings of the later system unjustifiable. Fortunately, leniency in this direction would be superfluous, for the superiority of electric traction, on its own merits, is placed beyond question. The total operating expenses per car-mile were 8·21d. for cable haulage and 8·98d. for horse cars, but only 5·12d. for the electric conduit system. These figures include power costs, transportation or traffic expenses, maintenance and general management; but capital charges are omitted, though if included would probably still further improve the showing in favour of electric traction. A still better result is shown by the three months' working ended September 30th last, the figures being 8·78d., 8·99d. and 5·03d. respectively.

NOR did this low cost of electric traction arise from the electric cars having shirked their due share of the work, as will be seen when we compare the ratios of the expenses to

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the receipts. With the cable cars, the operating expenses were 47 per cent. of the total passenger receipts, with horse-cars the percentage was 63 per cent., while with the electric cars the low ratio of only 38 per cent. was attained. Success so marked will not fail to afford encouragement to electric traction engineers, nor will its significance be overlooked by the numerous local authorities and tramway companies upon whose minds it is gradually dawning that electric traction is *facile princeps* among tramway systems.

THE human element must always introduce uncertainty and risk into engineering operations, and the handling of a trolley car is no exception. The lamentable accident which took place on the Bradford tramways on September 19th last has been made the subject of a careful inquiry by Major CARDEW, on behalf of the Board of Trade; and in the report just issued he states that "although the accident was in great measure due to the inexperience and injudicious action of the driver and conductor, in his opinion they both did their duty to the full extent of their skill and ability." Major CARDEW recommends the continuous use of a slipper brake on the dangerous gradient, and a limit not exceeding six miles an hour in descending it. An abstract of the report is given in another column.

AN important legal decision affecting contractors is reported in our Legal Intelligence column this week. Payment to engineering contractors is commonly made by instalments regulated by the stages of progress of the work. In the case referred to a second 40 per cent. instalment became due when the work had been completed, but payment of this was refused because the plant had not passed the engineer's tests. The case became complicated by the refusal of the clients—the Corporation of Bedford—to agree to any arbitrator other than their own engineer. The judgment of the High Court was that the Corporation must agree to the arbitrator appointed by the court below.

MR. H. E. KERSHAW, the Chairman of the Electricity Committee of the Shoreditch Vestry, has just issued a pamphlet setting forth a brief statement of the dust destructor and electric lighting accounts for the year ended June 24 last. As the statement lacks the detailed completeness of the Board of Trade returns, it is difficult to know how much credence to attach to the claim that a profit of £3,184 has been made. We notice, however, that whereas the revenue from the sale of current to consumers was £8,254, the revenue from current sold to the ever-useful dust destructor was as much as £586, or equal to about one-sixteenth of the outside revenue. Nor did the utility of the dust destructor stop at this handsome contribution to the coffers of the electricity department, for it has apparently also paid an unpublished proportion of the engineer's salary. We shall deal with the matter more fully in our next issue.

The Houllevigue Prize.—The Académie des Sciences has awarded the Houlevigue prize of £200 to M. Branly, the discoverer of the coherer.

The Royal Society.—Among the Papers down for reading yesterday was one by Prof. Smithells, H. M. Dawson and H. A. Wilson on "The Electrical Conductivity and Luminosity of Flames Containing Vaporised Salts."

Cable Interruptions and Repairs.—

	Date of Interruption.	Date of Repair.
Bissao—Bolama	Aug. 3, 1898 ...	Nov. 17, 1898
St. Louis and Noronha	Oct. 17, 1898 ...	—
Pernambuco—Ceara	Oct. 19, 1898 ...	—
Ceara—Maranham	Nov. 15, 1898 ...	—

The New German-Swedish Telegraph Cable.—The new telegraph cable between Germany and Sweden has been laid by the Telegraph and Maintenance Co.'s s.s. "Britannia." The cable, which was made by Messrs Felten and Guilleame, is 70 miles long and contain four conductors.

Obituary.—It is with regret that we announce the death of M. Nicolas Jules Raffard, best known to electrical engineers in this country through the type of absorption dynamometer bearing his name. M. Raffard was one of the pioneers of electric traction, having already in 1881 designed the first accumulator tramcar built in France, and some inventions in connection with direct-driven cars are also due to him. He died on Nov. 1 at the age of 74.

Errata.—In "Electricity Works Accounts," in this issue, the following corrections should be made in the table at the bottom of p. 116: The last figure under "Revenue" should read 4,846 instead of 4,946, and the last figure under "Expenditure" should read 5,688 instead of 5,788. The figures under "Expenditure" in this table represent the total expenditure, including the sums carried to the sinking fund and paid as interest on loans.

Gift to Owens College.—Alderman John Hopkinson, the members of his family, and near relatives, have offered to the Owens College, in memory of the late Dr. John Hopkinson, a gift of £1,600 to cover the expense of building the dynamo house connected with the new physical laboratory. It is hoped that by additional contributions from friends, who desire to see a suitable memorial to Dr. Hopkinson in Owens College, where he was a student for three years, it may be possible to complete and equip the annexe, containing, in addition to the dynamo house, a number of rooms devoted to electrotechnics, and that the whole may be known as the "Dr. John Hopkinson Electrotechnical Laboratory."

The Institution of Junior Engineers.—On Saturday, Nov. 12, a party, numbering over 120, visited the site of the Lombard-street station of the northern extension of the City and South London Railway. The feature which naturally attracted the greatest interest was the work connected with the underpinning of St. Mary Woolnoth Church, immediately underneath which the main shaft for the lifts has been sunk. The large oblong shaft is 73ft. 6in. by 24ft., divided into five bays in which will work electric lifts made by Messrs. Easton, Anderson and Goolden. It is lined with cast-iron segments for a depth of 52ft. from the top, the remaining 28ft. being brickwork, in which are formed the entrances and exits to and from the lifts. The two station tunnels are 21ft. diameter and lined as usual with cast-iron rings.

Motor-Car Clubs.—The Automobile Club of Great Britain and Ireland, with which is now incorporated the Self-Propelled Traffic Association, held a dinner on Monday last to commemorate the second anniversary of the Locomotives on Highways Act, which came into force on Nov. 14, 1896. Mr. R. W. Wallace, Q.C., the chairman of the Club, presided, and among those present were Mr. G. Shaw Lefèvre, Sir Hugh Owen (permanent secretary of the Local Government Board), Mr. J. W. Swan, and several members of the Automobile Club de France.——The third annual meet of the Motor-Car Club took place on Monday morning in Whitehall-place, the run being to Sheen House, as last year. The majority of the vehicles taking part in the run were driven by oil motors, but there were some electrically-propelled cars, the total number of automobiles taking part in the procession being about 80.

Another Proposal for a Railway up Mont Blanc.—*Electricity*, of New York, states that a French engineer, of Marseilles, has suggested a plan which he considers feasible for reaching the top of Mont Blanc. The scheme contemplates the building

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of a rack railway from what is known as Les Houches, a station on the line of the Geneva-Chamounix Railway, to a plateau on the side of Mont Blanc, at an altitude of 6,888ft. The line would have an average grade of 60 per cent. It is proposed to propel the trains electrically, utilising a waterfall on the upper Arve for the necessary power. From this point he proposes to run a tunnel into the mountain, which would have a rise of 600ft. in 18,864ft., and would terminate at a point 7,500ft. above the sea level. The final section of this novel railway is to consist of an elevator in a vertical shaft from the end of the tunnel to the summit of the mountain.

The Late Dr. John Hopkinson and Mr. Latimer Clark.—At the meeting of the Institution of Electrical Engineers on the 10th inst., the president (Mr. J. W. Swan) made some feeling remarks upon the great loss the Institution has sustained by the death of two of its most prominent members and past-presidents, Dr. John Hopkinson and Mr. Latimer Clark. He spoke of the valuable work done by both, referring to Mr. Latimer Clark as one of the pioneers of ocean telegraphy, who held a place of the highest honour in the records of the Institution and in the memory of its members. We quote also the following tribute to Dr. Hopkinson:—"What can I say of his character more than that it was in perfect symmetry with his work? Simple, unpretentious, sedate, honest and self-possessed; everyone trusted John Hopkinson; trusted him implicitly and without any misgiving. No man ever carried so great a weight of learning so lightly. Like the athlete he was, he did the heaviest work without any sign of effort. We must mourn that we shall see the face of these dear old comrades no more, and that the precious work they did cannot be added to."

A New Paris Tramway.—Like the London County Council, the municipal authorities of Paris have set their face against the introduction of the trolley. The line from Aubervilliers to the Place de la République runs only as far as the fortifications on the trolley system, but a new line from Charenton to the Bastille has now actually brought the trolley wires within the gates of the city. The length of the line is 8·8 miles, and it is all on the overhead trolley system, with the exception of two sections, aggregating half a-mile, on which the underground conduit is employed. Three Thomson-Houston compound-wound generators (one serving as reserve), each of 150 kilowatts capacity, furnish the power. These are driven through belting by single cylinder Farcot non-condensing engines. The station pressure is 550 volts. Three semi-tubular Meunier boilers, with a heating surface of 6,500 sq. ft., furnish steam at 100lb. per square inch pressure. These boilers work under forced draught on M. Prat's system, and a chimney 56ft. high is found amply sufficient. There is a battery of 250 cells, with a capacity of 350 ampere-hours, used for supplying the conduit sections of the line which are electrically isolated from the remainder. The battery is charged by one of the generators, a special switch being provided to short-circuit the series windings. The track is double throughout, made up of 90lb. rails with Falk cast-welded joints. In nearly all cases the posts supporting the trolley wire are in the centre of the street, and span wires are not used. The posts each carry two 5-ampere arcs on brackets, the lamps being connected five in series across the terminals of the battery. The conduit part of the lines is similar to that in use in Ninth-street, Washington, with a slot 1in. wide. There are in all 18 cars, with single-reduction motors, and differing but little from the usual Thomson-Houston construction. We are indebted to the *Industrie Electrique* of November 10th for the above particulars.

Interruptions to Supply.—A slight interruption to the electricity supply to one circuit at Tunbridge Wells took place one day last week. An earth developed on a consumer's installation, and his fuse not blowing, the transformers were overloaded. New transformer fuses were inserted and the supply was resumed from half-an-hour to 1½ hours of the occurrence. About 600 lights were affected.

At Woking the supply to about three-quarters of the total number of consumers was interrupted from 7 p.m. on Wednesday to 5 p.m. on Thursday, last week, through the failure of a pair of vulcanised rubber mains. The cables in question had been laid in earthenware pipes under an unmade road, and it is surmised that they suffered last week by the process of making the road. Difficulties were experienced in removing the cables, and the fact that Wednesday was "early-closing" night, and that a new cable-way was in process of construction, decided the engineer-in-charge to await making a re-connection till Thursday afternoon, by which time the new cable-way was finished and new cables drawn in.

At Manchester, on the 10th inst., at 8:25 p.m., a dead short-circuit was experienced, the locality of which could not be discovered for an hour. During this time the pressure could only be maintained on one out of the four circuits. The plant was kept running the whole time, and was not shut down. The exact position of the fault could not be discovered until later in the evening, and while seeking it the faulty portion of the network was again connected, causing, unfortunately, another interruption in the supply at 9:45 p.m., lasting 15min. or 20min. The short-circuit was a very severe one, four out of the five conductors being in contact, yet no damage was done either to the plant or to the roadway.

Half of the arc lamps for the Dublin street lighting remained extinguished all Tuesday night. A similar thing has happened on more than one occasion in Dublin during the last few months.

Earth Returns and Electrolysis.—Two recent Papers, one read by Mr. A. A. Knudson before the American Institute of Electrical Engineers, and the other presented to the Municipal Improvement Association at Washington by Mr. H. P. Brown, give details of extensive, and in some cases quite unexpected, damage done by currents leaking from rail return-circuits. Mr. Knudson, in his Paper, gave particulars of an "electrical survey" he had made in the Manhattan borough of New York City. Differences of potential of from ½ to 8¾ volts were detected between the rails, water-pipes, the iron structure of the elevated railway, &c., and in some cases the rails were positive to the pipes, while in others the reverse was the case. On inspection of the rails of one of the lines, it was found that a large amount of metal had been removed by electrolysis, and that the bottom sides of the rails had been "cut by the current down to knife edges," for several feet back from the ends, the edges being irregular in shape and somewhat jagged in appearance. The tie-rods of this line, originally 1½in. wide by ⅜in. thick, had been nearly all so eaten away that the middle part was missing. Mr. Brown had found that in Dayton, Ohio, cast-iron pipes had been seriously injured by stray currents. Tests showed that the pipes in the business portion of the city, 1½ to two miles from the power house, were positive to the rails, the highest readings being 4½ volts. Near the power house, however, the pipes were as much as 9 volts positive to the rails. The corrosion of the pipes at Dayton Mr. Brown attributes to a reaction of the soil surrounding them, when a current passes through it. A tar paint seems to be no protection whatever, the surface of the pipe being changed into a soft black material resembling graphite, and easily cut with a knife, this material being a conductor instead of more or less an insulator, as is the oxide, the adherent moulding sand and the tar paint usually surrounding the pipe. Chemical analysis of the soil showed that it contained carbonate and chloride of sodium.

A New Controller Governor.—On account of the general disregard by motormen of rules and regulations for handling the controllers, and the consequent waste of current, an ingenious controller governor or retarding device has been developed at the repair shops of the Chicago City Railway Co. The *Street Railway Review* describes the apparatus as follows:—"The mechanism occupies so small a space that it can be placed within any controller case between the top of the drum and the hood of the case, and it requires only the removal of a cam from the main drum shaft. The frame of the device carrying the entire mechanism is a small malleable iron casting held in place by two machine screws tapped into the back of the controller case. On the main drum shaft is a ratchet wheel having 12 notches, and a hole in the hub affords a stop in place of the cam removed. On the frame is a lever escapement with two pawls, one pawl being always engaged. Two springs, one a ½in. and the other a ¼in. closed coil spring,

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hold the pawls in place in the notches of the ratchet wheel. Connected to the lever escapement is a link attached to a plunger of a dash pot 1½in. in diameter and 1½in. deep. The piston is ¾in. thick, with two iron packing rings. When the controller handle is turned one notch the air in the dash pot is compressed and holds the pawls firmly in position so that the handle cannot be turned another notch. In the bottom of the dash pot is a very small hole into which projects a needle-pointed screw, by which the area of the hole can be regulated. As soon as the air escapes, one of the springs acts and frees a pawl so that the controller handle can be turned another notch. The time occupied by this action depends entirely upon the size of the hole in the dash pot. If it is large the air escapes rapidly and frees the pawl quickly, but if it is small, the reverse is the case. By means of experiments, the size of the hole can be nicely determined and the operation of the controller is automatically regulated. It is impossible for the motorman to turn the controller handle faster than the predetermined rate."

Some Amusing American Tramway Data.—We quote the following figures from an amusing article in the *Street Railway Review* on the "greatness and possibilities" of the electric railway. Every day the street cars in the United States carry as many passengers as there are inhabitants in Greater New York, Chicago, Philadelphia and Boston. To purchase the street railways would take all of the $525,000,000 of gold, the $120,000,000 of silver, the $400,000,000 of certificates, the $225,000,000 of National bank notes and the $250,000,000 of United States Treasury notes in circulation. If the street railways were to be sold the sum realised would easily pay the debt of the United States. A fair estimate of the paying passengers carried by the street railways per annum would be 2,660,000,000, and this would be increased by 50 per cent. if the transferred passengers were included, which, in the aggregate, represents two rides for every inhabitant of the globe, and tells its own story when compared with the 535,000,000 carried annually on the 182,000 miles of steam road in the States. No less than 33,000,000 sleepers have been placed in the road beds, and the track rails, if placed end to end, would reach around the equator, leaving enough over to extend as an axis from the north to the south pole. These rails weigh 3,500,000 tons, and represent the entire output of the rolling mills of the United States for two years. It is estimated that the power stations have an aggregate capacity of 525,000 H.P., and consume per annum 2,300,000 tons of coal, evaporating 3,300,000,000 gallons of water. To operate the present street car equipment would require 320,000 horses, which, if harnessed two abreast, would form a solid procession extending from Chicago to Cleveland; but to transport the passengers carried by electric cars in the slower-going horse cars would necessitate one-third more cars than now, and this would extend the line of animals to 480 miles. The average electric car travels 120 miles a day; each one of its wheels makes 84,500 revolutions, and in the course of a year passes over 8,000,000 rail joints; yet with all this constant wear and opportunity for accident from breakage, a passenger is as safe on a trolley car as in the retirement of his own home. Only one in 28,000,000 passengers is killed, and only one in 800,000 is injured in any way; and if a man were to spend his time on the street cars waiting for a chance to present a damage claim against the Company, he would have to travel one hour a day for 31 years, and spend $1,180 in car fare before he would be hurt. Before his time for being killed would come he would be a patriarch of five and a-half centuries, having been continually on the cars day and night.

The London County Council and the Telephone.—A letter signed by Mr. W. E. L. Gaine, the General Manager of the National Telephone Co., and published in *The Times* of Nov. 11, states that to whatever extent the London telephone service may be inefficient or inadequate at the present time, is entirely the fault of the London County Council:—

In May, 1896, the Company applied to the County Council for the consent of that body, as required by the Telegraph Act, 1892, to enable the Company to place its wires underground—the only solution of the serious difficulties which otherwise beset the Company from the use of overhead wires. Prolonged negotiations followed, and finally terms were agreed and embodied in a series of resolutions passed by the County Council on June 1, 1897. . . . The draft of the formal agreement was . . . submitted to the Company for consideration on January 29, 1898. It was then found that two additional conditions not forming part of the bargain had been inserted. These conditions were—(1) That the Company should make a wayleave payment to the County Council which would impose a burden upon the Company amounting to several thousand pounds per annum, and (2) that the Company should reduce its tariffs to an arbitrary scale as fixed by the County Council, which would involve the Company in an immediate loss of revenue of upwards of forty thousand pounds per annum. The Company considered that the importation of these conditions after more than twelve months had been spent in concluding the bargain was not in accord with good faith. The Company replied that . . . it was willing to make wayleave payments . . . if the County Council indemnified the Company against any claims which might be made by the road authorities in the Metropolis, and, as regards tariffs, it . . . offered to agree to fix the Company's present tariffs as the *maximum* charges to be made, and to come under an obligation to supply all intending users equally and without undue preference. On May 19, 1898, the County Council broke off the negotiations. . . . On the 3rd inst., there were 992 people in London waiting to be joined up to the Company's system. As regards the bulk of these they will have to wait an indefinite time, on account of the difficulties in the way of the Company in physically connecting their premises with its exchanges owing to the want of facilities which it is in the power of the County Council to give. . . . I see that it was stated in the course of the debate that the Highways Committee is prepared to recommend the requisite facilities being given to the Company, if the Company will concede to London similar terms as to tariffs and wayleave payments as the Company has given to Manchester, Liverpool, and other towns. The position of London is not comparable with that of any other town. It covers an area of 634 square miles. The working cost of a telephone system throughout this great area is nearly double what it is anywhere else, and the tariffs must therefore be proportionately higher. At the same time I may add that the Company is considering whether it cannot meet the requirements of small users and those requiring a more limited service. It is the intention of the Company to invite the County Council to re-open negotiations, and it will not be the fault of the Company if a proper arrangement is not come to. Let me give one instance of the treatment to which the Company is subjected. When the bargain was concluded with the County Council on June 1, 1897, the Company was allowed to go on with certain portions of underground work which were very urgently needed. Amongst the works authorised is a system of pipes for upwards of 6,000 miles of wires which the Company has laid down in the districts governed by the Holborn Board of Works and the Vestry of St. Giles, all centring upon a large exchange of the Company situate at the corner of Holborn-viaduct and St. Andrew-street. These pipes are stopped close to the north-west corner of Holborn-viaduct, and for months they have been lying idle . . . because the Company cannot obtain from the local authority the permission to carry them across one road and into the exchange.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, November 18th.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7.30 p.m. Second General Meeting of the Session in the Literary and Philosophical Society's Lecture Hall, Newcastle-on-Tyne. Paper to be read: "Repairs to Iron and Steel Vessels in way of Boilers and Stokeholes," by M. W. Aisbitt.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting, when the following Paper will be read: "Liquid Air: A Short Description of its Production and Summary of its Application to the Chemical or other Industries," by Cecil Lightfoot.

MONDAY, November 21st.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture I.—"Acetylene," by Prof. Vivian B. Lewes.

TUESDAY, November 22nd.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting, when the following Paper will be further discussed: "Electrical Transmission of Power in Mining," by W. B. Esson.

WEDNESDAY, November 23rd.

SOCIETY OF ARTS.

8 p.m. Second Ordinary Meeting. Paper to be read: "Long Distance Transmission of Electric Power," by Prof. George Forbes, F.R.S.

THURSDAY, November 24th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting, when Prof. Silvanus P. Thompson's Paper on "Rotatory Converters" will be further discussed.

FRIDAY, November 25th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Papers to be read: (1) "On the Properties of Liquid Mixtures," by R. A. Lehfeldt; (2) "On certain Diffraction Fringes as applied to Micrometric Observations," by L. N. G. Filon.

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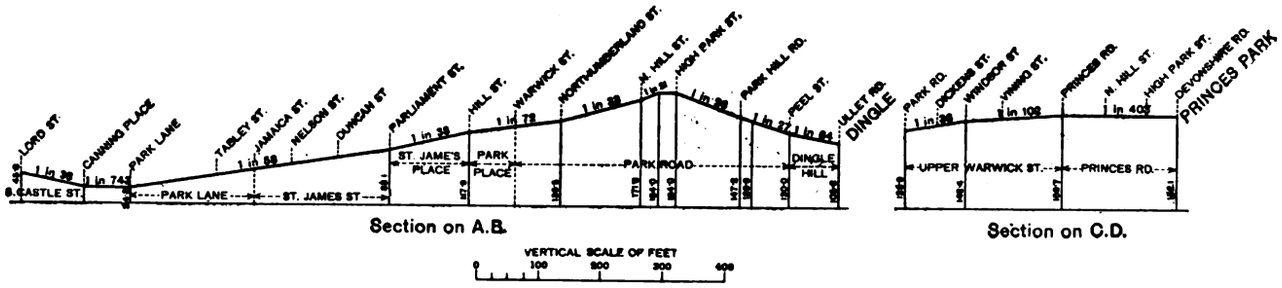
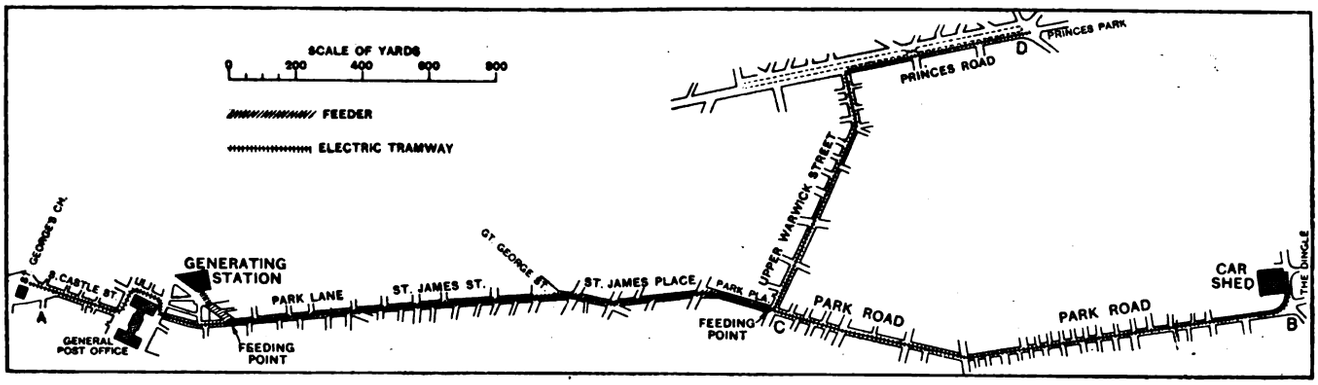
LIVERPOOL CORPORATION ELECTRIC TRAMWAYS.

The history of the development of the electric tramway scheme at Liverpool is well known to our readers, but we may briefly mention that on the acquisition of the horse tramway system of that city it was brought prominently before the Corporation that the service would be greatly improved by conversion to the overhead trolley system. Dr. John Hopkinson was appointed consulting engineer to report on the proposed scheme, and ultimately the overhead trolley system was recommended for a short length of what has been termed an experimental line. Upon the death of Dr. Hopkinson last August, Mr. John Brodie, the city engineer, and Mr. A. Bromley Holmes, the city electrical engineer, were appointed the joint engineers to complete the electric line, which is now on the point of being opened, these engineers, of course, working in co-operation with the representatives of the late Dr. John Hopkinson.

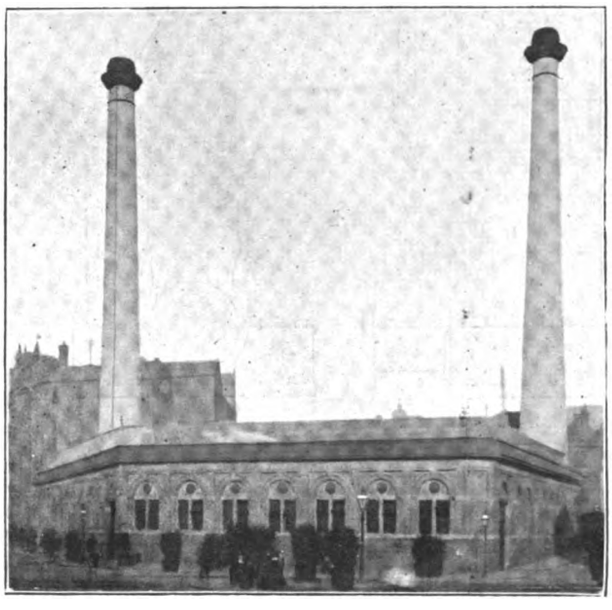
In adopting a system of electric traction for the tramways the Liverpool Corporation has departed somewhat from the practice initiated at Leeds, and subsequently adopted at Glasgow. In the last two places the tramways are driven from an independent power station, whereas at Liverpool the tramway generating plant is erected in the same station as the Corporation electric lighting plant; and, although separate generators are used, and are driven by separate steam engines, the management of the generating plant is the same, and identically the same steam boiler plant is used. Liverpool, therefore, affords the first example of a municipal combined electric lighting and tramway system, the lighting and tramway departments being owned and worked by the Corporation.



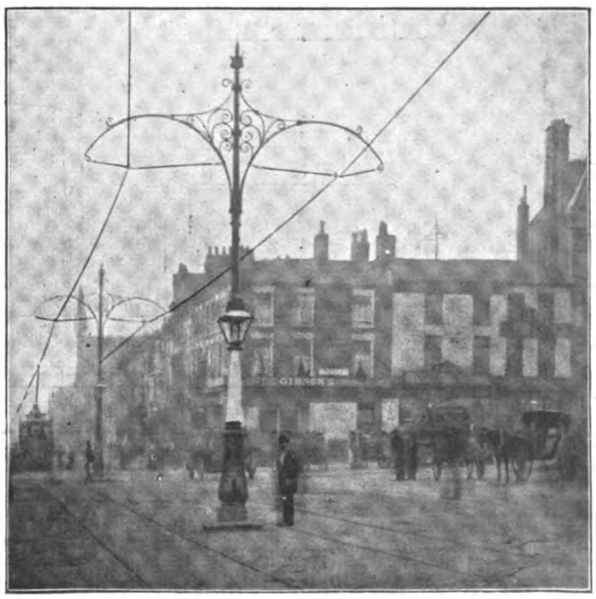
Section of the Liverpool Corporation Electric Tramways, showing Gradients.



Map of the Liverpool Corporation Electric Tramways, Power Station and Car Sheds.



Paradise-street Combined Electric Supply and Tramway Power Station.



Centre-pole Construction on the Liverpool Electric Tramways.

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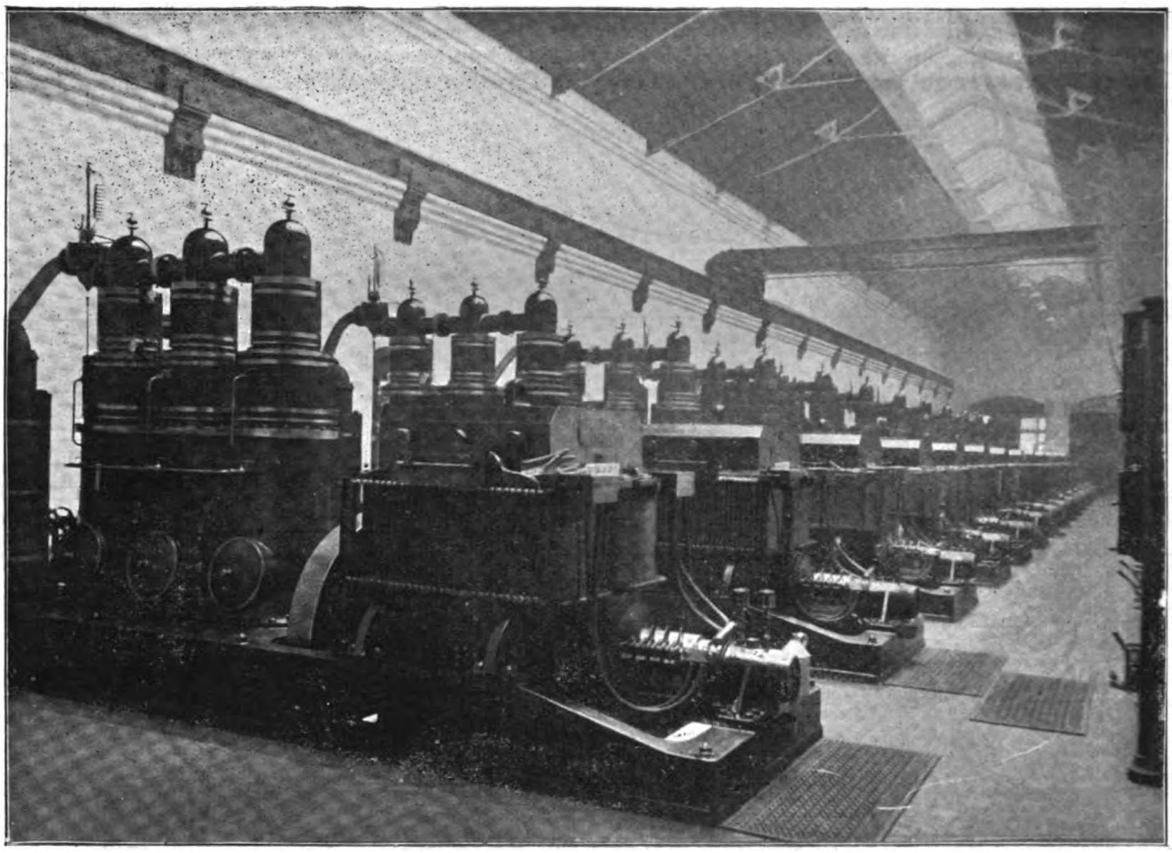
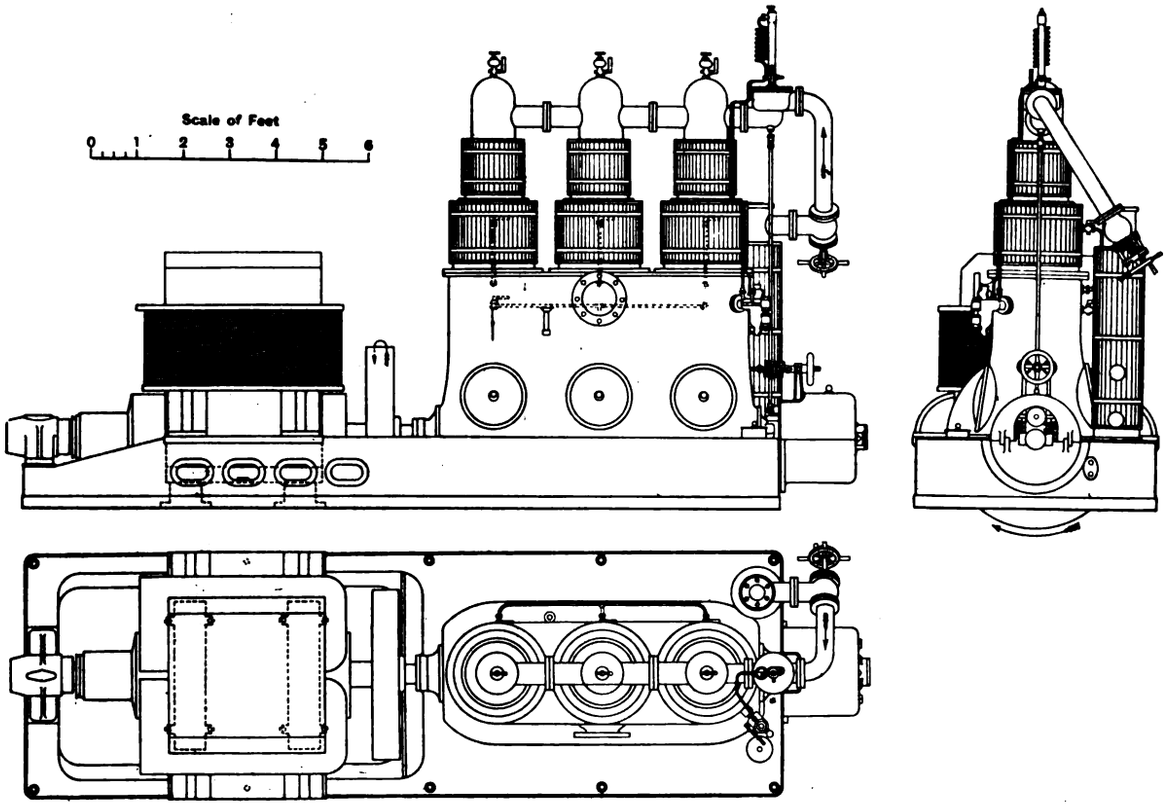


Machinery Room at Paradise-street Combined Lighting and Tramway Power Station, showing in the foreground the three Willans-Siemens Tramway Generators.



Plan and Elevations of the 300-H.P. Willans-Siemens Tramway Generators at the Liverpool Corporation Power Station.

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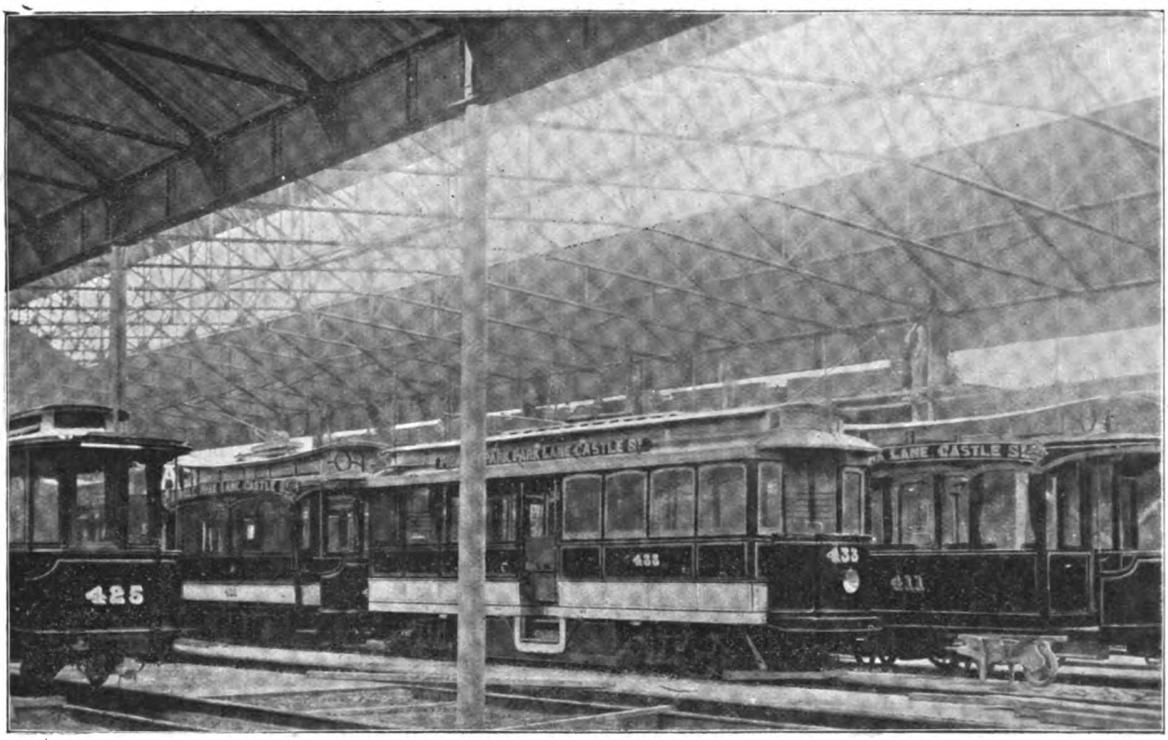
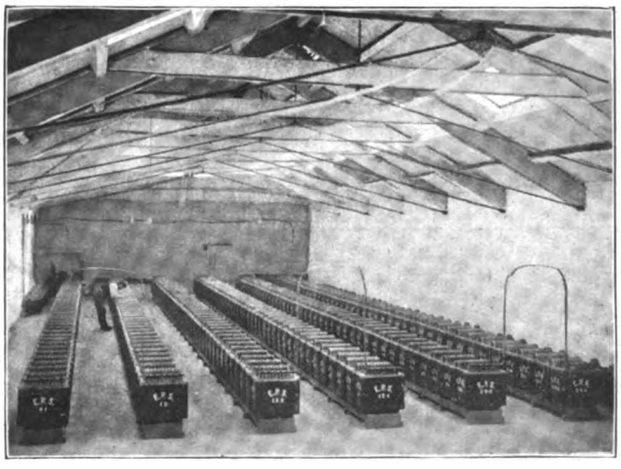
The experimental line extends from a point near the old Post Office to Prince's Park and to the Dingle, as shown on the accompanying map. The route is largely undulating, and has many steep gradients but few awkward curves. The pilot cables are lead-sheathed and armoured. The feeders are laid on the solid system in iron troughs, similar in all respects to those exclusively used in Liverpool for the last 10 years for the ordinary electric supply. The pilot cables con-



Interior of Car Sheds, showing various types of Motor Cars and Trailers for Liverpool Corporation Electric Tramways.

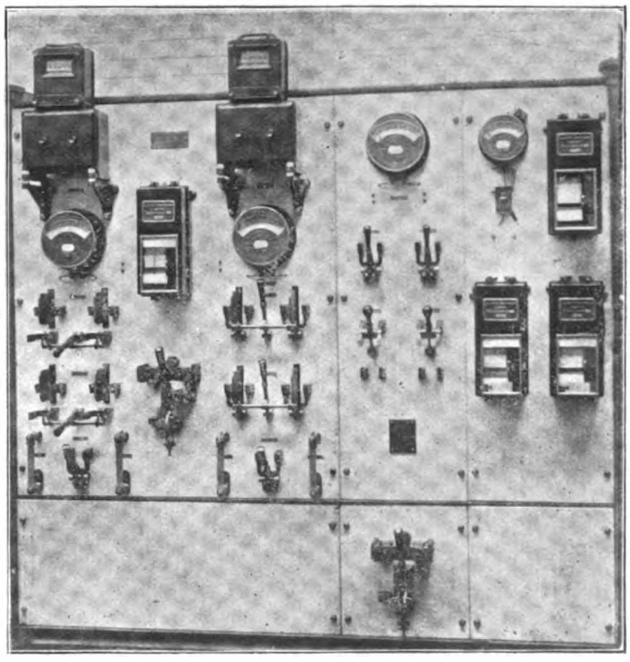
entire length of the track is 6¼ miles, principally double. It is equipped partly on the centre pole system, but principally on the span wire system, with side poles erected along the pavements. The trolley wires, which are duplicated throughout, are of 0·4in. diameter hard-drawn copper wire of circular section. They are placed centrally with respect to the track, the trolley poles being of the centre under-running type, commonly used in America. The overhead trolley system, which has been constructed by Messrs. Robert Blackwell and Co., is divided into sections of about half-a-mile in length,



Battery Plant erected by the E.P.S. Co. for Liverpool Corporation Tramways.

and is fed at two points shown on the map. The feeder cables are 0·4 sq. in. section, and provide for both the supply and pilot return. These were supplied by Callender's Cable and Construction Co., and are of their well-known vulcanised bituminous dielectric type, while the Board of Trade

ist of three-core 7/18 conductors, with fibrous insulation, lead-covered, armoured with steel tape and yarned. The route of the mains is as follows (as shown on the map). Start-



Liverpool Electric Tramways. E.C.C. Switchboard at Paradise-street Power Station.

ing from the generating station by Paradise-street, two pairs of feeders are laid as far as the corner of Paradise-street and Park-lane, together with two three-core and one single-core armoured cable. At this point two of the feeder cables are finished off in the pillar-box. The single core pilot is con-

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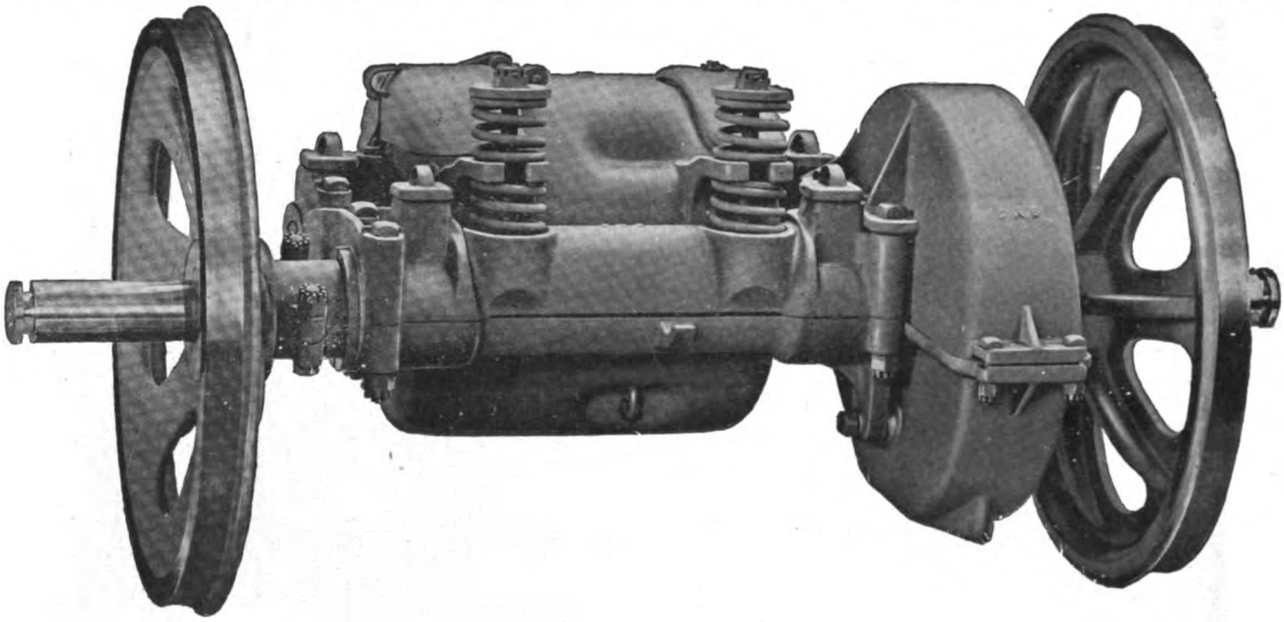
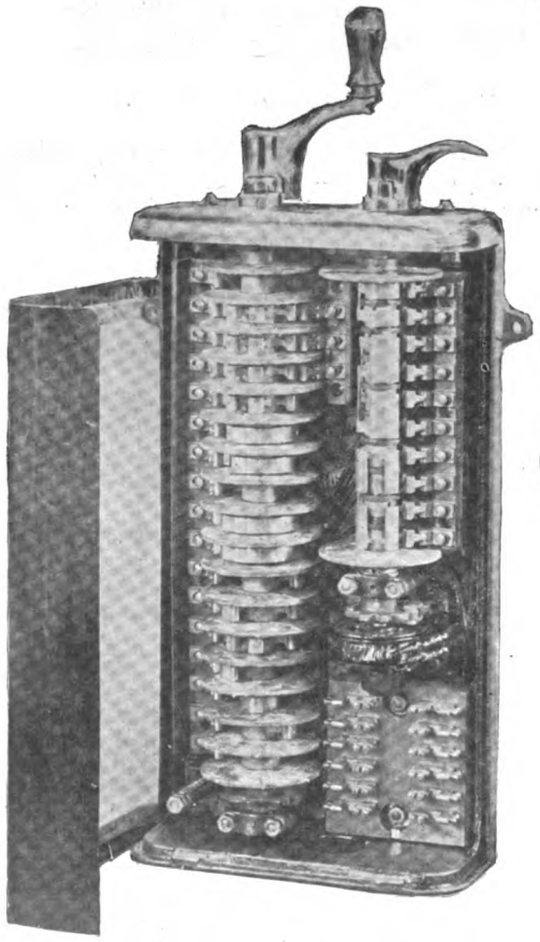
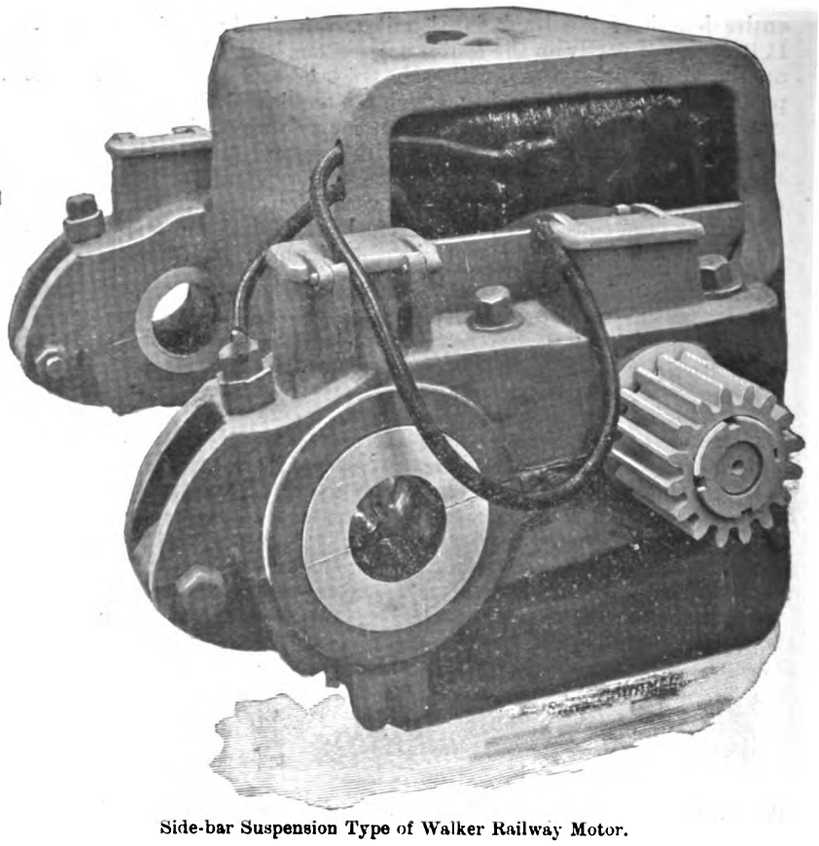
nected to the rails, and two of the cores in one of the three-core cables are laid through the pillar-box for telephonic purposes. Proceeding along Park-lane the two remaining feeders and the two three-core armoured cables are laid as far as the corner of Park-place and Upper Warwick-street, at which point the feeders are finished off in the pillar box. Similar connections, as at Paradise-street, are here made for telephonic purposes, and also at Duncan-street, in Park-lane. From Upper Warwick-street the armoured cables are alone continued, the one to the car sheds at the Dingle and the other to the end of Princes-avenue. At the rail head, at both Princes-avenue and also at Dingle, one of the conductors in the three-core armoured cable is connected to the rails, and the other two are used for telephonic purposes. Provision is also made for telephoning from the pillar box at Haliburton-street. The Board of Trade wire is intact from the generating station to the rail head in each of the two routes, one for Dingle and the other for Princes-avenue. The telephone circuit is a series one, and the conductor is arranged to form one continuous loop, traversing the whole route, into which the instruments may be inserted at the points mentioned above. The vulcanised bitumen feeders are laid through from



Walker Tramway Motor mounted and geared to Car Axle.



Walker Series-Parallel Controller, showing Interior.



Side-bar Suspension Type of Walker Railway Motor.

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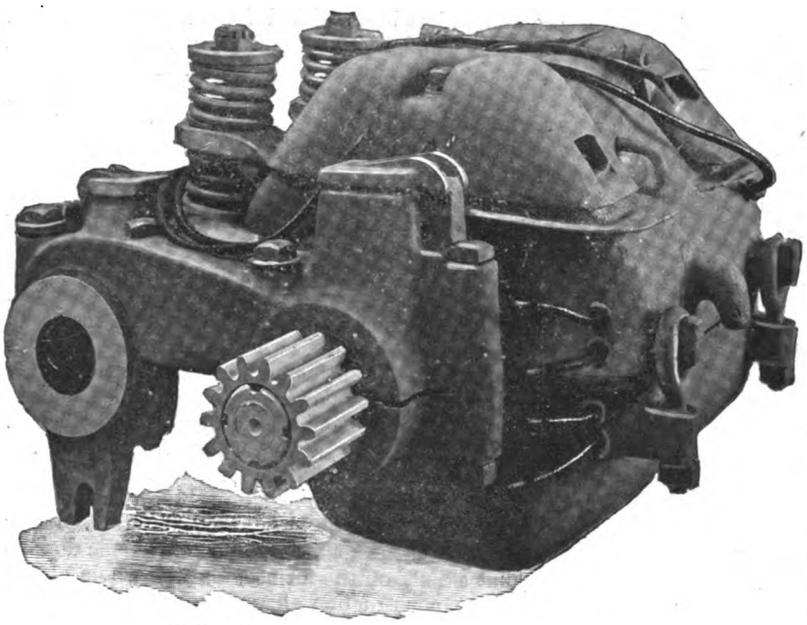
the station to the feeder points without any intervening boxes, the lengths of the two being to Park-lane 180 yards, and to Upper Warwick-street 1,840 yards. The lengths of the two Board of Trade pilots are: to Dingle 3,560 yards, and to Princes-avenue 3,200 yards. The total length of the telephonic circuit is some 17,200 yards.

At the Dingle terminus well-equipped car sheds, capable of housing 50 cars, are now in course of completion. At the far end of these sheds there is a single traversing table, capable of handling one car at a time. There is also a fan rail system at the other end of the sheds. The sheds are provided with workshops for small repairs, and with inspection pits and arrangements for handling motor trucks.

The deputation which visited the Continent and America, prior to the adoption of electric traction by the Liverpool Corporation, decided to make an all-round experiment with various types of motor cars. Accordingly, at first, one American and one German car were ordered, and subsequently 14 additional American motor cars and 14 German motor cars. The various types of car are shown in one of the accompanying illustrations. The American cars are of the double bogey type, similar to those used in Cleveland, Ohio. They were supplied by Messrs. Dick, Kerr and Co., and are fitted with Brill maximum traction trucks and with Walker motors and trolley equipment, each car having two 35 H.P.



Walker Tramway Motor built for Spring Suspension.

Walker motors, controlled on the series-parallel system. The German cars are of two kinds: the "Altona" type and the "Ringbahn" type, as used on the Hamburg tramways bearing these names. Both types of cars are carried on rigid trucks, and are equipped with two 20 H.P. Schuckert motors together with Schuckert series-parallel controllers. There are, in addition, 15 German trailers. Each of the American cars is capable of carrying 40 passengers, while the German motor cars have a capacity of only 20 passengers and the trailers 18. One car is fitted with a Standard air brake, the air pump being worked off one of the axles and the pump automatically cut-out when the pressure in the air vessel reaches the maximum amount, which is capable of slight adjustment. This brake actuates the same brake blocks on the car as the hand brakes, and is found to work very satisfactorily. Electric emergency brakes are fitted to all the cars.

The power station plant for this tramway consists at present of three Willans-Siemens 300 H.P. generators, together with a 150 ton E.P.S. battery. The engines are of Messrs. Willans and Robinson's I.I.I.S. type, and differ in no way from the ordinary pattern except that they have considerably heavier fly wheels than are used for the lighting sets. In the illustration the tramway generators are the three nearest in the long line of generators shown. The engines are of the compound triple-crank type and work non-condensing. They are coupled to two-pole 550-volt shunt dynamos, built by Messrs. Siemens Bros. and Co., having smooth-wound armatures of the drum type. The regulating resistances for the shunts are carried on the side of the generators. The normal speed of the generating sets is 350 revolutions per minute. In addition to these three generating sets, larger tramway generators of 1,500 H.P. each are now in course of construction, and will be erected before the tramway system is extended. These were described briefly in an article in *The Electrician*, Vol. XL., p. 786, but the following additional particulars may be of interest. The engine is of the three-crank compound type, fitted with Willans automatic expansion gear, and is designed to run at 230 revolutions per minute, developing a normal load of 1,250 H.P. under a pressure of 160lb.; but for short periods a load of 1,500 I.H.P. may be allowed. The effective area of each high-pressure cylinder is 277 sq. in., and of each low-pressure cylinder 854 sq. in.; the stroke is 16⅞in., and the diameter of crank shaft 11in., the shaft being of Siemens-Martin mild steel. The overall height of the engine is 19ft. 4in., and the floor space, including the generator, to which the engine is to be direct-coupled, 24ft. by 13ft. 6in. The engines are so designed that they may be converted into triple-expansion engines with the least possible trouble. The variation of speed, from full load of 780 kilowatts to one-eighth load of, say, 96 kilowatts, is guaranteed not to exceed 2 per cent., and from full load to no load 3 per cent. The dynamo to which this engine is coupled is a Siemens multipolar continuous-current generator of the type known as 10 B 84/15, and will develop 1,420 amperes at 550 volts. The set is not provided with a separate flywheel, the necessary weight being located in the armature.

The tramway switchboard is independent of the lighting switchboard, and is placed immediately opposite the three tramway sets. It consists of a cast-iron frame carrying three marble panels, the left-hand one being the main board, the middle the booster board, and the right-hand the Board of Trade board. Upon the main board are mounted four double-pole switches and single-pole fuses for connecting three dynamos and one battery to the tramway 'bus bars; and two Chamberlain and Hookham electric meters, one of which is connected to the battery circuit and works in either direction. There are also on this panel one recording ammeter in the battery circuit, one automatic circuit-breaker, two single-pole switches, one of which is for disconnecting the near rail and the other the near trolley, one voltmeter for reading the potential across the 'bus bars, and one ammeter in the circuit of the near rail. The capacity of all the switches is 300 amperes, but the circuit-breaker is adjusted for 500 amperes normally, and is capable of being adjusted to 800 amperes. The booster board has mounted upon it two single-pole two-way switches of the throw-over type for connecting the line feeder and the track feeder direct to the 'bus bars or to the 'bus bars through the booster; also two single-pole main switches, one for disconnecting the distant rail and for the distant trolley wire. There is also an ammeter on this panel. The capacity of all the instruments and switches is 300 amperes. The Board of Trade panel has the usual equipment on it, viz., one recording ammeter reading to 10 amperes, one low-reading ammeter with two scales of 0·0005 to 0·005 and 0·05 to 5 amperes. This instrument is connected across the terminals of the circuit-breaker on the main board. On this panel there is a spring contact switch and fuse provided for the ammeter, also two low reading recording voltmeters. The instruments on this switchboard were made by Messrs. Elliott Bros., and the switchboard was constructed and erected by the Electric Construction Co.

The Electric Construction Co. are now building a special E.C.C. booster for the tramway supply. This combination consists of three E.C.C. upright bipolar type machines, mounted rigidly together in line. The centre machine is a

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shunt-wound 500-volt motor, the outside machines being generators of the series-wound type, giving a potential at any speed proportionate to the current up to a maximum of 300 amperes, the magnet coils of the generators being in series with one of the armatures. The motor is provided with the usual starting resistance, and has also a rheostat in the shunt coils for slight adjustments.

The battery is erected on the floor of a spacious room adjoining the machinery room. It consists of 246 cells, manufactured by the Electrical Power Storage Co., each cell containing 21 plates of the K.L.P. type, the battery being rated at a maximum discharge of 480 amperes at 550 volts for one hour.

The total cost of the construction and equipment of the 6¼ miles of tramway in this experimental line is estimated at £82,000, viz., £33,000 for the line construction and equipment, £24,000 for the total of 45 cars, and £25,000 for the car sheds and workshops. It is proposed to charge 2d. for a seat in the non-smoking section and 1d. in the smoking section of the car, for a complete single journey.

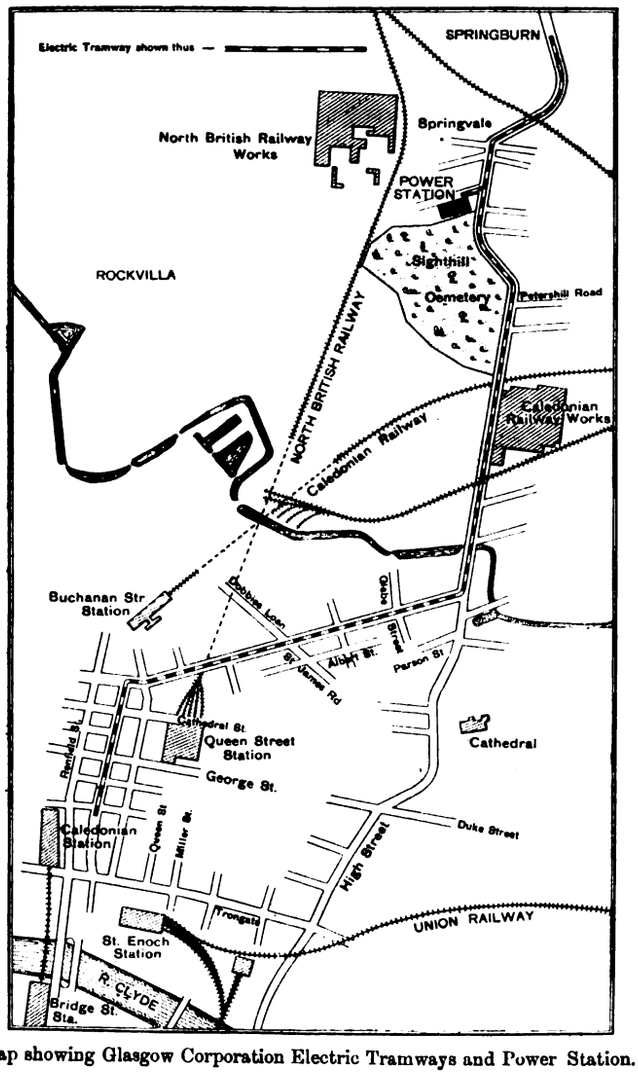
Following is a list of the principal contractors and manufacturers who have supplied plant or carried out work on these tramways:—

Complete equipment of lines.	Robert Blackwell and Co.
Cars, motors and controllers (American)	Dick, Kerr and Co.
Do. (German)	Busch and Co.
Motors & controllers (German)	Schuckert and Co.
Cables	Callender's Cable and Construction Co.
Engines	Willans and Robinson.
Dynamos	Siemens Bros. and Co.
Booster	Electric Construction Co.
Switchboard	Electric Construction Co.
Instruments	Elliott Bros.
Battery	Electrical Power Storage Co.

We have pleasure in acknowledging our indebtedness to Mr. A. Bromley Holmes, the Corporation electrical engineer, and to Mr. W. H. Collis, the engineer-in-charge of the tramway department, for the courtesy extended to us during our visit to the tramway system and for the information they have kindly placed at our disposal. We are also indebted for much of the information to the contractors who have carried out the work.

GLASGOW CORPORATION ELECTRIC TRAMWAYS.

The development of electric traction at Glasgow has, broadly speaking, followed the same lines as that at Liverpool, a description of the tramways at which place is given in the preceding article. But there is this difference between the two, that whereas at Liverpool electric traction was decided on almost simultaneously with the taking over of the tramways by the Corporation from the original Company, at Glasgow the system has been worked for a considerable time by horses since the acquisition of the lines by the Corporation in 1894. The enormous advantages of electric traction over every other system of tramway operation could not, however, for long remain unheeded by so progressive a body as the Glasgow municipality, and although they have shown great hesitation in the adoption of the overhead system, the fact that they are desirous of giving electric traction a trial is proved by the short experimental line which was recently equipped on the trolley system between Glasgow city and the district of Springburn, and which, as refuted on p. 88 of our last issue, has already given the greatest satisfaction. The decision to make this experiment was the result of a visit of a sub-committee, together with the tramway engineer and general manager, to the Continent and America; and we may add that the equipment of the power station and line has been carried out under the supervision of the Corporation officials.



Map showing Glasgow Corporation Electric Tramways and Power Station.

Although representing only a very small fraction of the total tramway system of Glasgow, the electric line, a map of which accompanies this article, serves admirably for the purpose of an experimental trial of the overhead trolley system. It has been equipped both on the span-wire and centre-pole double-track system, but chiefly on the former, and the whole of the electrical overhead construction has been carried out by Messrs. Robert Blackwell and Co. The track has been relaid with 100lb. steel girder rails, bonded at the fish plates with double Daniel bonds of No. 00 B. and S. gauge. The rails, which are also cross-bonded at frequent intervals, are laid on a 4ft. 7½in. gauge of cement concrete. They were rolled by the Barrow Hæmatite Iron and Steel Co., in 45ft. lengths, somewhat over the usual length. The span wires are carried partly on side poles and partly on wall rosettes of an artistic design. The poles are built up of three sections of parallel steel pipe, and are principally 30ft. in length, but some of heavier type are 31ft. in length. When tested in position they are found to comply with a specified strain, viz., for the lighter type 1,000lb. strain at the top, with the pole sunk 6ft. 6in. in the ground, producing a temporary deflection of not more than 6in., and a strain of 160lb. producing a deflection of only ½in. With the heavy pole strains of 1,200lb. and 260lb. respectively produced these deflections. We may say that the poles were made by Messrs. Morris, Tasker and Co., and the rest of the overhead construction by Messrs. Macartney, McElroy and Co., under the contractors, Messrs. Robert Blackwell and Co. As at Liverpool, the trolley wires, where brackets are used, are carried on fiddle-string supports, instead of, as is commonly used in America, the rigid insulating support. It is found that the first-named gives a much easier passage to the trolley wheel under the support, and prevents the fracture of the wire at this critical point. The trolley wires are of

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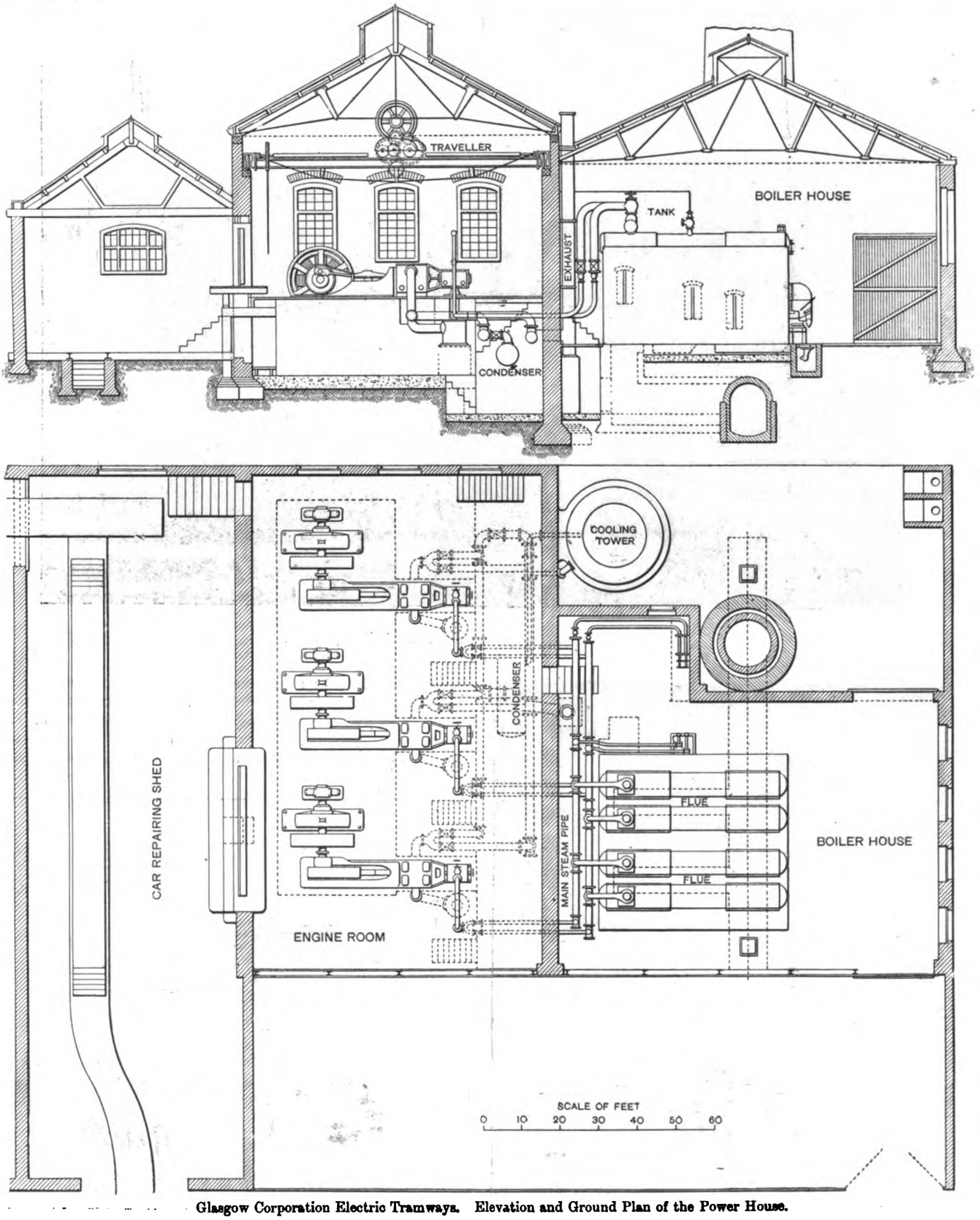
No. 00 B. and S. hard-drawn copper wire having a breaking strain of 6,000lb. They are duplicate throughout, and are supported by the usual type of strain insulators. The line is divided into half-mile sections, a section box being placed at each sub-division. These boxes are of cast iron, copper is half a square inch to each feeder, and cables are provided both for supply and return.

The rolling stock for this line is principally of American type, consisting of double bogey cars with centre and end entrances, besides a few shorter cars on rigid trucks. Some of



Glasgow Corporation Electric Tramways. Elevation and Ground Plan of the Power House.

and provide a switch connection with the feeders. There is also in each section box a telephone outfit and a set of lightning arresters. The feeder cables were manufactured by Messrs. Siemens Bros. and Co., and are buried. The section of the cars have been equipped by the Westinghouse Electric Co., and in other cases the cars are equipped with British Thomson-Houston plant. The motors, of which there are two in each motor car, are rated at 35 H.P., and are con-

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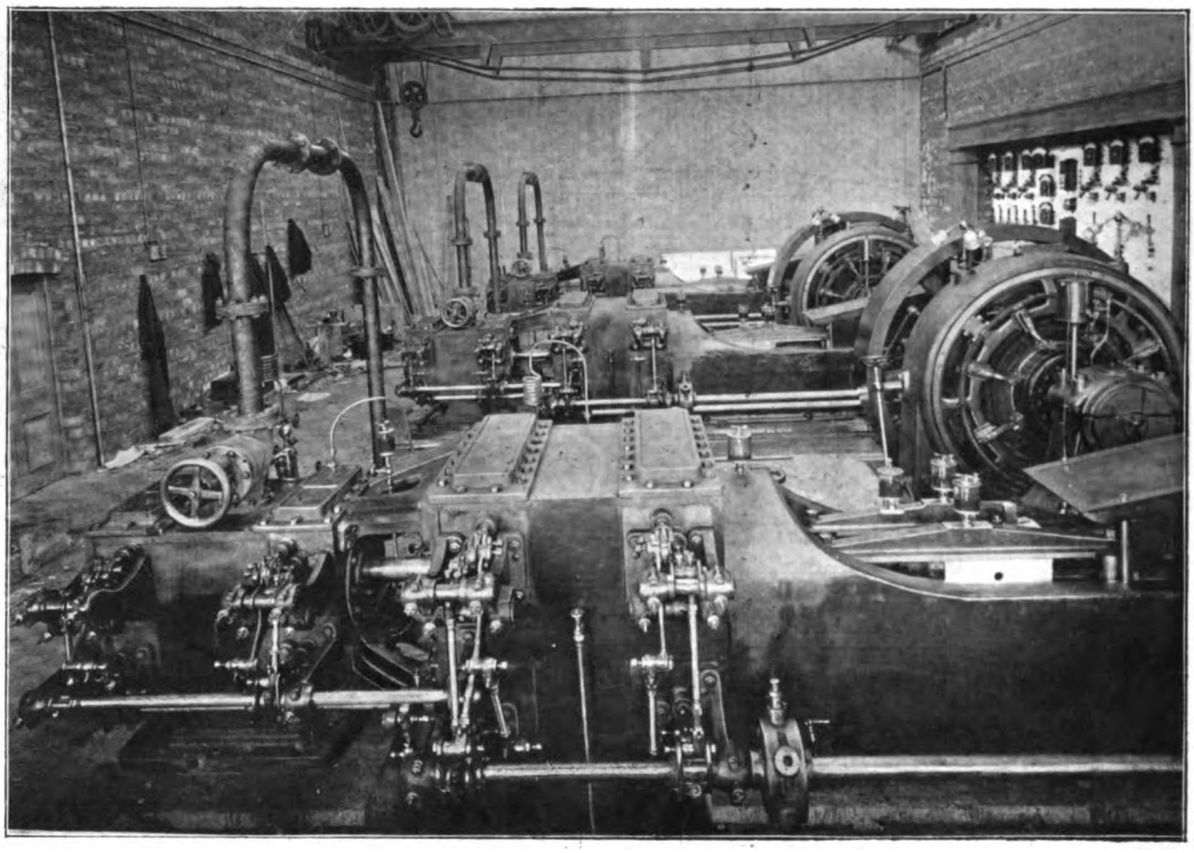
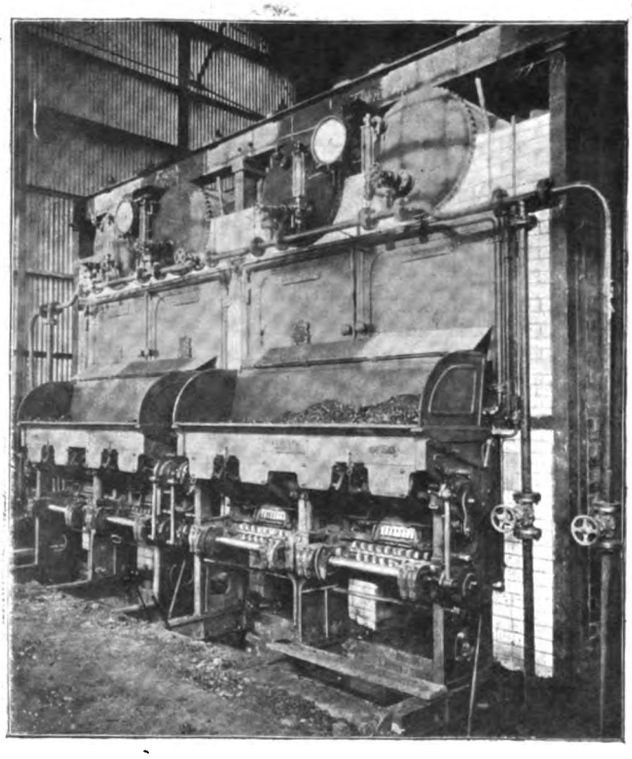
trolled on the series-parallel system. A special arrangement has been introduced for the car lighting, a diagram of which is shown in an accompanying illustration. This arrangement provides for two circuits for the lamps in each car, there being two three-way switches so connected up that either head light can be put on to either circuit according to the direction the car is going. The switches for the lighting circuit are worked from one handle, and are so locked that the same lamp cannot be put on to both circuits at the same time. The motors are of the well-known enclosed railway pattern and call for little comment. The armature is of the drum type, and the fields are, of course, series wound. The motors are geared to the axles by single reduction spur gearing, the gear wheels being wide faced and of ample size to stand the heavy strains of tramway service. The motor gears are enclosed in an oil-tight casing, and the lower teeth of the spur wheel dip into a bath of oil. It will be of interest to our



Glasgow Electric Tramways. Interior of Machinery Room.



Glasgow Electric Tramways. Babcock-Wilcox Boilers at the Power Station.

Rigid-truck Car equipped by the British Thomson-Houston Co.

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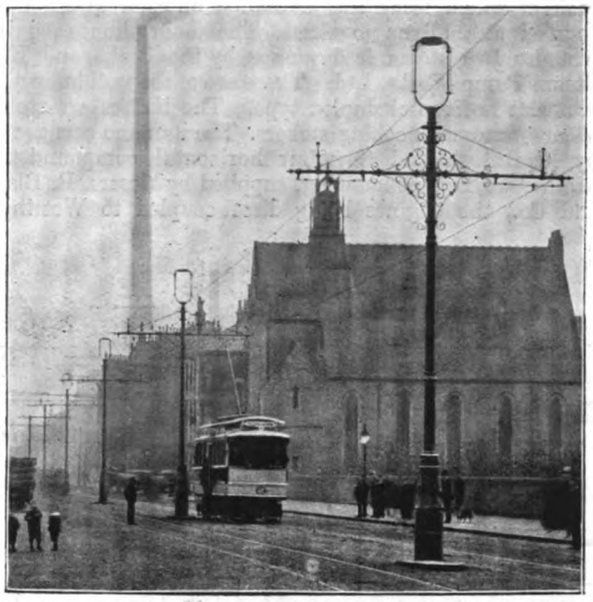
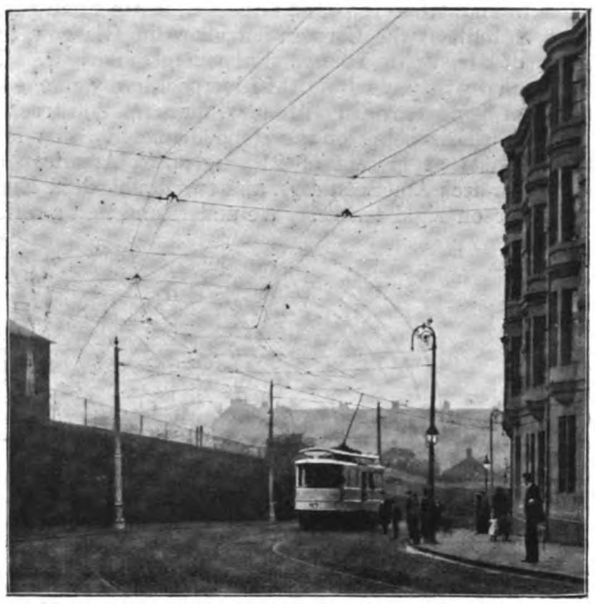
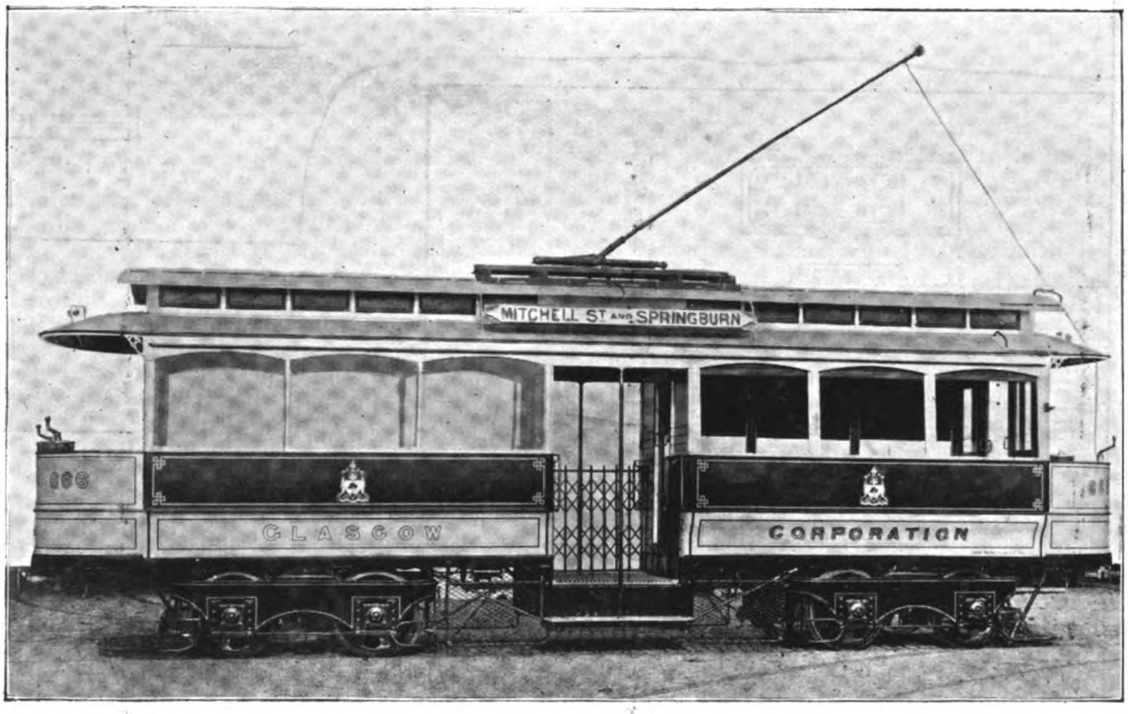


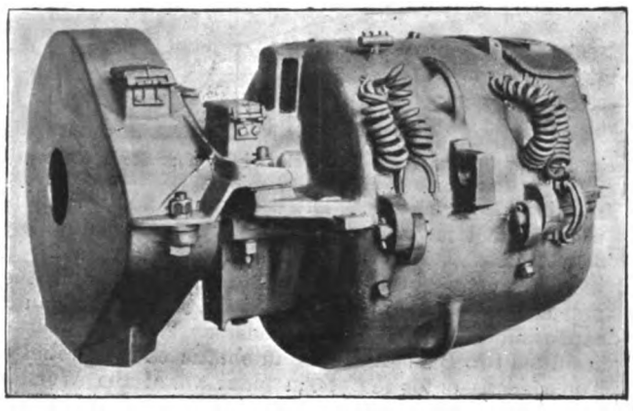
Double-bracket Centre-pole Construction on Glasgow Electric Tramways.



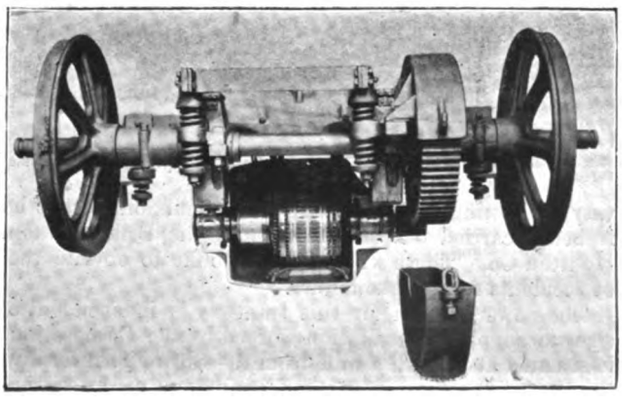
Span-wire Side-pole Construction on Glasgow Electric Tramways.



Glasgow Electric Tramways. Double-Bogey Car equipped by the Westinghouse Electric Co.



Westinghouse 35-H.P. Tramway Motor and Gear, enclosed as used on Car.



Westinghouse Motor mounted on Car Axle, with Field and Case removed to show Armature and Gear.

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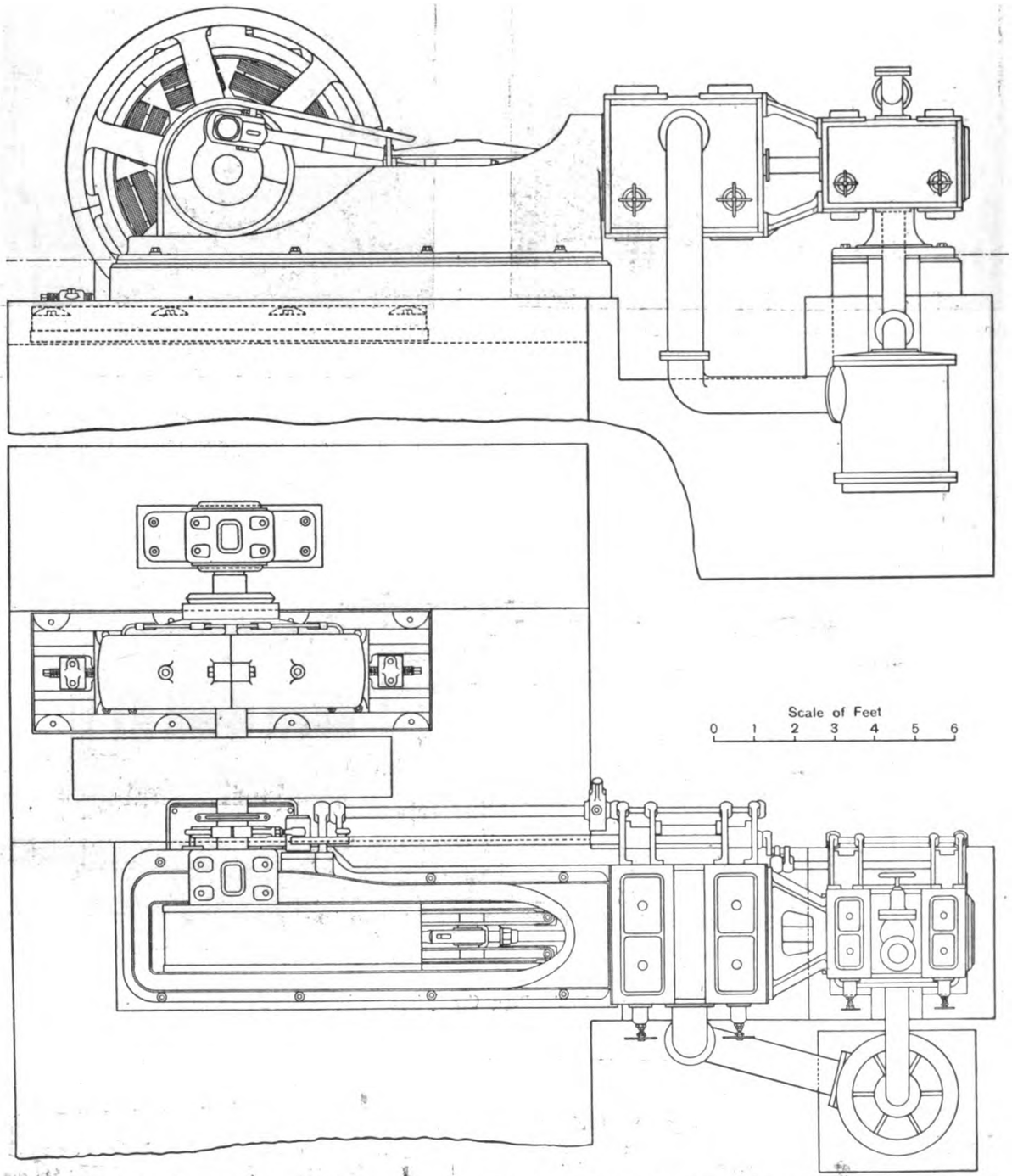
readers to know that the cars, although of American pattern, have been built at the Corporation shops in Glasgow, to the designs of Mr. John Young, the general manager. They differ in many respects from the Liverpool bogey cars, especially in not being provided with maximum traction trucks, all the bogey wheels being of the same diameter. The rolling stock consists at present of 21 single-deck American cars, two double-deck American cars, and two double-deck English type of car on rigid trucks. We understand that a series of very interesting and important experiments on electric brakes is being carried out on the cars by the British Thomson-Houston Co. These will no doubt go far to obviate the risk of accidents from brake failure.

The power station for this tramway is independent of the electric supply power station worked by the Corporation, and is situated about half a mile from the Springburn terminus of the line. The dimensions and equipment of the station are shown in the accompanying scale drawings. Steam is generated by a battery of two Babcock-Wilcox water-tube boilers connected to independent duplicate steam main ranges, each of which feeds the standpipe of each of three direct-coupled steam-dynamo sets. The boiler-house equipment includes two steam feed pumps by the Blake and Knowles Steam Pump Works, Ltd. These are of the well-known Blake-Knowles horizontal duplex type. The boilers are stoked by Vicars' automatic coking stokers. The dynamo sets are driven by MacIntosh and Seymour horizontal compound tandem engines working condensing, supplied by Messrs. R. Blackwell and Co., the engines being direct-coupled to Westinghouse multi-polar generators. The sets run at 200 revolutions per minute, and have a rated capacity of 200 kilowatts, viz., 380 amperes at 550 volts. The engines have a 2ft. stroke, with cylinders of 11in. and 22in. diameter, and they are provided with exceptionally heavy flywheels and automatic expansion valves on both cylinders. To the exhaust mains are fitted two Blake-Knowles automatic exhaust relief valves. The condensers for the steam plant are of the Worthington type, the condenser water circulating through a large cooling tower, the air draught for which is produced by an 84in. fan driven by a Brotherhood steam engine of 10 H.P.



Glasgow Electric Tramways. Direct-coupled Westinghouse Multipolar Railway Generator and McIntosh and Seymour Steam Engine.

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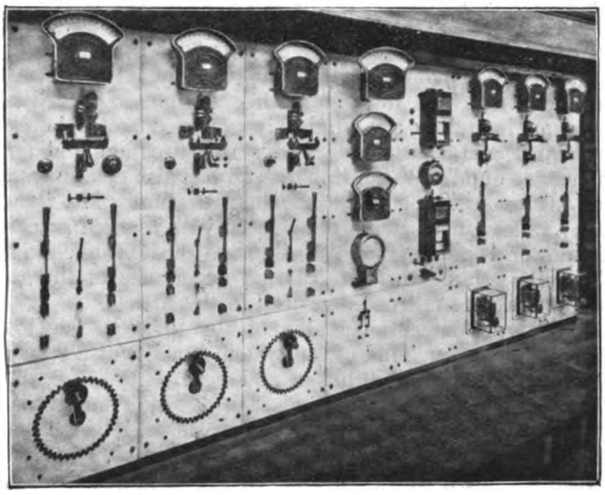
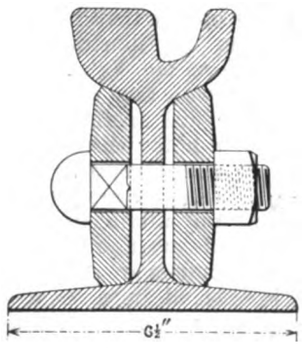
The generators are of the Westinghouse eight-pole railway type, consisting of a circular yoke, carrying inwardly-projecting pole-pieces of laminated soft steel, with field castings divided vertically and set up end-wise upon an independent bed-plate. The vertical position of the field affords excellent facilities for immediate inspection or removal of the armature or field coils without the necessity of removing the outside bearing or dismantling the engine. The generators are over-compounded for 10 per cent. drop at full load. The shunt and series coils are separately wound and are removable independently. The series coils are of forged copper conductors of rectangular



Glasgow Electric Tramway Power Station. View of Switchboard.

section. The armature core consists of punched discs of annealed steel, held together by cast-steel end plates, securely bolted in place. This core is carried on a spider pressed and keyed upon the engine shaft. Ventilating spaces through the spider and armature core are arranged so as to allow of a constant circulation of air through the commutator and wind-

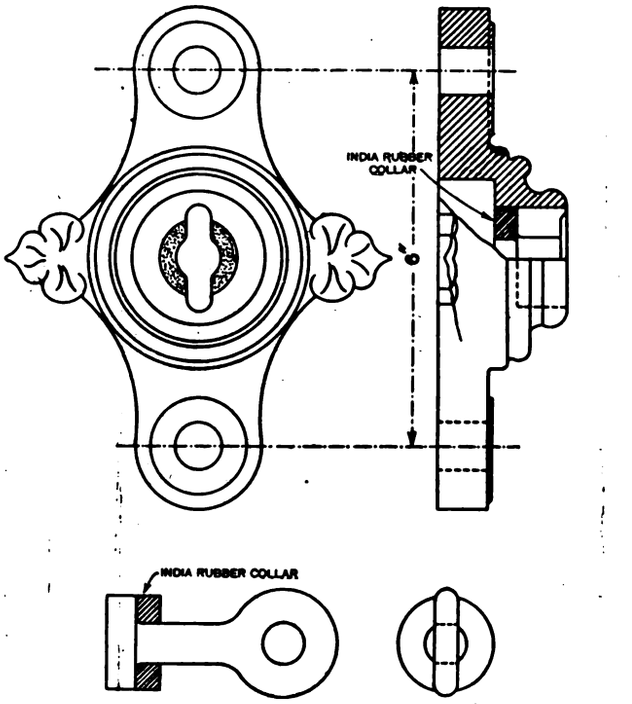


Section of Rail Joint on Glasgow Electric Tramway.

ings when the machine is running. The armature windings are carried in slots, and are made from bars of drawn copper, forged into shape on cast-iron formers. When shaped the bars are insulated with mica and fuller-board, and are baked to remove moisture. The coils are held in the slots by means of wedges of hard fibre driven into the armature near the end of the slots. The commutator consists of hard-rolled copper, the segments being insulated by mica. The brush holder mechanism is carried by brackets projecting from a ring concentric with and supported by the field. A hand worm engaging with the gear on the rim of this ring works the adjustment of all the brushes simultaneously.

The switchboard is also of the Westinghouse standard railway pattern, and consists of marble panels built into a framework of timber in one of the main walls of the building. It consists of eight panels, three of which are feeder panels, two Board of Trade panels, and the remaining three panels for the three generator sets. Inspection of the switchboard is provided by means of a gallery running behind it.

A very rapid service of cars is being run on these tramways, viz., a 2½ minutes headway for the entire route. The British public is not yet accustomed, either in Glasgow or in Liverpool, or in fact in any of the cities provided with electric traction, to the high speeds commonly met with in America; but, notwithstanding this, the round trip is made in very much less



Span-wire Wall Rosette designed by Messrs. Robert Blackwell and Co.

time than originally with horse cars. When the public is educated up to the maximum speed at which trolley cars can safely be run, the advantages of electric traction will be still more apparent than they are now. It is stated that the speed at Glasgow averages seven miles per hour, so that the entire journey of 2½ miles occupies about 21 minutes. The fare for the entire single journey is 1½d., and there are four ½d. section fares.

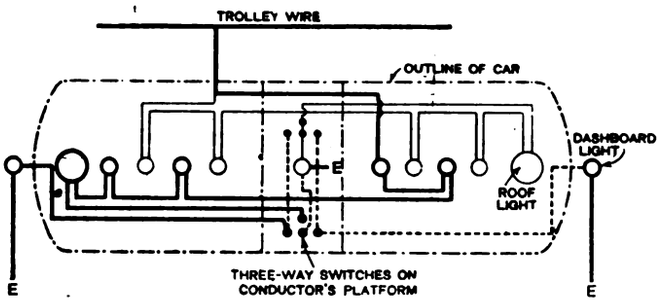


Diagram of Connections for Car Lamps on the Glasgow Electric Tramways.

The following is a list of the contractors and manufacturers who have supplied plant or erected work in connection with the Glasgow Corporation electric tramways:—

Overhead trolley equipment	Robert Blackwell and Co. Macartney, McElroy and Co.
Poles	Morris, Tasker and Co.
Rails	Barrow Hæmatite Iron and Steel Co.
Drain rails	Miller and Co.
Steam engines	Robert Blackwell and Co.
Electric generators	Westinghouse Electric Co.
Switchboard	Westinghouse Electric Co.
Motors, controllers & brakes	Westinghouse Electric Co. British Thomson-Houston Co.
Cables	Siemens Bros. and Co.
Boilers	Babcock and Wilcox (Limited).
Steam pumps, &c.	Blake and Knowles Steam Pump Works.
Automatic stokers	Vicars and Co.

Mr. A. E. le Rossignol is the electrical engineer in the tramway department, and the general manager and engineer are respectively Mr. John Young and Mr. William Clark. In conclusion, we have to acknowledge our indebtedness to the various contractors for supplying us with information and drawings for this article.

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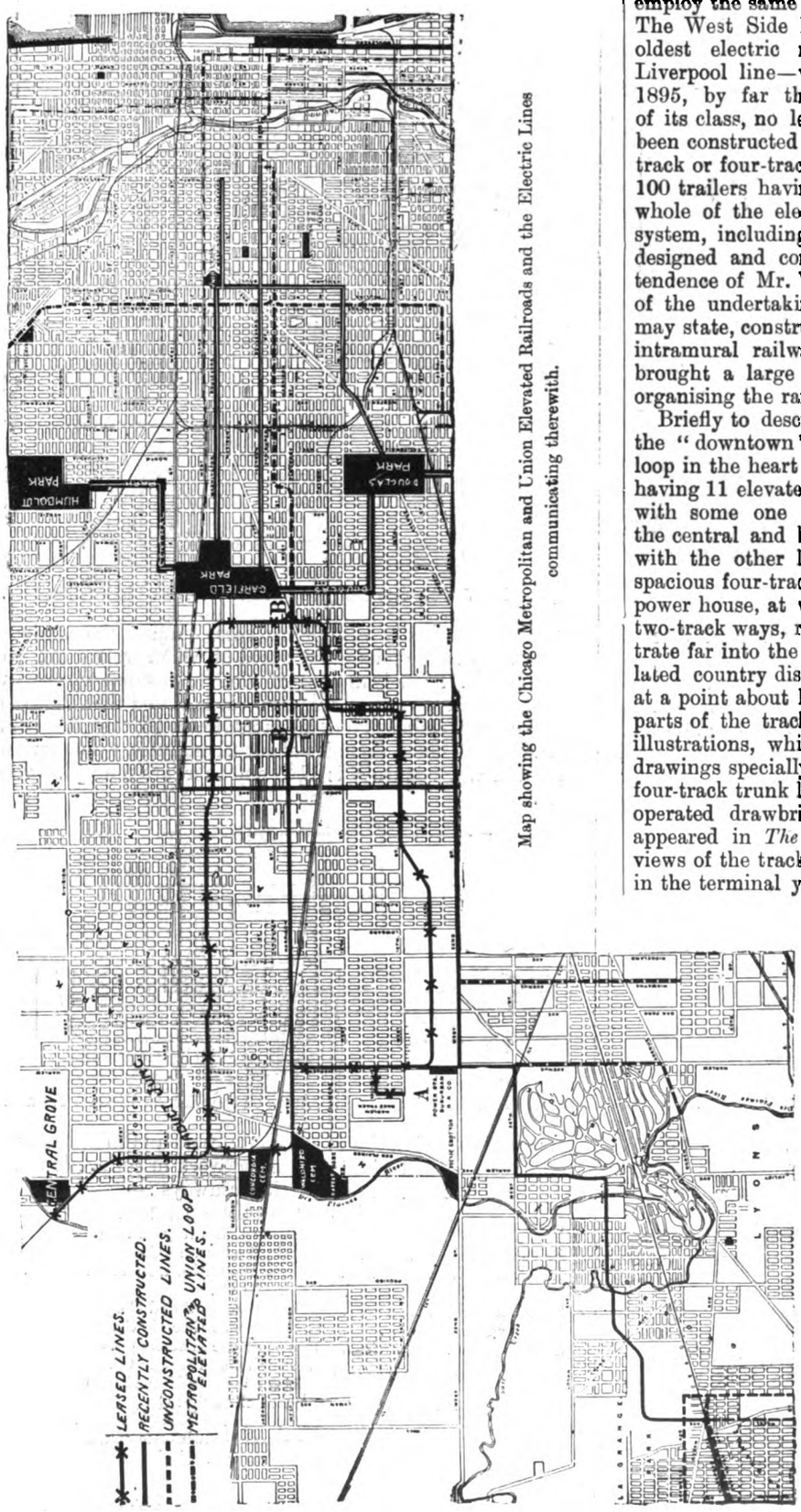
CHICAGO METROPOLITAN WEST SIDE ELEVATED ELECTRIC RAILROAD.

The Metropolitan West Side elevated railroad of Chicago was projected as far back as 1892, but was originally intended to be operated by steam. The success of the intramural electric line built for service during the Chicago Exhibition, however, encouraged the promoters to adopt electric traction, which has proved an uniform and pronounced success. Were there wanting anything to support this claim, apart from the operation of the line itself, such might be found in the conversion of all the Chicago steam elevated lines to electric traction on an identical system, and in the recent decision to employ the same system on the New York elevated railroads. The West Side line, or system of lines, although not the oldest electric railroad—having been ante-dated by the Liverpool line—was, at the time of its opening in April, 1895, by far the most important and extensive example of its class, no less than 18 miles of overhead road having been constructed at that date, all of which was either two-track or four-track way, and no less than 55 motor cars and 100 trailers having been at that time put into service. The whole of the electrical and other engineering work of this system, including the admirably-equipped power house, was designed and constructed under the direction and superintendence of Mr. W. E. Baker, who has also acted as manager of the undertaking since the inauguration. Mr. Baker, we may state, constructed and operated with marked success, the intramural railway at the Chicago Exhibition, and thus brought a large measure of ripe experience to the work of organising the railroad described in this article.



Map showing the Chicago Metropolitan and Union Elevated Railroads and the Electric Lines communicating therewith.

Briefly to describe the plan of the lines, we may say that the "downtown" end of the system consists of a rectangular loop in the heart of Chicago and near to the lake, this loop having 11 elevated stations, at each of which junction is made with some one or other elevated line. The loop encircles the central and busiest blocks in Chicago, and is connected with the other lines of the "West Side Elevated" by a spacious four-track way extending westward, or inland, to the power house, at which point it makes a junction with three two-track ways, radiating south, north and west. These penetrate far into the suburbs and beyond into the sparsely-populated country districts, the north-going branch being forked at a point about half way along its length. Views of various parts of the track are shown in some of the accompanying illustrations, which have been made from photographs and drawings specially prepared for us by Mr. W. E. Baker. The four-track trunk line crosses the Chicago river by electrically-operated drawbridges, an illustrated description of which appeared in *The Electrician*, Vol. XL., p. 233. One of the views of the track shows details of the third-rail construction in the terminal yards, and another shows a cross-over track running entirely through the yard, and still permitting the contact rail to be used for every movement without in any way altering its position. In one of these views the inspection sheds, where the motors are carefully inspected, and where small repairs are effected is shown. Each motor truck is inspected on an average once every three days. The intermediate stations on this line are very much of the same type as the specimen shown in one of the views. The terminal city station, however, is a more extensive structure.

As already stated, the power house is situated some distance from the terminus. It has been erected on a plot of land lying between the up and down tracks of the four-track way, and two of the tracks pass over the boiler house, as shown in the view of the exterior. This is one of the most compact, and, at the same time, admirably equipped stations we have ever seen. Its total capacity is 7,400 H.P., and there are four vertical compound engines, each coupled direct to multipolar railway generators. Two of the sets are rated at 2,500 H.P., and the other two at 1,200 H.P. each, the large generators having 12 poles, and the smaller ones only 10 poles. The engines are of the condensing type, water from the Chicago

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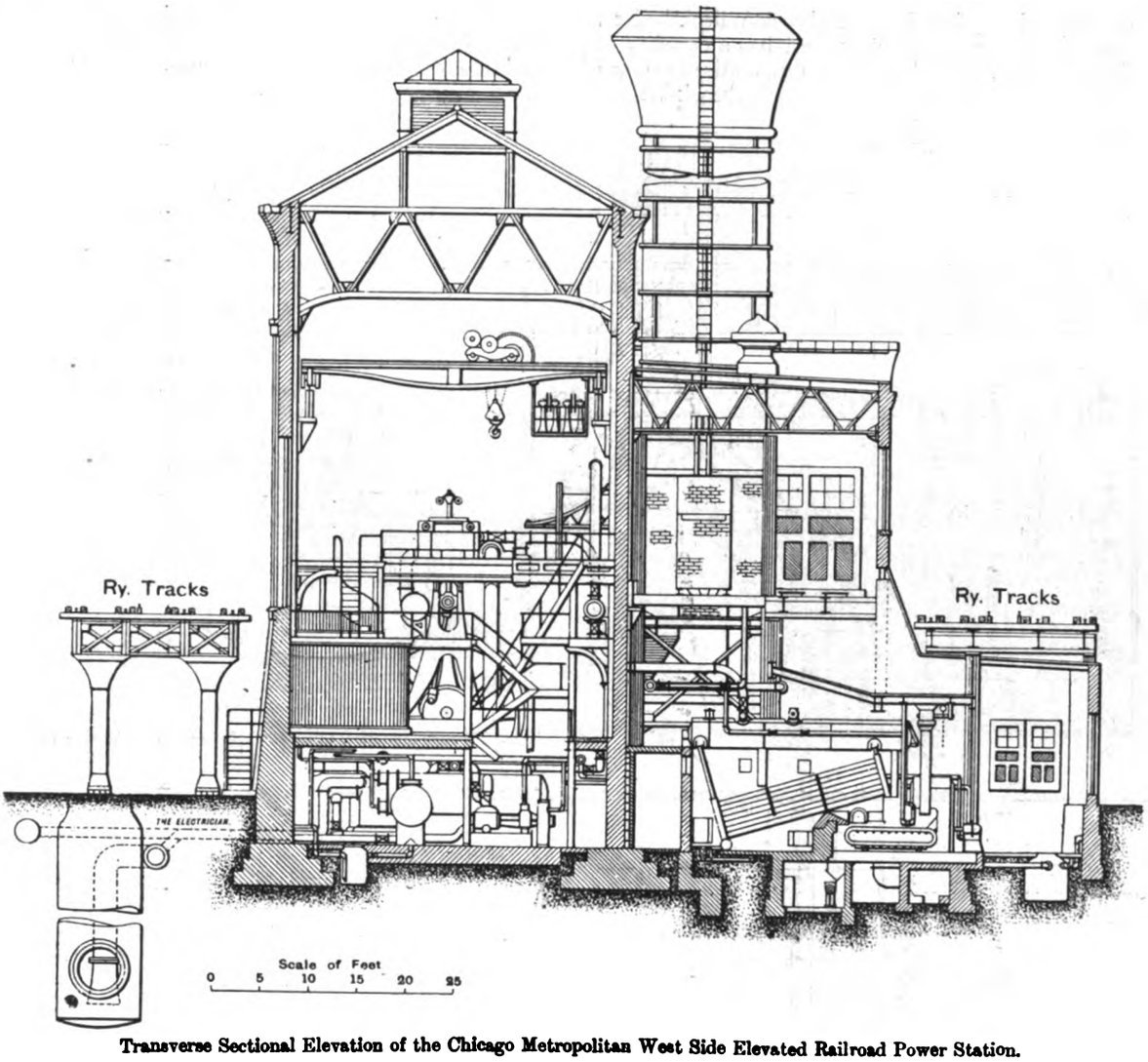
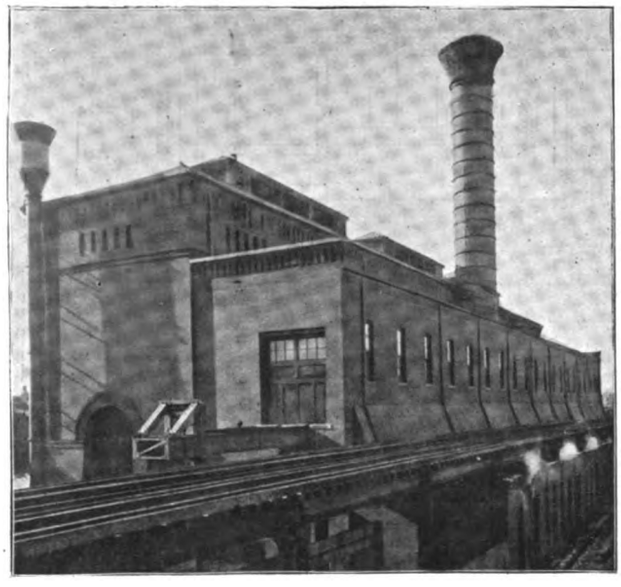
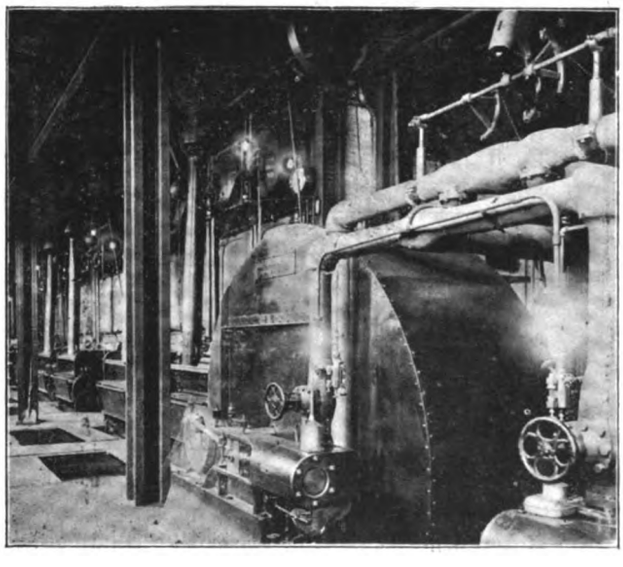
river being brought through a special tunnel to the power station, and returning through another tunnel, the distance from the river being considerably over one mile,* diameter, weighing 70 tons in the case of the larger engines, while on the smaller engines the fly-wheels are only 18ft. diameter, and weigh 45 tons. The speed of the larger sets is



Transverse Sectional Elevation of the Chicago Metropolitan West Side Elevated Railroad Power Station.



Exterior of Power House.



Interior of the Boiler House.

The generators are of the standard general electric slow-speed type, and carry on the engine shaft fly-wheels of 25ft.

75 revolutions per minute and of the smaller 100. Steam is distributed to the engines through duplicate steam mains 18in. in diameter, with copper bends. A Stratton separator is

* See *The Electrician*, Vol. XXXIX., p. 782.

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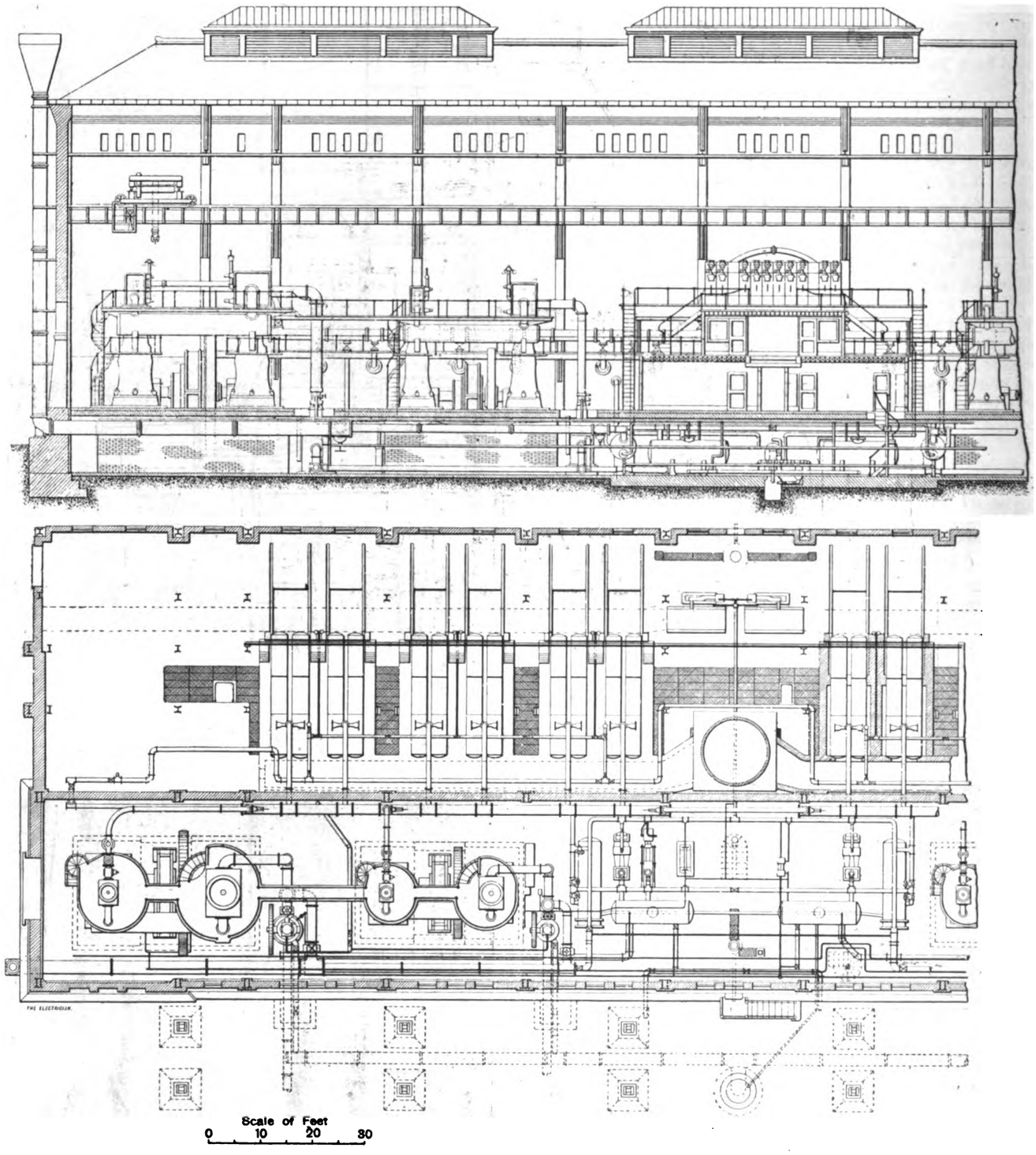
provided for each engine. All four engines were built by Messrs. E. P. Allis and Co., and are of their well-known railway type.

The boiler house is equipped with Babcock-Wilcox boilers, of the type well known in this country, and has a capacity of 7,200 H.P. in 12 boilers. The boilers are automatically stoked with chain-driven mechanical stokers of the Babcock-Wilcox type, the stokers being operated by two small oscillating steam engines, placed one at each end of the stoker's shaft. The coal is delivered to bunkers overhead, and is fed automatically to the stoker hoppers. The boiler furnace draught is produced by a chimney 150ft. in height and 12ft. 6in. internal diameter; also by two large Sturtevant centrifugal fans. In the boiler house there are two 1,000 H.P. Berriman feed water heaters, and two compound duplex boiler feed pumps manufactured by the Deane Steam Pump Co., of Massachusetts.

The track construction consists of 90lb. high grade T steel rail spiked to cross ties, the rails being electrically bonded near its centre to the supporting structure, which is also of steel. The third rail consists of 45lb. inverted channel iron elevated slightly above the timber safety guards, so as to provide certain contact with the car shoes. The third rail is insulated at intervals of about 5ft. on square blocks of pine saturated with paraffin wax, the blocks resting on iron pedestals uninsulated other than by the paraffin wax. Differing from the construction of the Liverpool Overhead Railway, the third rail of this, as, indeed, on all American elevated railroads, is carried at the side of the track either on one side



Part Longitudinal Sectional Elevation and Plan of the Chicago Metropolitan West Side Elevated Railroad Power Station.

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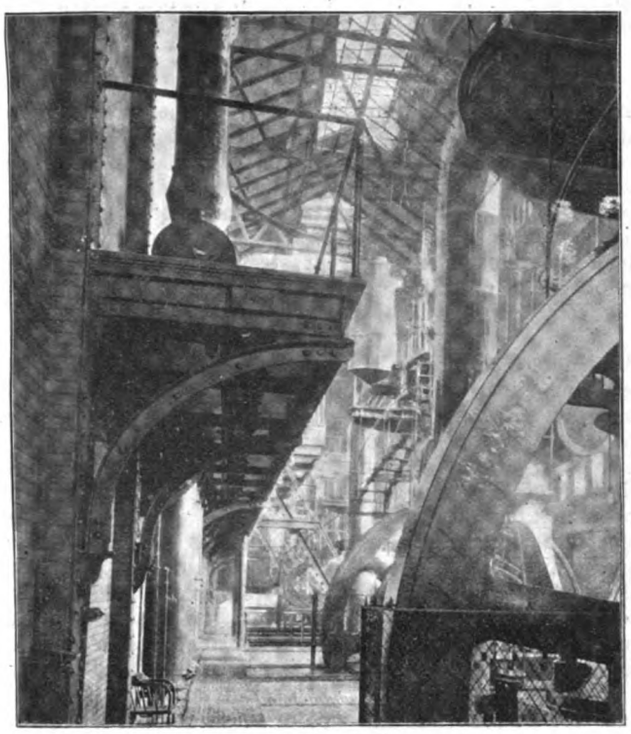
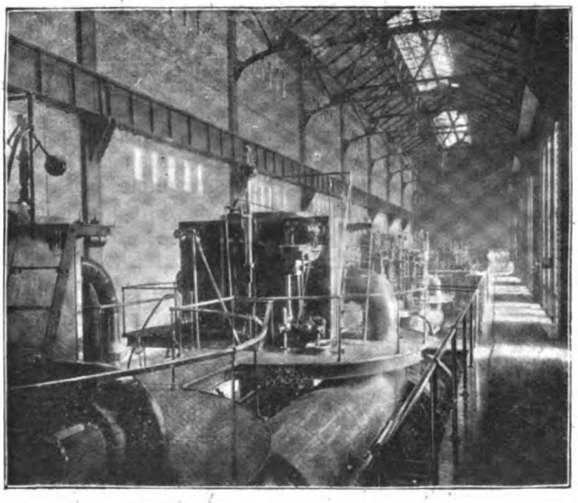
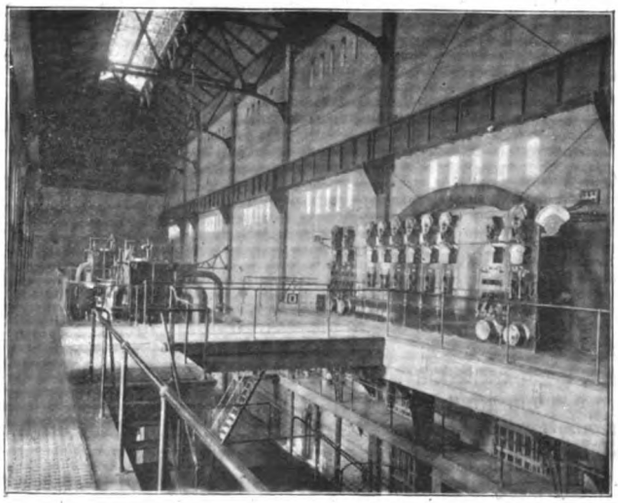


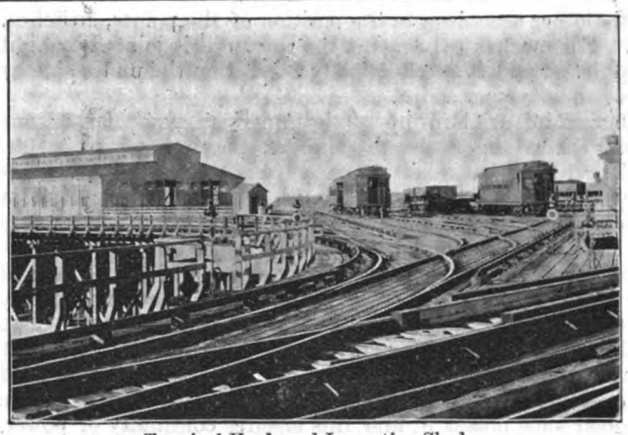
Interior of the Machinery Room, viewed from the Lower Gangway.



View of Engines from Upper Gangway.

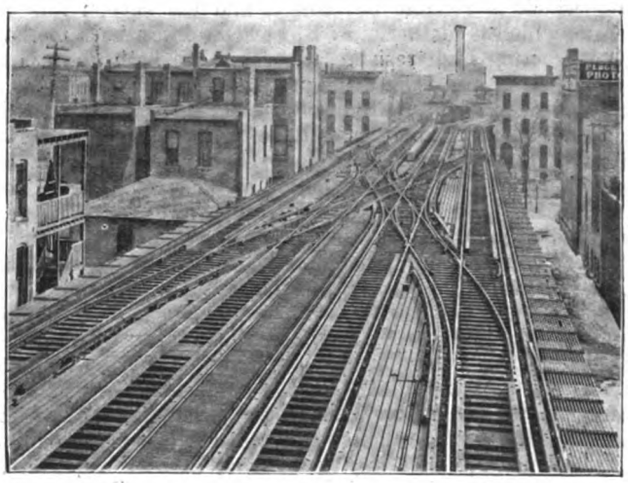


View of Upper Gangways and Switchboard.

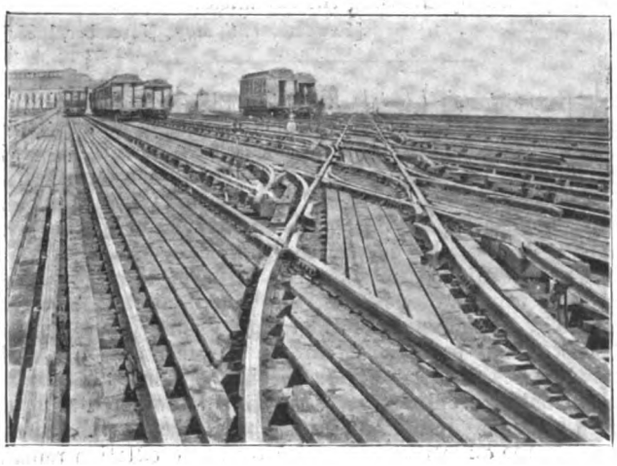


Terminal Yards and Inspection Sheds.

A Typical Passenger Station.



The Main Four-track Railroad, with Power House in the distance.



Third-rail Construction at Cross-over Track.

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or the other according to the position of the points, switches, &c. For mechanical support the third rail is jointed by light fish-plates, and it is electrically bonded on the under side by three short copper strips.

The trains are built up of the American type of cars, one motor car hauling one or two trailers. Each motor car is 40ft. in length, and has a seating capacity of 40 passengers. It is equipped with two cabs, one on either end of the car, and in one of these there is a 3 H.P. motor for operating the air-pump for controlling the brake. The car is carried on two independent bogeys, and each bogey truck carries a 100 H.P. motor of the G.E. 2,000 type—*i.e.*, having a tractive force of 2,000lb. The motors are worked on the series parallel system. The collecting shoe for taking current from the third-rail slides at the side of the car on stiff springs, so as to ensure a good contact. On crossings the front shoe makes contact before the rear shoe breaks it, and this ensures continuity of power. Owing to the third rail shifting from one side to the other, the cars are, of course, equipped with shoes on both sides. The weight of the motor car, exclusive of the electrical apparatus, exceeds 20 tons. The trail cars are similar in construction, but of somewhat lighter build, and are not, of course, provided with cabins.

In conclusion, we have to acknowledge our indebtedness and express our thanks to Mr. W. E. Baker for the information he has placed at our disposal for the compilation of the above description of the railway.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Standard High Resistances.—There are at present two principal forms of high resistance in use: that made of insulated wire, which is reliable but costly, and the carbon line on ebonite, which is neither. F. B. Fawcett describes a method of constructing high resistances, which are both cheap and reliable. It is based upon the properties of the deposit from a cathode of gold or platinum on a glass surface in its neighbourhood. By making the cathode in the form of a grid of several wires stretched parallel to one another, and in the same plane an even deposit of the metal is obtained. The author twists gold and platinum wires tightly together, and thus obtains the deposit as an alloy. When a film is freshly deposited its resistance alters at a rapidly decreasing rate, the alteration continuing for many months. It is probably due to dissolved gas and to molecular rearrangement. It may be artificially matured by boiling the film for several hours under reduced pressure in a non-conducting and chemically inactive oil. If after this the film is kept in its oil bath its resistance undergoes no perceptible change for seven months, at all events. The resistance may be adjusted to any desired value by scratching gaps half way across it from both edges alternately. The capacity and inductance are negligible, and the temperature coefficient is very small, and may be made to vanish by suitably choosing the thickness.

[Fawcett, *Phil. Mag.*, November, 1898.]

Measurement of Electric Quantity.—R. Blondlot gives a method of measuring a quantity of electricity direct in electromagnetic units, and describes an electric meter based upon it. A long coil is laid down so that its axis is horizontal. In its centre is suspended another coil in the form of a ring, movable about a vertical axis. Both coils are traversed by the same current. The earth's magnetism being compensated, the ring assumes a position parallel to the turns of the coil. When displaced from that position, the ring oscillates, say, with period T. The moment of the couple exerted upon the ring is proportional to i^2, the square of the current. Hence the product i T is constant, and is nothing else but the quantity of electricity passing any cross section of the wire during the period of one oscillation. In other words, whatever the current strength, the quantity passing during one oscillation remains the same. Hence the total quantity may be obtained by counting the oscillations. To reduce to absolute measure the formula—

$$iT = \sqrt{\frac{K\pi}{ns}}$$

is used, where n is the number of turns of the fixed coil per centimetre of its length, s the area of the ring, and K its movement of inertia. The meter consists of an electro-magnetic arrangement, in which the ring only makes excursions in one direction, and an arm attached to it breaks the magnetising current on its return. The apparatus follows any sudden variations of the current strength with the greatest promptitude.

[Blondlot, *Journ. de Phys.*, October, 1898.]

Magneto-Optic Effects.—Henri Becquerel has repeated the interesting experiments of Macaluso and Corbino (see *The Electrician*, Nov. 4, p. 45). His verdict is that these new experiments present the greatest interest, inasmuch as they show, in a particularly sensitive manner, the profound disturbances of the propagation of light which are due to the proper motions of transparent media, when the latter vibrate nearly in unison with the luminous waves traversing them. With proper regulation of the breadth of the flame and the quantity of sodium in it, a number of bands can be obtained in fixed positions. The most striking form of the experiment is obtained when the nicols are crossed at right angles. When no magnetic field is present, the field is dark, and the D lines are feeble. On exciting the field, two very bright bands appear on each side of the two D lines, in place of the dark bands obtained with parallel nicols. These bright bands represent the radiation whose plane of polarisation has been turned through 90deg. by the magnetic field. An important fact discovered by the author is that the distances of the bands from D_1 and D_2 respectively are notably different, the distances from D_1 being about three-quarters of those from D_2. This recalls a similar anomaly in the cases of reversal and the Zeeman effect. In conclusion, though the discovery of the Italian physicists might have been foreseen from Kundt's law that $dn/d\lambda$ rapidly increases near an absorption band, it illustrates one of the consequences of that law in a peculiarly elegant manner.

[Becquerel, *Comptes Rendus*, Oct. 31, 1898.]

Emissivity of Platinum.—J. E. Petavel has added an important contribution to the already large literature on the heat given out by a platinum surface at high temperatures. The radiator used was a wire, and the author found that a thick wire had to be used for the double purpose of radiator and thermometer, even at the cost of a slight loss of sensitiveness, owing to the facts that in a thin wire maintained at a temperature above 1,200deg. the resistance increases rapidly with the temperature, the emissivity varies largely with the diameter, and convection currents have a strongly marked effect. The author used a platinum wire 0·112cm. in diameter, mounted in the axis of a glass, gun-metal, or iron cylinder 3cm. in diameter and 30cm. long, surrounded by a water bath. The numerous results obtained by the author are recorded in tables and curves. The first set of the latter shows the emissivities of the platinum wire in hydrogen and in air respectively, at various pressures. The emissivity is highest in hydrogen at 228cm., and decreases as the pressure is diminished. In dry air the emissivity is considerably less. In every case the emissivity rises with the temperature, of course, but whereas the curve of increase is approximately a straight line in hydrogen, it shows an acceleration at the higher temperatures in air, carbon dioxide and steam. To quote a few figures, the emissivities at atmospheric pressure and 1,000°C. in absolute C.G.S. units are: In dry hydrogen 0·0053, in dry air 0·0021, in air saturated with moisture 0·0021 (no difference), in carbon dioxide the same, in steam 0·0024. The author examined the formulæ of Stefan, Dulong and Petit, Rosetti and Weber for radiation at various temperatures, but found only the last to be approximately true between 400deg. and 800deg. For the intrinsic candle-power b per sq. cm. of glowing platinum at temperature $t°$ he finds the important formula $(t - 400) = 889 \cdot 6 \sqrt[6.9]{b}$.

[Petavel, *Phil. Trans.* A, 1898, Vol. 191, p. 501.]

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THE THEORY OF THE ROTARY TRANSFORMER.

BY GISBERT KAPP.

(COMMUNICATED BY LLEWELYN B. ATKINSON, A.M.I.C.E.)

In the *Elektrotechnische Zeitschrift* of September 15th and the following numbers, Mr. G. Kapp has made an interesting contribution to the theory of rotary transformers, and the growing importance of this class of apparatus suggests that a *resumé* of this will be of interest to English readers. Mr. Kapp himself points out that, after all the controversy on continuous *v.* alternating currents, the present move, undoubtedly somewhat dominated by the necessities of railways and tramways, is in the direction of generation at the most suitable site, transmission by high-pressure alternating currents, and transformation to continuous current at a pressure suitable to the consumer. This contention he supports by the instance of New York, where one great central station is being established to supply all the existing stations, which will merely become transformer stations from which the supply is distributed. He also instances the Dublin tramways, where part of the line is fed direct from the generating station and part by current generated by three-phase alternators, transmitted and transformed by rotary transformers to continuous current at intermediate points on the line. The same system is being adopted for the Central London Railway.

The current may be generated by alternators of one or more phases, and two methods of transformation to continuous current may be adopted. The first is by means of a motor generator, with synchronous or non-synchronous alternating motor coupled by direct shaft connection or by belt to a continuous-current generator. A modification of this method is where the two windings are on the same armature in the same field, machines of this description having been built by the present writer so long ago as 1888; or, lastly, rotary transformers, in which an armature revolving in a field receives

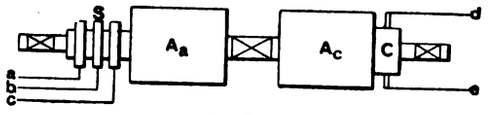

FIG. 1.

alternating current and emits continuous current from one and the same winding, a type of machine which, so far as the writer recollects, was first exhibited by Schukert at the Frankfort Exhibition of 1890.

The first arrangement is shown diagramatically (the magnet system being omitted) in Fig. 1, where a two or three-phase synchronous motor is coupled to a continuous-current generator. A_a is the alternating motor armature supplied from the line wires *a b c* through slip rings S; A_c is the continuous-current armature giving current from the commutator C to the lines *d e*. This arrangement has advantages. The pressure of supply and the strength of the field system of A_a, and thereby the phase relation between the supplying E.M.F. and current can be varied independently of the strength of the field system of A_c. But the loss of power is that due to the sum of the separate frictional and electrical losses of both machines, so that the net efficiency will not exceed, say, 92 per cent. by 92 per cent., or 85 per cent. The second arrangement, viz., that of two windings on one armature, has structural difficulties; it precludes independent field regulation, and is only a little more efficient than the foregoing. It is, however, better so far as armature reaction is concerned, particularly with multiphase currents. The third solution precludes independent field regulation, but has an enormous advantage in efficiency. The general considerations which lead to this result may be thus indicated. The alternating supply is led to certain points on the armature through slip rings, whilst the continuous current is taken off from a commutator; it therefore follows that twice in each revolution the point on the winding where the alternating current enters is in direct connection with the brushes, and at this point the current, or rather part of it, passes directly to the continuous current circuit, so that only during a portion of the revolution is the whole current traversing the windings of the armature. The object of Mr. Kapp's investigation is to show what is the relation between the normal output of a machine as a mechanically-driven generator and the output of the same machine as a rotary converter, the heating remaining the same. He also investigates the relation between the pressure of the continuous current generated and the pressure of the alternating supply.

We now follow Mr. Kapp:—

The E.M.F. of a continuous current armature with continuous winding rotating in a field of $2p$ poles is given by the equation

$$e_c = pNz\frac{R}{60}10^{-8},$$

where z is the number of effective windings, N the field strength, and R the revolutions per minute.

If the frequency $\sim = p\frac{R}{60}$,

we also have $e_c = \sim Nz10^{-8}$.

In the case of a single-phase armature the points on the armature at the intervals 0, 2π, 4π, &c., are connected to one slip ring, those at intervals π, 3π, 5π, &c., to a second slip ring.

In the case of a two-phase armature a further pair of slip rings are provided connected to the points $\frac{\pi}{2}\ \frac{5\pi}{2}\ \frac{9\pi}{2}$, &c., and the points $\frac{3\pi}{2}\ \frac{7\pi}{2}\ \frac{11\pi}{2}$, &c., and the pressure per phase is in each case given by the number of windings lying within the interval π.

We have, therefore, in the case of the alternator side, to take for z half the value before named, and the equation for the alternating E.M.F. stands

$$e_a = K \sim N\frac{z}{2}10^{-8},$$

where K is a coefficient which depends on the constructive data of the machine, so that

$$\frac{e_a}{e_c} = \frac{K}{2}.$$

The two-phase armature has four independent leading wires, that is the wires a_1 a_2 for the phase a and the wires b_1 b_2 for the phase b. The pressure between a_1 and a_2 or between b_1 b_2 is called the phase pressure. Such an armature can, however, be worked also at a four-phase armature, in which case the pressure is that between two points separated by points $0\ \frac{\pi}{2}$ or $\frac{\pi}{2}$ and π that is between a_1 b_1 or b_1 a_2 being a resultant pressure. The resultant pressure is $\frac{1}{\sqrt{2}}$ of the phase pressure, and the relation between the resultant pressure and the direct current pressure is given by the equation

$$\frac{e_a}{e_c} = \frac{K}{2\sqrt{2}}.$$

For a three-phase armature the leading in points are at intervals $0\ \frac{2}{3}\pi$, $\frac{4}{3}\pi$, &c., and as only a mesh coupling is possible the resultant pressure must be the phase pressure. For the alternating current side of such an armature in place of z must be used $\frac{1}{3}z$, and the coil width is $\frac{2}{3}$ of that first taken. We therefore have

$$e_a = K \sim N\frac{z}{3}10^{-8},$$

$$\frac{e_a}{e_c} = \frac{K}{3}$$

If now we take the values of K corresponding to the pole widths comprised between $\frac{2}{3}$ and $\frac{1}{2}$ of polar pitch (v) we can set out the following table for the values of the alternating E.M.F. in terms of the continuous current E.M.F.:—

$\frac{P}{v}=$		Current system.
$\frac{2}{3}$	$\frac{1}{2}$	
75 per cent.	82 per cent.	Single phase.
75 „	82 „	Two phase.
65 „	71 „	Three phase.
53 „	58 „	Four phase.
37 „	42 „	Six phase.

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For the three, four, and six-phase systems, the percentages given refer to the resultant E.M.F. Loading the machine does not much alter the values. The alternating current is a motor current, the continuous current a generator current, and, in consequence, the armature reaction is only dependent on their difference. This is small, however, with moderate phase lag, and with no lag varies little. Another point tending in the same directien is the small internal pressure fall due to resistance in modern generators, so that for present purposes no further corrections are necessary.

A study of the table shows that in all cases the alternating pressure is less than that of the direct current, and since in most cases the continuous current is required not to exceed 100 volts, it becomes necessary to provide a transformer between the high pressure line and the rotary converter. Fig. 2 shews the arrangement for converting from three-phase high pressure to continuous moderate pressure current. A three-phase transformer receives current from the high-pressure lines *a*, *b*, *c*; A is the armature of the rotary, C the commutator S, the slip rings of the magnet system being omitted.

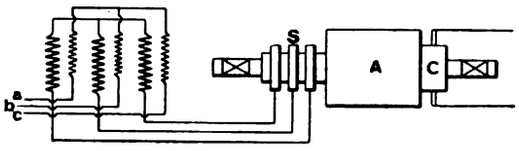

FIG. 2.

The relation of the output of such a rotary converter will next be considered, and in the course of the investigations it will be shown that whereas for single phase currents the output of a given machine is less than that of the same machine used as a belt-driven generator, for two, three and other phases the output is greater, the effect of current lag will also be discussed.

(*To be continued.*)

ELECTRICITY WORKS ACCOUNTS.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared :—

Ayr (Municipal)	Nov. 11	Kens'gton & Knightsbr'ge (Co.)	Sept. 30
Bedford (Municipal)	Mar. 4	Kingston-upon-Hull (Municipal)	Aug. 19
Belfast (Municipal)	Sept. 23	Kingston-upon-Thames (Mun.)	Mar. 25
Blackpool (Municipal)	Oct. 7	Lancaster (Municipal)	Oct. 21
Bournemouth (Company)	June 3	Leeds (Company)	April 8
Bradford (Municipal)	May 20	Leyton (Municipal)	Sept. 23
Brighton (Municipal)	May 6	Liverpool (Municipal)	Aug. 12
Bristol (Municipal)	July 29	Manchester (Municipal)	July 29
Burnley (Municipal)	Sept. 16	Newcastle-upon-Tyne (Co.)	April 29
Burton-upon-Trent (Municipal)	April 15	Northampton (Company)	April 15
Cambridge (Company)	June 17	Notting Hill (Company)	Mar. 11
(Central) Kensington (House-to-House (Company)	Sept. 30	Nottingham (Municipal)	Oct. 28
Charing Cross (Company)	April 22	Oxford (Company)	April 1
Chelsea (Company)	May 20	Portsmouth (Municipal)	Nov. 4
Cheltenham (Municipal)	Oct. 7	Preston (Company)	Oct. 28
Chester (Municipal)	Oct. 14	Reading (Company)	Sept. 16
Clerkenwell (Company)	Mar. 18	Richmond (Company)	Mar. 4
Dover (Company)	Mar. 11	Scarborough (Company)	April 1
Dundee (Municipal)	Nov. 4	St. James' & Pall Mall (Company)	July 1
Eastbourne (Company)	July 22	St. Pancras (Vestry)	May 13
Edinburgh (Municipal)	Oct. 14	Shoreditch (Vestry)	May 27
Exeter (Municipal)	Aug. 5	Southampton (Municipal)	June 3
Glasgow (Municipal)	Aug. 12	Stafford (Municipal)	Oct. 21
Guildford (Company)	May 13	Sunderland (Municipal)	Aug. 19
Hammersmith (Vestry)	June 10	Taunton (Municipal)	Aug. 5
Hampstead (Municipal)	Sept. 9	Tunbridge Wells (Municipal)	July 22
Hanley (Municipal)	April 8	Walsall (Municipal)	Nov. 11
Harrow (Company)	Sept. 9	Wandsworth (Company)	Mar. 18
Hastings & St. Leonard's (Co.)	April 29	Westminster (Company)	April 22
Hove (Company)	May 6	Wolverhampton (Municipal)	July 15
Huddersfield (Municipal)	Mar. 25	Worcester (Municipal)	May 13
Islington (Vestry)	June 24	Yarmouth (Municipal)	June 17

Oldham Municipal Electric Supply Works.

The Oldham undertaking, which commenced supply on March 20, 1894, stands in a high position among electrical supply concerns as regards costs of working. There are only about four stations of any output with lower costs per unit than Oldham for 1897-8, while for its output—viz., 322,000 units—it bears the lowest figure in this respect.

The authorised capital stands at £52,000, of which £46,650 has been received, borrowed at rates varying from 2⅝ per cent. to 3¼ per cent.; £2,000 (at 3 per cent.) has been repaid, and £49,060 expended at March 25th last, representing £75 per kilowatt of generating plant installed. During the year the extension of the station has been completed, and an additional boiler has been connected to the dust destructors of the Sanitary Committee. Another generating set of a capacity of 360 H.P. has also been put down, and contracts entered into for yet another boiler and two 360 H.P. generating sets. The expenditure during 1897-8 amounted to £3,777 to buildings, plant £3,675, and miscellaneous £79.

Consequent upon the addition of 50 consumers the equivalent lamp connection has risen from £15,763 to £21,626, or about 37 per cent., while the output has increased from 227,982 to 322,203 units sold, or more than 41 per cent. The average price obtained per unit has dropped in consequence of substantial reductions in the tariff.

Very satisfactory is the reduction noticeable in the total costs, viz., from 2·76d. per unit in 1896-7 to 1·79d. for last year. Works costs have been reduced by no less than 0·7d., and economies have also been effected in the management charges.

A working profit of £3,492 has been made, representing nearly 8 per cent. on the mean capital. Out of this and the balance from the previous year of £2,793, £2,793 has been carried to the depreciation fund, £905 towards the sinking fund, and £1,236 has been paid in interest on loans, leaving a balance for next year of £1,351.

Further reductions have been made in the price charged per unit; from March 25th last the rate is 4d. for the first two hours of average maximum demand, and 2d. after; while for street lighting the charge is 2½d.

Halifax Municipal Electric Supply Works.

The Halifax concern started electric supply in December, 1894; our tables, therefore embody analyses of the second and third completed years of working. The authorised capital amounts to £59,950; of this, £50,434 has been received (borrowed at rates from 2¾ per cent. to 3¼ per cent.), and £1,558 repaid. The capital expenditure to date is £57,783, representing £68 per kilowatt of generating plant. Included in this total is a sum of £2,389 on accumulators in view of supplying the tramways with energy. Seventy additional consumers and an equivalent of 6,654 8-c.p. lamps have been connected up to the supply during the year. The output in units sold shows an increase of 35 per cent., having reached 239,814, as compared with 177,531 in 1896-7.

Reductions in the price charged per unit has reduced the average price obtained from 5·86d. to 4·85d. A great improvement has been effected in the costs, the total cost per unit last year being 2·87d., as compared with 3·57d. Works costs have been reduced a halfpenny, and management and property charges nearly 0·2d.

The working profit for the year amounted to £1,975 or 3·77 per cent. of the mean capital. £1,846 has been carried to the sinking fund, and £1,471 paid as interest on loans, resulting in a deficit of £842, which, like that of the previous year, is met by a vote from the general district rate.

The following table is instructive as regards the progress of the Halifax undertaking since its inauguration :—

—	Quantity generated B.T.U.	Quantity sold.			Quantity used in works.	Number of public lamps.	Number of consumers.	No. of 8-c.p. lamps connected.	Revenue.	Expenditure.	Deficiency.
		Public lamps.	Private consumers	Total.							
March 31, 1895, four months ...	27,100	...	21,793	21,793	2,200	...	92	4,630	£571	£1,661	£1,090
1895-6	158,458	4,815	114,213	119,028	12,520	6	179	9,816	2,844	4,315	1,471
1896-7	259,800	12,430	165,101	177,531	16,240	11	235	14,146	4,332	5,132	800
1897-8	334,280	21,107	218,707	239,814	19,861	26	305	20,800	4,946	5,788	842

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	HALIFAX.		OLDHAM.	
Undertaking Worked by	Halifax Corporation.		Oldham Corporation.	
Date of Commencement of Supply	1894.		1894.	
System of Supply	Alternate-current transformer sub-stations.		3-wire continuous current, with batteries.	
Chief Engineer	T. P. Wilmshurst (since resigned).		S. Wilmott Newington.	
YEAR ENDED	MAR. 31, **1897.**	MAR. 31, **1898.**	MAR. 25, **1897.**	MAR. 25, **1898.**
QUANTITIES—				
Units generated	259,800	334,280	274,954*	396,744[a]
„ **SOLD (TOTAL)**	177,531	239,814	227,982	322,203
„ sold to consumers	165,101	218,707	213,951	305,859
„ sold for public lighting, &c.	12,430	21,107	14,031	16,444
„ used on works	16,240	19,861	7,253	11,222
UNITS SOLD PER 8 C.P. LAMP CAPACITY	9·50	9·04	16·9	15·7
Maximum supply demanded	—	—	300	413
Number of public lamps	11 arc	26 arc	22	22
Number of consumers	235	305	163	213
Connections to mains in 8-c.p. lamps	14,146	20,800	15,763	21,626
CAPACITY OF PLANT IN 8-C.P. LAMPS	18,700	26,500	13,500	20,500
CAPACITY OF PLANT IN KILOWATTS	600	850	432	657
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£59,950 / £99·9	£59,950 / £70·6	£52,000 / £120	£52,000 / £79·2
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	59,950 / 99·9	59,950 / 70·6	52,000 / 120	52,000 / 79·2
RECEIVED (TOTAL)	45,334 / 75·6	50,434 / 59·3	33,490 / 77·5	46,650 / 71·0
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	45,334 / 75·6	50,434 / 59·3	33,490 / 77·5	46,650 / 71·0
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	14,616 / 24·4	9,516 / 11·2	18,510 / 42·8	5,350 / 8·15
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	14,616 / 24·4	9,516 / 11·2	18,510 / 42·8	5,350 / 8·15
REPAID (TOTAL)	958 / 1·60	1,558 / 1·83	500 / 1·16	2,000 / 3·04
RESERVE OR SINKING FUND	— / —	— / —	2,095 / 4·84	1,062 / 1·62
DEPRECIATION FUND	— / —	— / —	— / —	2,836 / 4·32
EXPENDED (TOTAL)	47,067 / 78·5	57,783 / 68·0	39,605[b] / 91·7	49,060[b] / 74·7
Lands and buildings	17,452 / 29·1	18,024 / 21·2	— / —	— / —
Plant	16,600 / 27·7	21,768 / 25·6	— / —	— / —
Mains	12,567 / 20 9	16,083 / 18·9	— / —	— / —
Miscellaneous	447 / 0·75	1,908 / 2·25	— / —	— / —
BALANCE OF CAPITAL ACCOUNT	−2,733* / −4·55	−7,349* / −8·65	−6,115[c] / −14·15	−2,410[c] / 3·67
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£4,332 / 5·860d.	£4,846 / 4·850d.	£5,565 / 5·860d.	£5,899 / 4·396d.
Revenue from supply	3,870 / 5·230d.	4,223 / 4·222d.	5,139 / 5·410d.	5,461 / 4·070d.
„ meters, &c.	129 / 0·174d.	174 / 0·174d.	107 / 0·113d.	154 / 0·115d.
„ public lighting	233 / 0·315d.	396 / 0·396d.	234 / 0·246d.	206 / 0·153d.
„ sale of lamps, &c.	87 / 0·118d.	40 / 0·040d.	85 / 0·090d.	78 / 0·058d.
„ miscellaneous sources	13 / 0·018d.	13 / 0·013d.	— / —	— / —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£2,642 / 3·573d.	£2,872 / 2·874d.	£2,619 / 2·760d.	£2,406 / 1·792d.
WORKS COSTS	1,885 / 2·550d.	2,046 / 2·047d.	1,870 / 1·970d.	1,685 / 1·255d.
Generation of electricity	*1,824 / 2·466d.*	*1,975 / 1·976d.*	*1,456 / 1·534d.*	*1,486 / 1·107d.*
Fuel (including cartage, &c.)	655 / 0·886d.	794 / 0·795d.	448 / 0·472d.	619 / 0·461d.
Oil, waste, water, stores	294 / 0·398d.	306 / 0·306d.	45 / 0·047d.	64 / 0·048d.
Wages at station	800 / 1·082d.	772 / 0·772d.	429 / 0·452d.	520 / 0·387d.
Repairs and maintenance at station	74 / 0·100d.	102 / 0·102d.	535 / 0·563d.	283 / 0·211d.
Distribution of electricity	*61 / 0·083d.*	*71 / 0·071d.*	*414 / 0·436d.*	*199 / 0·148d.*
Wages, &c.	51 / 0·069d.	57 / 0·057d.	7 / 0·007d.	15 / 0·011d.
Repairs, renewals of mains, &c.	10 / 0·014d.	14 / 0·014d.	407 / 0·429d.	185 / 0·138d.
Public lighting	— / —	— / —	— / —	— / —
Attendance	— / —	— / —	— / —	— / —
Renewals	— / —	— / —	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	757 / 1·023d.	826 / 0·827d.	749 / 0·789d.	721 / 0·537d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*278 / 0·376d.*	*356 / 0·356d.*	*240 / 0·253d.*	*244 / 0·182d.*
Management	*479 / 0·648d.*	*470 / 0·470d.*	*509 / 0·536d.*	*477 / 0·355d.*
Salaries	353 / 0·477d.	299[c] / 0·299d.	317 / 0·334d.	331 / 0·247d.
Stationery, &c.	12 / 0·016d.	36 / 0·036d.	73 / 0·077d.	31 / 0·023d.
Establishment charges	59 / 0·080d.	101 / 0·101d.	59 / 0·062d.	54 / 0·040d.
Law charges, &c.	55[a] / 0·074d.	34[d] / 0·034d.	60[d] / 0·063d.	61[e] / 0·045d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£1,690 / 3·78%	£1,975 / 3·77%	£2,946 / 8·28%	£3,492 / 7·88%
Sum carried to Depreciation Fund	— / —	— / —	— / —	2,793 / 6·30%
Sum carried to Reserve or Sinking Fund	1,120 / 2·51%	1,346 / 2·57%	905 / 2·54%	905 / 2·04%
Net interest on loans (incl. Debenture charges)	1,370 / 3·065%	1,471 / 2·81%	998 / 2·80%	1,236 / 2·79%
BALANCE FROM LAST ACCOUNT	— / —	— / —	1,750 / 4·92%	2,793 / 6·30%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	— / —	2,793 / 7·84%	1,351 / 3·05%
Deficit	*800[b] / 1·79%*	*843[b] / 1·606%*	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	61%	59·3%	47%	40·8%
Expenditure per kilowatt capacity	£4. 8s. 5d.	£3. 7s. 7d.	£6. 1s. 2d.	£3. 13s. 3d.
REVENUE PER KILOWATT CAPACITY	**£7. 4s. 5d.**	**£5. 14s. 1d.**	**£12. 17s. 7d.**	**£8. 19s. 10d.**
Expenditure per 8-c. lamp capacity	2s. 10d.	2s. 2d.	3s. 10½d.	2s. 4d.
REVENUE PER 8-C.P. LAMP CAPACITY	**4s. 7½d.**	**3s. 8d.**	**8s. 3d.**	**5s. 9d.**
REVENUE PER 8-C.P. LAMP CONNECTED	**6s. 1½d.**	**4s. 8d.**	**7s. 0¾d.**	**5s. 5½d.**
Price charged for lighting, per unit	6d.[e]	5d.[e]	6d. to 4½d.[f]	4½d. to 3½d.[f]
Price charged for power, per unit	3d.[e]	2½d.[e]		
Price charged for public lighting	—	3d.[e]	4d. per unit.	3d. per unit.

HALIFAX.—REMARKS—* Over-expended. *a* Includes insurance, £18. *b* Met by general district rate. *c* After *deducting* £100 contributed from tramway account in respect of engineer's services. *d* Includes £17 to insurance. *e* Subject to discounts varying from 5 per cent. to 15 per cent.

OLDHAM.—REMARKS—* Of which 7,919 units were expended in batteries, and 29,298 units in the feeders. *a* Of which 9,262 units were expended in batteries, and 51,391 in the feeders. *b* Details of expenditure not available. *c* Over-expended. *d* Includes auditing £10, and insurance £14. *e* Includes auditing £10, and insurance £25. *f* Maximum demand system in use, with 4½d. in 1896-7 and 3½d. in 1897-8 after two hours of consumption.

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THE SOCIAL INFLUENCE OF ELECTRIC POWER.

That the introduction of electric power into civilised life exerts a marked influence tending towards improvement in the social condition of the community must afford no little gratification to every member of the electrical profession with a soul for something beyond mere sordid gain. Engineers are not to be expected, any more than are other business men, to place this consideration in front of the prosaic desire to find bread and butter for themselves and those dependent upon them; but it is nevertheless pleasing to know that the general influence of their collective activities makes for something higher than profits and dividends. It is, perhaps, not recognised as often, nor emphasised as forcibly, as might justly be done, how much more than any other of the material forces that have elevated social life has electricity in all its varied applications wrought social and even moral good to mankind. That the influence of these forces is not purely material, but has a pronounced social and moral aspect, cannot be denied by anyone who choses to examine the facts; and it is tacitly implied by the dictum admitted by those in whose charge is more directly placed the spiritual and moral welfare of the people—the clergy—namely, that crime and social evil of every description are to an enormous extent fostered by the influence of the environment within which they abound. In the early days of electric lighting in public streets, it used to be said, we remember, that each arc lamp obviated the services of one policeman; but this is not the only direction in which the adoption of electricity has wrought the higher service of preventing, rather than *ex post facto* curing, the mischievous effects of an unhealthy environment. Again, while it may be admitted that material conditions largely influence social and moral welfare, some may be disposed to deny that, in this respect, electricity has done more than has been accomplished by other material forces, such, for example, as steam. The point is one which cannot be argued conclusively except at greater length than space can be devoted to now; but we would remark that, whereas in many respects the introduction of steam power has created in society conditions of living that are physically, socially and

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morally unhealthy, this has never resulted in consequence of the introduction of electricity, in whatever manner applied. We do not, of course, imply that in the whole range of electrical engineering there is not one unhealthy industry; though these, be it noted, are in an extremely small minority. What we do insist is that, wherever electric power has been introduced as a material agent in social or industrial life, the tendency towards a better condition of living has been greatly accelerated thereby. Whether in its earlier application in the electric telegraph, or in the later and heavier forms of electrical engineering represented by electric lighting and power supply, and whether we contemplate its introduction into this country alone, or turn to the parts of the world where these latter applications have been more extensively fostered, electricity surely can lay claim to be the foremost of the civilising and socially-elevating physical forces at human command.

It is not, however, our purpose in this article to discuss in detail the social influences of every one of the numerous applications of electricity, but rather to deal only with two of them which are at the present time more prominently occupying the attention of the electrical profession; we refer to electric traction, and to the use of electric motors for industrial purposes. Electric traction, indeed, is fast assuming, if it has not already done so, the magnitude of a question of national importance. There is not a leading city and scarcely an important town in the United Kingdom the local authorities of which are not holding in serious consideration the advisability of sanctioning the introduction of electric tramway traction, or of introducing it themselves. Broadly speaking, these local authorities are divided into two classes: those which recognise that electric traction is better adapted than any other form of traction to meet the needs of the community, and who encourage its introduction; and those who, upon various pretexts, throw obstacles in its way. Upon this latter class a tremendous responsibility must rest, to which, we believe, they are scarcely alive; for if, as we hope to show, the social and moral welfare of important sections of the population of our cities and large towns can be vastly improved by the provision of electric tramway traction, how shall they be judged who blindly withhold this blessing from the community? Let us commence our argument by going to the core of the problem; and, for simplicity's sake, we will take one city—the largest in the world—by way of illustration. The argument can be applied to any other large city by merely changing the names. Fringing the south side of the Thames, between, say, Lambeth and Southwark, there is a belt of densely-populated districts, the majority of the inhabitants of which belong to the wage-earning class, and are unable to live elsewhere because their small earnings and long hours of work prevent them from spending daily the time and money that would be involved by living further from town. It will scarcely be credited that the density of population of many of these districts considerably exceeds one thousand individuals per acre. Beyond this belt of squalid humanity there lies another belt of suburban residences; and outside this, not more than five or six miles from the City, there commences a wide stretch of sparsely inhabited and but scantily used country. These are conditions repeated in innumerable large towns. They formerly occurred in many of the cities of Canada, the United States and on the Continent; but in those places the advent of the electric tramway wrought a complete change in the conditions of life of the class of people akin to those so unhealthily packed together in Walworth and the Old Kent-road. Rapid transit and cheap fares have enabled the artisan and the humble wage-earner to flee from the scene of squalid life, and to establish a healthy cottage home on the outskirts of the city where he works. No longer are the sons and daughters of toil obliged to herd together in barrack-like tenement buildings or dingy courts and alleys; for, with no more cost to themselves, and without cutting too much into their hours of recreation and rest, they find it possible to live six, or even ten, miles from their business. With horse tramways this, of course, is impossible, both on account of the time wasted and because of the high fare; but electric traction is not dangerous at much higher speeds than are possible with horses, and the low cost of operating electric tramways permits of very low fares being charged. In many American cities, for instance, the fare for a ten-mile journey is only the equivalent of our penny fare—taking into account the higher scale of American living—while the distance is covered in considerably less than an hour. We have no hesitation in asserting that electric traction, more than any other factor, has completely transformed the conditions of town life in the United States and in Canada, and the change has been one wholly tending towards social and moral elevation. There appears to us no valid reason why its introduction into this country, in places similar to the example we have cited from London life, should not produce equally beneficent results. On the contrary, the density of population of our large cities being now far in excess of what it ever has been in America, it would be reasonable to expect a proportionally greater amelioration. To remove from over-crowded areas a large proportion of the working class, and to place these people in rural homesteads, in a healthy atmosphere and close to the sources of wholesome and fresh food supply, is a task well befitting those responsible for the condition of the people. In the face of facts like these it undoubtedly behoves local authorities who have the welfare of dense masses of humanity in their charge to see to it without delay that efficient systems of electrically operated tramways are provided, so that this highly desirable process of decentralisation of the population may be brought about.

Apart from traction, the gradual adoption of electric power is working a change for the better in the social condition of the working classes, through the substitution of electric motors for other forms of engine power in mills and factories, &c. We do not believe that the provision of cheap electric power tends to scatter workmen from large factories to small home workshops, as has so often been asserted it would do. There are factors more important than the cost of power which decide between the factory system and the home-workshop system. But even in large mills and factories the change from the old method of running to the modern method of driving by electric motors is not without an elevating influence upon the character of the men which is not unobserved by those who have the opportunity to judge. The cleanliness of the electric motor itself, and the neatness, cleanliness and order which it renders possible in the workshop, in a way that no other motor can do, are in themselves potent, if simple, influences for social good. Men working in such surroundings are as surely elevated by their sweetness and light as they must be depressed and brutalised when obliged to do their daily work amidst grime and filth and in an atmosphere charged with unhealthy vapours.

The lesson which, in the foregoing reflections, we have principally sought to drive home, is that every encouragement should be given by Parliament and by local authorities generally for a well regulated and efficiently controlled supply of electric power, and for systems of electric tramways, throughout the United Kingdom. For, the advantages that will accrue therefrom to the nation count for much more than

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the mere provision of motor-driven in place of horse-drawn tramcars, and motors in place of steam or gas engines in industrial works. Indeed, when regarded from the point of view of lasting national good, it will probably be conceded that the merely material advantages derivable from the introduction of electric power for these purposes are of less importance than the elevating influence they are known to exert upon the social and moral condition of the community.

REVIEWS.

Street Railway Roadbed. By MASON D. PRATT and C. A. ALDEN. (Street Railway Publishing Co., New York.) 1898.

This little work of 135 pages has been written by two engineers having a thoroughly practical knowledge of their subject, and this is the more welcome, as the problems connected with such work as the choice and laying of rails and the filling in of the roadway are almost entirely of a practical nature, and the merits and demerits of various systems and designs can only be determined by actual and continued experience. Most of the contents of the book apply as well to horse and cable as to electric traction, for the work confines itself to the discussion of rails, and their joints, switches, &c., and of the materials and methods employed for laying the track; though, of course, owing to the enormous extent to which electric traction is employed in the States, the authors have evidently had electrical working chiefly in mind. Still, from the electrical engineer's point of view, the work is somewhat disappointing from the very fact that its scope is so contracted. For instance, nothing is said of bonding between the rails; or of the methods of laying the bare or insulated feeders connected to the rails for the purpose of reducing the drop of voltage on the rail return; or of the construction of the culverts employed with slotted-conduit systems. Information on these subjects from authors who are acquainted with the best American practice would be of the very greatest value, and we hope to see before long a second work from the same writers dealing with them. Likewise something might be said concerning trolley poles and the foundations, &c., they require.

But enough as to sins of omission; it is pleasanter to dwell on the many positive virtues exhibited by the work. The first part, that dealing with the development of the design of the rails themselves, is particularly lucid and well written. There is in this connection a great difference between American and English practice. In the States it is common to give the rail what is called a "tram"; that is, a flat surface, perhaps 3in. wide, flush with the roadway, for the convenience of the ordinary vehicular traffic. Once on this tram a vehicle is easily kept there owing to the projecting head of the rail. This system bears very hard on the tramway company, as not only are the cars hindered by the traffic in front, but also the track between the rails, which the Company has to keep in repair, suffers from abnormal wear and tear. Yet in many cases the local authorities insist on the trams being adopted. With reference to rails it is interesting to note that, whereas with horse or cable cars the wear may not exceed $\frac{1}{4}$in. in five years, with electric cars running under the same conditions it will be but one year before the same amount of wear has taken place. This is partly due to the increased weight of the electric car and partly to the fact that its power is applied internally to axle. The wear when going up an incline may be double that on the parallel downward track. But space will not permit of even the mention of the many interesting facts noted in the particularly well written first half of the book.

The second half is, perhaps, not so complete and satisfactory as the first. For instance, no illustrations are given of switches and mates, though these are by no means the least important parts of the equipment of a track. Nevertheless the methods of laying-out the curves where the track passes round corners are well and fully dealt with. On the whole the work can be thoroughly recommended to those who have to deal practically with tramways or light railways.

Electrical Traction. By ERNEST WILSON. (London: Edward Arnold.) 1897.

It is with mixed feelings that we lay down this book. On the one hand the work is undeniably interesting so far as it contains numerous descriptions of work actually done and plant actually employed, taken for the most part from various technical journals. On the other hand, it bears throughout evidence of the hand that has had little or no practical experience of its subject matter. This shows itself not only in errors, or half errors, of statement, but also in that manifest lack of the sense of proportion and importance of things which above all marks off the mere writer from the man who has lived (and shall we say suffered?) amidst that which he describes. For instance, take the six pages devoted by the author – in a work of only 250 pages—to a full account of some comparatively trivial tests that he has himself happened to make with two out of the numerous types of storage cell. He gives the experiments, table after table, in full, and leaves us there without so much as an attempt to point out the merits of the cells or in any way to sum up the results. Perhaps had he done so he would have seen how unimportant these were, and have spared us.

As examples of the errors that the author makes we may refer to pp. 27 and 28, where the efficiency of motors when arranged in series and in parallel is discussed. Throughout the discussion it is assumed that the losses in eddy currents, hysteresis, friction and windage remain constant over very great variations of speed and output. Now those practically acquainted with dynamos and motors know that these losses (which are as important as the copper losses in the machine) vary enormously with speed and output, and that any calculations of efficiency based upon the assumption that the losses are constant are altogether misleading. Further, from the table on p. 22, and the remarks thereon, it would seem that the author is unaware that over seven years ago methods of ascertaining by direct experiment the way in which these losses vary were published. Again, a few pages further on (p. 24), we have additional evidence that the author is by no means at ease with his subject. A second collecting shoe, if required at all, is not required "to diminish the risk of breaking the shunt circuit," but to diminish the risk of breaking the main circuit, which might lead to the magnets losing their magnetism and an excessive current passing through the armature when the shoe again makes contact with the conductor. To take another random instance of the author's uncertainty, we may point out that, on page 190, he takes the voltage on the Dublin line as 3,000, though, on p. 188, he has just told us that the generators only give from 2,300 to 2,500 volts.

But, after all, the question is, for whom was the book written? to what class of reader was it intended to appeal? It must be admitted that it could not be intended for the traction expert, for its scope is manifestly elementary and too incomplete for such a purpose; nor for the student, for, though elementary and incomplete, it yet assumes considerable knowledge of the subject, particularly when anything at all difficult is being discussed; *a fortiori* it is far too technical for the popular reader. This almost well clears the field, and all that can be said is that it may prove agreeable reading for the engineer who, having a desire to know how an electric tramway is worked, but has no intention of going further into the matter.

The style in which the book is written is often unnecessarily obscure; and it is not without a shudder that we read such phrases as "when hot weather steps in," "magnetically speaking," or "motors deliver only 21 H.P. to the rails."

The Telephone. Outlines of the Development of Transmitters and Receivers. By WILLIAM J. HOPKINS. (New York: Longmans, Green and Co.)

This is a short treatise dealing merely with the construction of transmitters and receivers, and passing in review some of the principles underlying their design. All other pieces of apparatus used for telephoning are considered outside the scope of this book. Narrow as the subject is when confined within these limits, the author cannot be said to have done full justice to it, as the historical notes and descriptions of historical

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forms of instruments are very scant, and, although the present American types of instruments are well described, no reference is made to some of the receivers and transmitters most used in this country and on the Continent of Europe. Notwithstanding, the author gives much matter that will be useful to the student of telephony, the most interesting, perhaps, being an account of the experimental investigations carried out by the Massachusetts Institute of Technology, under the direction of Prof. Cross, on the efficiency of different types of microphonic contacts, and the effect of different degrees of magnetisation of the permanent magnet in the receiver. This account would be more useful, however, if the curves had numerical scales marked on them. Before concluding this notice it is necessary to correct two somewhat misleading statements in the book. It is unfair to say that no patent was issued to Prof. Hughes for his microphone; no patent was applied for. The other statement is that the action of transmitters depending on magnetic induction "is not altogether simple, and is still somewhat in dispute." To quote further:—

> The operation of a magneto telephone has been variously attributed to one or more of these causes—(*a*) Molecular vibration of the iron core as in the Reis receiver. This undoubtedly exists, but is so weak that probably in most cases it would be impossible to detect it. (*b*) Variation in the attraction of the core for the mass of the diaphragm; (*c*) Action of the spirals of the core. It would be difficult to separate this last action from the general change in magnetic flow, and indeed no good reason appears why this separation should be attempted. The second cause named is by far the strongest, and in most cases probably the only observable action.

Although the principles of the Bell telephone may have been in dispute when Du Moncel published his famous treatise, it is acknowledged at the present day that the action of the magneto transmitter is simply that the motions of the diaphragm cause variations in the length of the air-gap of the magnetic circuit, which in their turn cause variations in the magnetic flux and consequently produce currents in the coil. This is both simple and, we believe, undisputed; in fact, the author gives the correct explanation in his chapter on "Magneto Instruments," but in the passage quoted he seems to be thinking of what takes place in the receiver while he is writing about the action of the transmitter.

The Indicator Handbook: a Practical Manual for Engineers. By CHARLES N. PICKWORTH. Part I. The Indicator: Its Construction and Application. (Manchester and London: Emmott and Co.) 1898.

It is not often we have occasion to review a handbook which so consistently bears out its title as the one under present notice. As is so necessary in a handbook, the information on any point within the scope of the subject is remarkably get-at-able, chiefly because from beginning to end the little volume is unburdened with redundant matter. In its eight chapters the author has usefully and logically dealt with the construction, the errors, and the practical manipulation of the indicator and indicator-reducing gears. Not only are steam-engine indicators referred to, but indicators for gas, oil and ammonia compression engines or machines, and, finally, mean pressure, double and hydraulic indicators. The only misprint or error we have come across throughout the work is what appears to be a wrong reference to a figure on page 53. The book bears the stamp of having been written from actual experience, and we can heartily recommend it as a reliable guide on the subject with which it deals.

The Comprehensive International Wire Table. Compiled by WILFRID S. BOULT, Assoc. M.Inst.C.E. (London: "The Electrician" Printing and Publishing Co.) 1898.

It is a lamentable fact that there are so many wire gauges in existence, there being at present no less than three in constant and frequent use, and others which are employed occasionally. While regretting that such a thing as a comparative table of wire gauges should be necessary, we are glad to have one in such a comprehensive form as Mr. Boult's, which has just been re-issued. Over 450 conductors of different sizes are tabulated in order of their sectional area, a column being devoted to each, in which data are given concerning diameter, section, weight, resistance, current capacity and heating, there being twenty or thirty items in each column. The table should be of especial value to those engineers who have frequently to deal with foreign specifications; and for all who experience difficulty in the work of conversion from one gauge to another.

Taschenbuch für Monteure Elektrischer Beleuchtungsanlagen. By S. FREH. V. GAISBERG. Sixteenth Edition. (Munich and Leipsic: R. Oldenbourg.) 1898.

Less than a year ago we reviewed the fourteenth edition of this useful pocket-book. The present edition includes several slight additions, but the previous size of the book has been retained by the omission of obsolete and redundant matter.

Kalender für Elektrochemiker sowie Technische Chemiker und Physiker. For 1899. Edited by Dr. A. NEUBURGER. (Berlin: M. Krayn)

Several additions have been made to this two-volume pocket-book, but the numerous inaccuracies referred to in our review of the first edition have not all been corrected.

AN ELECTRICALLY-OPERATED FOUNDRY.

An article in a recent number of the *Western Electrician*, of Chicago, describes an interesting installation of electric motors for the foundry of the Reading Car Wheel works, in Pennsylvania. We give the following particulars, which are abstracted from the article referred to:—The adoption of

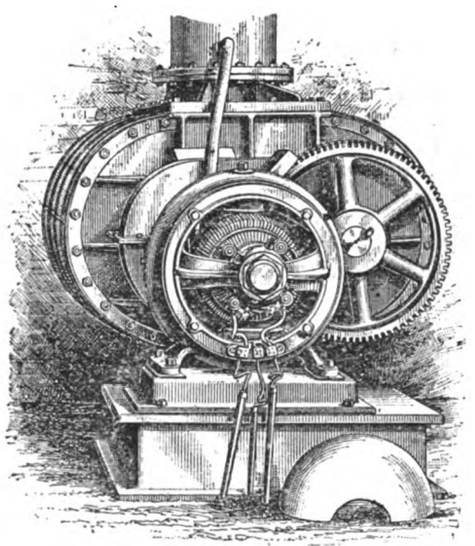

FIG. 1.—Electrically Operated Foundry.—Motor-driven Pressure Blower.

electricity for motive power was due to a belief that it would prove to be economical in cost and much more convenient than steam. The current is taken from the mains of the city lighting plant, and the service has so far been very satisfactory. The system covers all appliances which can be run by power, and is very complete. In Fig. 1 is shown a positive-pressure blower, with a special cast-iron sub-base and directly geared by a rawhide gear to a 85 H.P. motor.' In the illustration, the motor is shown with the casing removed, but when in operation the working parts of the motor are entirely covered up. Several times when the bottom of the cupola has been dropped, the motor has been spattered with molten iron, but no trouble has been experienced on that account. Fig. 2 shows the tumbling barrel, also directly connected to a back-geared motor, and used to separate the scrap iron and dirt coming from the cupola. In the cupola-charging room, which is directly over the testing room, are located the motors for driving the elevator and the drop for breaking old car wheels. These motors are equipped with regular reversing elevator controllers and are direct-connected to the elevator mechanisms. The elevator has a capacity of three tons and the break-drop has a weight of 2,000lb. and a fall of 40ft.

The casting and cleaning department has an area of 150ft. by 80ft. The moulds are arranged in rows or floors lengthwise of the building, each row or floor accommodating 20 moulds. There are ten floors, presenting a capacity of 200 car wheels

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per day. In the front part of the building, and running at right angles with the floors, is a track on which the ladle carriers run. These carriers are of iron, and carry the small ladles, which have a capacity of about 800lb. each, to the floors. The small ladles are operated by a small motor, which can be run by the man in charge of the large pouring ladle. A large electrically operated ladle, with a capacity of

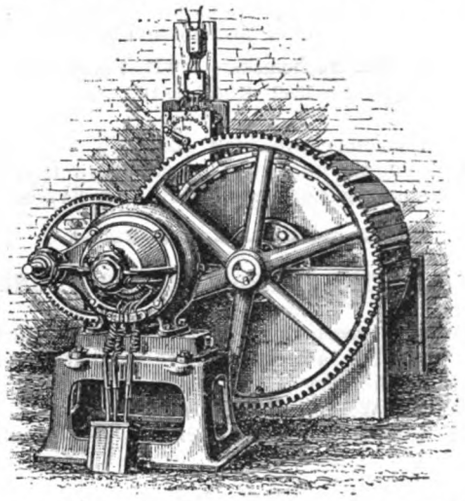

FIG. 2.—Electrically Operated Foundry.—Motor-driven Tumbling Barrel.

about 5 tons, is shown in Fig. 3. It is mounted on trunnions, and turned by the motor seen in the rear. The small ladles are carried to the front of the larger one, and each filled in turn and carried to the different floors. Over each floor is a track on which runs a small iron carriage. The carriage carries a steel cable, to which is attached an iron hook for lifting the ladles. There is also attached a cable for drawing the carriage back and forth over the floors.

150deg., but they do not give the slightest degree of trouble. They are all reversing, and equipped with controllers for reversing and varying speed. From each controller is run a hand-rope to the floor, so that each moulder has perfect control of the speed, and can vary it from 1ft. to 50ft. a minute on the hoist. Each hoisting motor is also equipped with an electric brake, which stops it instantly when the current is shut off, and also controls the lowering speed.

Directly under the motors and at right angles with the floors are the pits for annealing. There are three rows of pits, 20 pits in each. These pits, which are slightly larger than a car

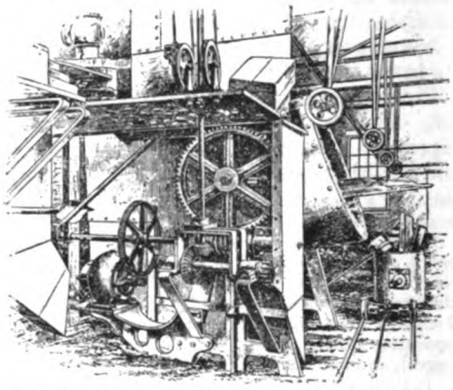

FIG. 3.—Electrically Operated Foundry.—Five ton Ladle Electrically turned.

wheel, are lined with fire-brick, and have each a capacity for accommodating 18 wheels. Leaving the moulds the wheels are carried along to the pits, in which they are placed by pitting cranes while still red hot. They are allowed to remain here several days for gradual cooling. Over each row of pits is a pack on which runs a carriage precisely similar to those running over the floors, and operated by motors in the same way.

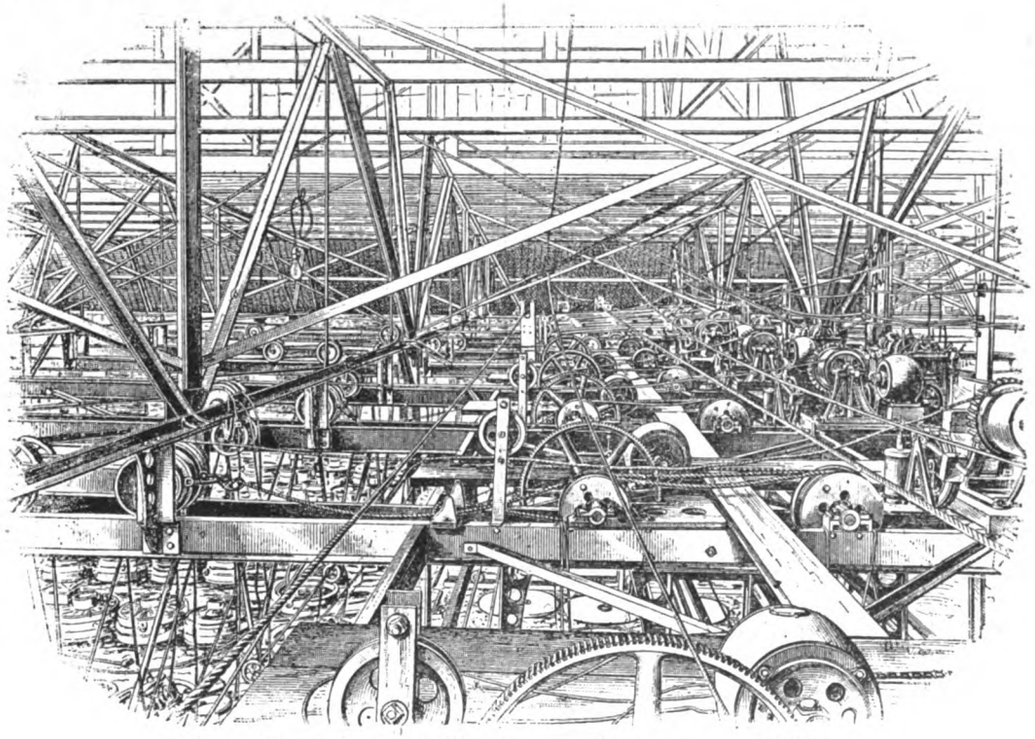

FIG. 4.—Electrically Operated Foundry.—Overhead Arrangement of Motors.

At the rear end of the building are located the motors for operating the system over the floors. The motors are shown in Fig. 4. There are two motors for each floor, one for operating the carriage, the other for the hoist. The motors were all built especially for the work they are required to do, and for the location, which required that they should be dust and heat proof. The temperature in their vicinity often exceeds

The current is distributed on the three-wire system. The motors are of 220 volts capacity, and are connected to the two outside wires. The plant has proved to be remarkably economical in operation, and the superintendent of the Company, Mr. Coleman, states that the running expenses have been much less than those of a similar plant operated by steam.

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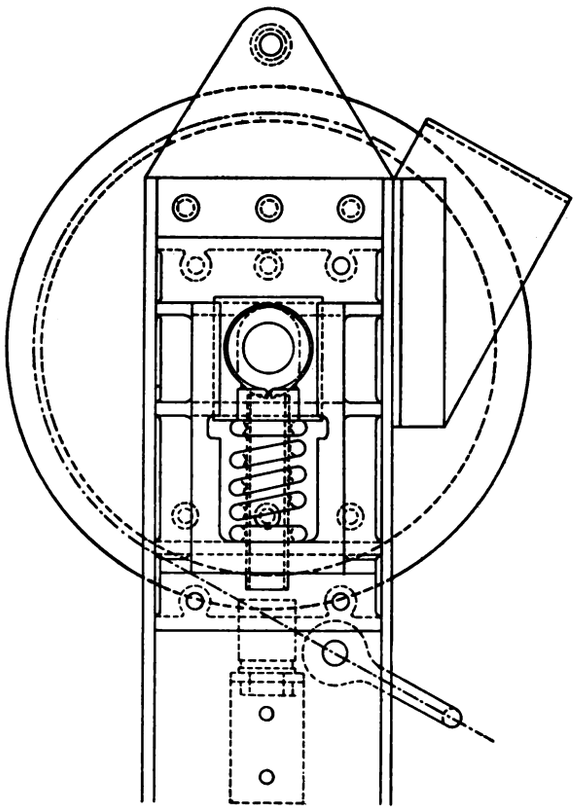
THE NEW ELECTRIC CRANES AT SOUTHAMPTON HARBOUR.

The completion and official trial, last week, of the new electric cranes erected by the Southampton Harbour Board, and their impending taking-over from the contractors, Messrs. Stothert and Pitt, of Bath, render opportune a description of these interesting machines and some account of the reasons which have led to their erection. We may say at the outset that, through the courtesy of Mr. J. G. W. Aldridge, the electrical engineer to the Southampton Harbour Board, we have recently had an opportunity of inspecting these cranes and of seeing them in operation. To him we are also indebted for the excellent photographs by Mr. J. M. Humby, of Southampton, as well as for the scale drawings, which illustrate this article.

In 1892, owing to the close competition between the harbour and the docks at Southampton, a Committee of the Harbour Board was formed which, together with Mr. Aldridge and Mr. W. Bowyer, the energetic traffic manager, visited several continental ports, with a view to discover the best means of expeditiously and cheaply handling cargoes by harbour cranes. Mr. Aldridge presented a report recommending the use of electric power, with the result that in 1893 the two 3-ton electric cranes described at that time in *The Electrician* were erected by Messrs. Statter and Co. So convinced did Mr. Bowyer quickly become as to the superiority in every respect of electrically-driven over every other kind of crane that he recommended an extension of the number of these cranes, and in 1896 specifications were drawn up by Mr. Aldridge and issued to contractors. The tender of Messrs. Stothert and Pitt, of Bath, was accepted for three 3-ton cranes and one combined 12-ton and 3-ton crane, the complete equipment being carried out for £7,288. Views of these new cranes, including a separate view of the combined 12 and 3-ton crane, accompany this article.



Jib End and Sheave, showing the Electrical Contacts, &c., for indicating Excess Load.

While the new cranes somewhat resemble in general appearance the older pair erected on another quay, they differ in many respects from these as regards essential points of detail. One of the most interesting of the new departures is the arrangement for automatically ringing an electric bell in the cabin when the crane is set to hoist too great a load. The sheave at the end of the jib, instead of being carried in a rigid bearing, has its bearings supported in guides on a steel coil spring. Excessive load compresses this spring sufficiently to close an electric circuit and ring a bell in the cabin. Another interesting feature attaches to the combined crane, the provision for which arose out of the necessity to have a 12-ton crane as a stand-by, although it would be infrequently used as such. Mr. Aldridge wisely decided not to have a separate stand-by crane, but to combine the 12-ton hoisting gear with a 3-ton crane; and this he has done by an ingenious arrangement of gears, whereby the motors are made to operate at will either the smaller or the greater hoist, the slewing gear being the same in both cases. Change from one hoist to another can be effected in 55sec., and is quite a simple matter.

The 3-ton cranes are constructed to lift 30cwt. at 200ft. per minute on a single rope, and three tons on a double rope at a proportionately lower speed. The radius of the cranes is 30ft., and the normal slewing speed 400ft. per minute with a 30cwt. load. Two separate electric motors operate the hoisting and slewing motions, the hoisting motor being rated at 50 H.P., and running at 600 revolutions per minute, and the slewing motor being rated at 10 H.P. The lifting motors of the 3-ton crane are not reversible, and have copper brushes on the commutators; the lifting motors for the 12-ton have carbon brushes, being reversible. The slewing motors are all provided with carbon brushes. All the motors were built by Messrs. Siemens Bros. and Co., and are of the two-pole drum-wound shunt-field type; they are supplied with current at 200 volts from the Corporation supply station. The pole-pieces are hinged to facilitate inspection. Upon the motor spindle is carried a Delta metal triple worm, gearing into a cut steel helical gear, the gear running in an enclosed oil bath. The gear wheel of the lift motor in the 3-ton cranes, carries the main drum, but in the 12-ton crane it actuates a throw-out back gear, similar to that employed in lathes, by which the interchange is effected. The back gear actuates either the 3-ton or the 12-ton hoist, the other hoist being locked.

The lever for working the hoisting motor, and the wheel for operating the slewing motor, in each case actuates automatically the regulating resistances of the motor fields. As the lever travels over it pushes a number of plugs resembling cornet pistons, these being thrown in *seriatim*, and each plug short circuits part of the resistance by a carbon contact. We believe this method was first adopted by Messrs. Siemens and Halske, of Berlin, by whom the regulators were supplied for these crane motors.

Each crane cabin is provided with a convenient switchboard, carrying the electric switches and Evershed indicating instruments. The field and armature switches are interlocked. In each cabin there are two 32 c.p. "Ediswan" glow lamps, also plugs for portable lamps, and near the top of the jib there is a group of glow lamps arranged in a reflector.

The manner in which current is led into the revolving cabin is of interest. In the centre of the floor there is an insulated box containing a brass ring rigidly fixed to the floor. Inside this ring, and pressing against the inner surface of the ring there is a copper brush of peculiar shape, rigidly connected to the stationary frame of the crane. This brush carries the current into the crane equally well, whether the cabin be stationary or moving in either direction. Current is brought to the crane through flexible diatrine cables, supplied by Messrs. W. T. Glover and Co. One end of the cable is attached to the crane; the other can be attached to any one of the connecting boxes along the quay. From the power station to the quay boxes the current is carried in bare copper strip laid in wooden troughs. The consumption of power is found to be from 3½ to 5 units per hour, and the present price charged is 3d. per unit, but it is expected that the price will shortly be reduced.

Even at the comparatively high price charged for current there is no doubt about the superiority of electric cranes for handling cargoes cheaply and quickly. Much more work can

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Four New Electric Cranes erected on Southampton Harbour Quay.

Combined 12-ton and 3-ton Electric Crane on Southampton Harbour Quay.

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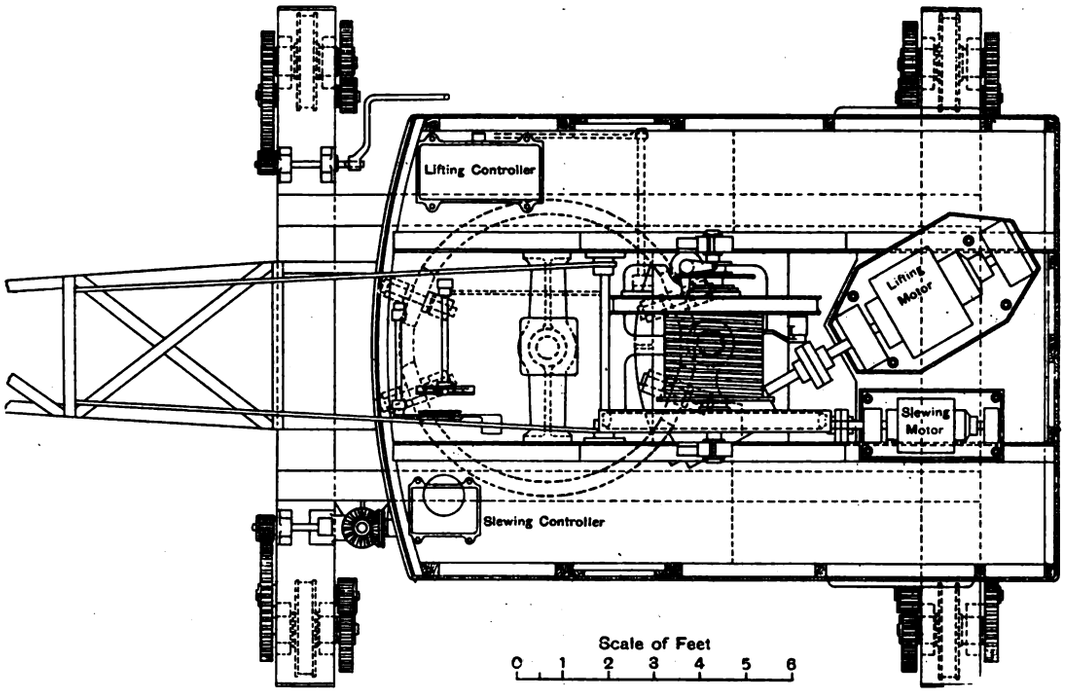
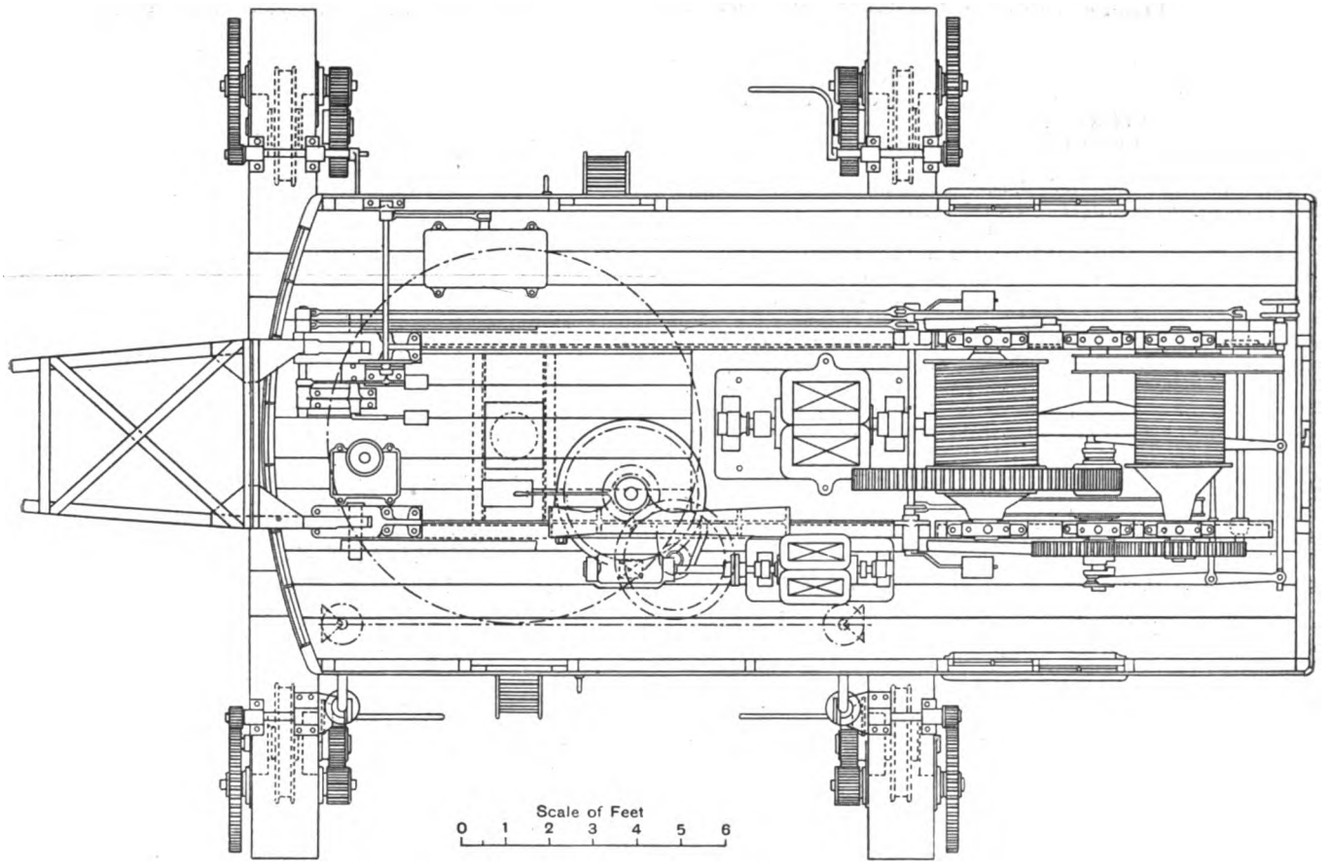
be got out of the cranes when in commission; they are less liable to get out of commission through breakdown, and are much more quickly repaired when breakdown occurs; and the cost of repairs is so trifling that at Southampton no separate account is kept of them. There is a great saving, also, in Southampton. Not only have men quite unskilled in electrical machinery been put in charge of the cranes, but they have acquitted themselves even better than the one or two men who possessed some knowledge of electric motors and their appurtenances. Curiously enough, the best craneman at South-



Plan showing Electrical Equipment of Cabin and Gear for the three 3-ton Electric Cranes at Southampton Harbour.



Plan showing Electrical Equipment of Cabin, Gear and Change-over Mechanism for the Convertible 12-ton and 3-ton Electric Crane at Southampton Harbour.

standing charges, since the same generating plant can be used—as it is at Southampton—for lighting the harbour and the town.

It is sometimes stated by parties interested in rival kinds of cranes, that electric cranes require specially skilled operators and cannot be safely placed in the hands of ordinary cranemen. This mythical notion has been completely exploded at Southampton—the man who "can make the cranes speak," who can get more out of them than anyone else—is a workman quite ignorant of electrical machinery: yet he has never had a breakdown; on the other hand, an electrical man who for some time had charge of the cranes was frequently responsible for interruptions. Facts like these speak for themselves.

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ROTATORY CONVERTERS.*

BY PROF. SILVANUS P. THOMPSON.

So much interest is concentrated at the present time upon the transmission and distribution of electric energy for motive and locomotive power, as well as for lighting, that attention may profitably be directed to a class of machines which hitherto have been little discussed—namely, rotatory converters. In general a rotatory converter may be described as a machine having something in common both with a dynamo and with a motor so far as its structure goes, and of which the function performed by its rotation is to transform the electric energy which is imparted to it in one form into an output of electric energy of some other form. Of such converters there are many varieties, subserving many different uses. For example, one sort of rotatory converter will change continuous currents at one voltage into continuous currents at a different voltage. Another will change two-phase alternating current into three-phase alternating current. Another will change three-phase alternating current into continuous current. Yet another will change an alternating current of a certain frequency into an alternating current of a different frequency. In the following table of the principal conversions which may thus be accomplished, C stands for continuous current, A_1 for alternate current of single phase, A_2 for two-phase, A_3 for three-phase :—

Table I.

1. C to C at higher or lower voltage.	7. C to A_3, or A_3 to C.
2. A_1 to A_1 ,, ,,	8. A_1 to A_2, or A_2 to A_1.
3. A_2 to A_2 ,, ,,	9. A_1 to A_3, or A_3 to A_1.
4. A_3 to A_3 ,, ,,	10. A_2 to A_3, or A_3 to A_2.
5. C to A_1, or A_1 to C.	11. A_1 to A_1 of different phase.
6. C to A_2, or A_2 to C.	12. A_1 to A_1 of different frequency.

Any one of these conversions might be accomplished by selecting an appropriate motor to receive and be driven by the primary current, and coupling it to a generator to give out a secondary current of the species desired. It will be noted that of these conversions No. 2 is the ordinary alternate-current transformation, and is better accomplished by ordinary stationary transformers, as also are Nos. 3 and 4. By a suitable combination of stationary transformers No. 10 can also be effected, whilst Nos. 8 and 9 may be more or less satisfactorily effected by the use of auxiliary choking coils and condensers. But all of them may, and all the others must, be effected by means of rotatory apparatus. From the above list there have been omitted several possible cases of conversion, as, for example, that of a current supplied at fixed voltage, but of varying amperage, to a current of fixed amperage, but delivered at varying voltage.

It is not proposed here to deal, save purely incidentally, with the continuous-current transformer (No. 1 of the above table), which was brought before this Institution seven years ago by Major-Gen. Webber (Vol. XX., p. 63, 1891);† nor with phase transformers (Nos. 8, 9, 10 and 11); nor with frequency transformers (No. 12); nor with any stationary kind of transformer. This Paper will be directed to the machines devoted to the purpose of converting continuous currents into alternating currents of one, two, or three phases, or *vice versâ*. The importance which such machines have now assumed in the electrical industry arises from several causes. Long-distance transmission, with its corollary of the employment of high voltages, has demanded for this service alternating currents. The development of the electric tramway with continuous-current motors has called for methods of feeding at distant points. For this service rotary converters are required. Also for charging accumulators in cases where the public supply is an alternating one, and for factory driving with three-phase motors in cases where the public supply is one with continuous currents, rotary converters are wanted. All these cases might, of course, be met by the use of coupled machines, motor and generator. An early example of this method was afforded by the lighting station at Cassel, where the high-voltage alternating transmission was effected by the use of synchronous single-phase alternators, and the town distribution by continuous-current dynamos coupled to the shaft of the synchronous motors. Even now, in the case of a three-phase transmission and a continuous-current distribution, some engineers recommend the use of a group converter, consisting of a non-synchronous three-phase motor coupled to a continuous-current dynamo. But in all such cases the efficiency of the group is necessarily lower than that of either of its component parts. If a motor having, say, a 90 per cent. efficiency is coupled to a dynamo, also of 90 per cent. efficiency, the efficiency of the group cannot possibly exceed 81 per cent. Two other solutions to the general problem are possible. One is to wind the revolving armature with two sets of windings—one to receive the primary current and revolve as a motor, the other to generate the secondary current. As only one field magnet and one pair of bearings are required, there is an obvious economy of material, though no great saving in efficiency. Another solution—not, it is true, of universal application, but having the advantage of effecting a considerable increase of efficiency as well as an economy in material—is to wind the armature with but one set of windings, furnished at one end with a commutator, and at the other with appropriate contact rings, the same winding serving both to receive the incoming primary current and to generate the secondary current. It is this specialised type of machine which is the main subject of the present discussion, and which is called *par excellence* a rotatory converter.

At this point it may be convenient to drop the adjective "rotatory," and speak simply of *converters*, leaving the term "transformer" to denote the stationary apparatus.

Converters of a simple kind have been known for many years. Ever since 1885 there has been one at the Technical College, Finsbury, consisting of a bipolar Gramme machine with the ordinary commutator, with the addition of two insulated contact rings at the other end of the armature, these rings being connected to two points on the winding at opposite ends of a diameter. It, therefore, belongs to the species CA_1 (or No. 5 of Table I.). The addition of three contact rings connected to three symmetrical points on the winding would constitute a machine of the species CA_3 (or No. 7 of Table I.). It may be convenient here to point out the relation between the number of contact rings (called for brevity slip-rings) that are applied in any alternate-current generator, and the uses to which such generator may be put with respect to the phasal relations of the currents that may be drawn from it. For brevity these are enumerated in Table II. The figures in the second column relate to the angles between the points on the winding at which the slip-rings are connected for the simple case of a bipolar machine.

Table II.

No. of slip-rings.	Angle.	Possible service.
2	180°	Single phase.
3	120°	3 single-phase in ternature = "three-phase."
4	90°	2 single-phase in quadrature = "two-phase," or 4 single-phase in successive quadrature = "four-phase."
5	72°	5 single-phase in quinature = "five-phase."
6	60°	3 single-phase in ternature = three-phase with separate leads, or 6 single-phase in successive sexature = "six-phase," or 2 three-phase in sexature.
7	51⅐°	7 single-phase in septature = "seven-phase."
8	45°	4 single-phase in successive octature = "four-phase" with separate leads, or 8 single-phase in successive octature = "eight-phase," or 2 two-phase in octature.
9	40°	3 three-phase in nonature, or 9 single-phase in successive nonature = "nine-phase."

The general principles of conversion from polyphase to continuous currents, or *vice versâ*, are well known. The relation between the respective voltages on the alternating-current side and the continuous-current side have long ago been investigated, and expressions for their values in the several instances that may arise have been given for those cases in which it is assumed (*a*) that the alternating currents are simple sine functions of the time, and (*b*) that the magnetic flux is distributed as a sine function in space with respect to the periphery of the armature. Calculations for the voltages of two-phase and three-phase converters were given by Prof. Ayrton in the *Journal* of the Institution of Electrical Engineers, Vol. XXII., p. 340, in a discussion on April 27, 1893. For the purpose of studying such machines they may be considered either as used to convert continuous currents into alternating, or as converting alternating into continuous. The latter function is of more frequent occurrence in practice ; the former is rather more easy to follow out in thought. Taking, then, the instance of the converters as used to change continuous currents into alternating, and applying Prof. Ayrton's results to the several cases, we obtain the following numerical values. If we take the continuous currents as being supplied at a constant pressure of 100 volts, the voltmeter readings at the alternate-current side will be as given in Table III.

A very complete discussion of the voltage relations, with formulæ applicable to the cases of open-coil windings as well as of closed-coil windings, was given by Herr R. M. Friese, in the *Elektrotechnische Zeitschrift* of Feb. 15, 1894. Throughout the series of articles, he assumes the sine values of the distribution of the magnetic flux around the periphery of the armature. More recently, Mr. Steinmetz has reconsidered the same problem in the same journal in articles which appeared on March 3 and 10, 1898. From these theoretical considerations it is easy to write down, not only the voltages in the several cases, but also to calculate the corresponding relative values of the working currents in the armature and in the line wires. Similar calculations, down to a certain

* Paper read before the Institution of Electrical Engineers, November 10, 1898.

† [*The Electrician*, Vol. XXVI., p. 399.—ED. *E.*]

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Table III.

No. of slip-rings	Angle between connections to rings.	Nature of service generated.	Voltage ratio.	Voltage (virtual volts).
2	180°	Single-phase ...	$\frac{1}{\sqrt{2}}$	70·71
3	120°	Three-phase ...	$\frac{1}{2}\frac{\sqrt{3}}{\sqrt{2}}$	61·23
4	90°	As two-phase...	$\frac{1}{\sqrt{2}}$	70·71
4	90°	As four-phase	$\frac{1}{2}$	50·00
6	60°	As three-phase	$\frac{1}{2}\frac{\sqrt{3}}{\sqrt{2}}$	61·23
6	60°	As six-phase ...	$\frac{1}{2\sqrt{2}}$	35·35

Table IV.—*Working Currents in Alternating Armatures.*

No. of slip-rings.	Angle between connections to rings.	Nature of service.	Armature current.		Line current.	
			Virtual.	Maximum.	Virtual.	Maximum.
2	180°	Single-phase	70·7	100·0	141·4	200·0
3	120°	Three-phase	54·5	77·0	94·3	133·3
4	90°	Two-phase [4 wires]	50·0	70·7	70·7	100·0
6	60°	Six-phase	47·2	66·7	47·2	66·7

point, have to be made by every designer of polyphase motors. If we assume the above values for the voltages, and proceed to calculate the corresponding currents for an output of 10 kilowatts, we find the value of the currents generated to be those in Table IV., the circuits being supposed non-inductive. Maximum as well as virtual values are given. Columns 4 and 5 refer to currents in the armatures, and columns 6 and 7 to currents in the lines. Star groupings are out of the question here, as they cannot be applied in armatures of converters. The only two-phase case that is possible is really a four-phase.

If the circuits are inductive, there will be a lag of phase in the currents, and wattless currents as well as working currents. For an equal output of power the numbers in columns 4 and 7 of the above table will need to be increased by dividing them by the cosine of the angle of lag.

Let us return to the problems presented by a converter, in which an armature, furnished with slip-rings at one end and a commutator at the other, is wound with but one set of windings, receiving current as a motor and delivering it as a generator. The question for consideration is how the current, in the act of being transformed from alternating to continuous, or *vice versâ*, flows through the windings of the armature. This is a matter that has not hitherto been considered in detail in any publication. Consider the general case of a revolving armature which is at the same time being traversed by continuous currents to drive it as motor, and by alternating currents which it is putting forth as generator. It is self-evident that the currents which it receives as motor must be flowing, in general, against the electromotive forces induced internally by its rotation, while the currents which it gives out as generator must be flowing with those electromotive forces. Further, since at every instant (under steady conditions of operation) the value of the continuous current is (by hypothesis) unvarying, whilst the instantaneous value of the alternating current is continually changing, it is clear that at some instants the motor current must be in excess of the generator current, whilst at other instants the reverse must be the case. Whilst the average speed of rotation remains uniform it is certain that during each period, or revolution, there will at times be a positive acceleration, and at other times a negative acceleration. Further, it is clear that if there are any irreversible sources of loss of energy, such as friction, hysteresis, or eddy-currents, the motor current must on the whole be greater than would otherwise be requisite, the power supplied at the motor side being greater than the output of power at the generator side, the difference being equal to the sum of the various items of power wasted in the machine. To make this clear, as well as to exhibit the way in which the circulation of current in the windings is effected, it is well to take some concrete case. All cannot follow an analytical argument; and, therefore, though the analytical treatment has many advantages, I have deliberately preferred, for the purposes of the present Paper, to avoid formulæ (though they have been used in its preparation), and, instead, to exhibit the arguments numerically by taking specific cases that are readily followed.

Let us consider a 10-kilowatt bipolar ring armature, having at its periphery 96 conductors, connected symmetrically down to a 48-part commutator, running at 1,200 revolutions per minute, or 20 revolutions per second. There will be two turns of the winding between each commutator bar and the bar next adjacent. (Or the armature might be wound as a lap-wound drum, with two conductors to constitute each element of the winding.) That it may run as a 100-volt continuous-current machine the magnetic flux through the armature core must be 5,208,333 lines, or a little over 5 megalines. Fig. 1 will serve to represent diagrammatically this armature when receiving 100 amperes at 100 volts, and running as a motor. The flow of current in the armature winding will, of course, be 50 amperes in each half of the ring.

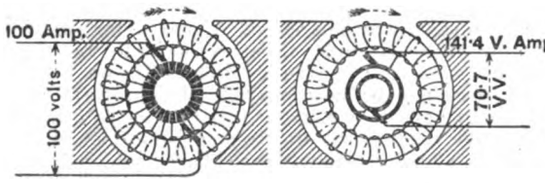

Fig. 1. Fig. 2.

Now, suppose a precisely similar armature to be revolving in a precisely similar field, but let its windings be connected at two diametrically opposite points to two slip-rings on the axis. If driven by power it will generate an alternating current. As the maximum voltage between the points that are connected to the slip-rings will be 100 volts, and the virtual volts (as measured by a voltmeter) between the rings will be 70 7 ($=100 \div \sqrt{2}$), if the power applied in turning this armature (Fig. 2) be 10 kilowatts, and if the circuit is non-inductive, the output in virtual amperes will be $10{,}000 \div 70{\cdot}7 = 141{\cdot}4$. If the resistances of each of the armatures is negligibly small, and if there are no frictional or other losses, the power given out by the armature which serves as

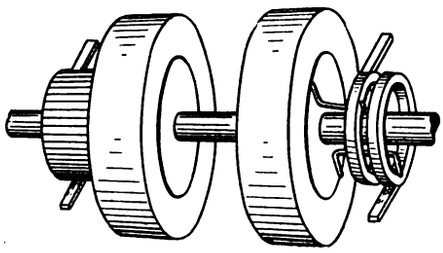

Fig. 3.

motor will just suffice to drive the armature which serves as generator. Accordingly, let us suppose them both mounted upon the same shaft, as in Fig. 3, and placed so that each lies in a similar and equal bipolar magnetic field. We have here the well-known combination of a *motor-dynamo*.* In every actual case there are, of course, losses (*a*) by friction, hysteresis, and eddy-currents, (*b*) by heating of the resistances in the armatures. The former have to be paid for by an increase in the motor current. Suppose them in the present case to amount to 4 per cent. for each armature, then 108 amperes instead of 100 must flow in from the supply circuit. The heat losses manifest themselves electri-

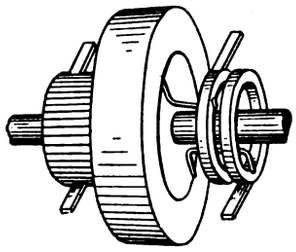

Fig. 4.

cally by a fall of potential at the terminals of the generator, and by a fall of speed in the motor if the primary voltage is not raised. Let the primary voltage be supposed to be raised the requisite small percentage to keep up the speed and to maintain the secondary voltage at 70·7 on the generator side: the output of the generator will then be 10 kilowatts, the input at the motor 10 kilowatts *plus* the number of watts required to make up all the various items of

* The term *dynamotor* is not only philologically bad, but is a misdescription. When two machines, of whatever kind, are thus coupled together, it is always the motor which drives the dynamo, not the dynamo which drives the motor.

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lost power. Though the armatures are of equal resistance, and are respectively receiving and giving out (approximately) equal amounts of electric energy, the armature of the alternate-current side (whether used as generator or motor) will heat more than that of the continuous-current side; for it carries $\sqrt{2}$ times as large a current, and the ohmic heat will be proportional to the square of this, or twice that produced in the continuous-current armature by the 100 amperes of working current. In each armature the heat will be developed equally in all the separate coils around the ring. As the armatures are alike, and as the similarly placed windings in each are passing through identical magnetic fields, there is no reason why one winding should not answer for both purposes. Fig. 4 shows the case in which this change has been made. One armature only is used; it is connected at one end to the commutator, at the other to the two slip rings, and the machine now becomes a simple *rotatory converter*. The total hysteresis and eddy-current losses will obviously be now one-half of their former amount. The total heating due to resistance will be also reduced, because now the single winding has to carry only the differences of the two currents—a point presently to be considered—and the ohmic losses will be less. The waste of power, in fact, is approximately halved. How far this economy of losses can be carried depends on the number of phases of the alternating current. But there is another consideration involved—the question of armature reactions and sparkless collection of current. In the combined pair of machines called a *motor-dynamo* the brushes on the continuous-current side must be set, exactly as in any continuous-current machine, with a lead, negative or positive, according as whether it is operating as motor or dynamo. In the *rotatory converter* no lead in either sense need be given to the brushes; for the armature reactions of the motor part being, in general, opposed by those in the dynamo part, they cancel one another to a large extent. This property, which is common to all those motor-generators in which there is used, whether with one winding or two, a common core in a common field, was pointed out by the author* in 1888, when giving the theory of continuous-current transformers.

(*To be continued.*)

CORRESPONDENCE.

ELECTRIC CANAL HAULAGE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In his letter on the above subject in your issue of Nov. 4th, M. F. Galliot takes exception to the statements in my Paper regarding the failure of earlier attempts to apply electric traction to canal haulage. I should like to point out that my remarks were in themselves perfectly correct; M. Galliot himself admits the unsuitability of his chain haulage system for general application.

When preparing the Paper, towards the end of August, I endeavoured to ascertain whether any other system had been successfully applied, with wholly negative results; the proceedings of the International Congress held in Brussels in the same month were not at that time accessible, nor have they as yet been published in our journals so far as I am aware.

With regard to the power required for haulage, ample data are available showing that on English canals, having a cross-sectional area four to five times that of the boats, one horse can haul a gross load of 120 tons at a speed of 2¼ miles per hour for four hours without difficulty. The pull, as measured with a dynamometer, is about 2lb. per ton, or 240lb. total at the outside. In my calculations I took 300lb. at a speed of 2½ miles per hour, the pull being increased in proportion to the square of the speed; the latter assumption is justified by experimental data in my possession. This pull, at the speed stated, is equivalent to two effective horse-power on the tow-rope; but it is specified that the motor shall be capable of exerting a pull of *twice* 300lb. when starting. In fact, the motor is 50 per cent. larger than is necessary for the power stated, though I expressly avoided rating it in horse-power, as this practice is misleading. A footnote to the Paper covers the case of canals of small cross-section, which were not discussed in detail for want of space.

I may add that the prevalent impression that the average horse can only perform ⅔ to ¾ of 33,000 ft. lbs. per minute is very much in error; a horse can work at the rate of 1½ mechanical horse-power for four hours per day, or 1 H.P. for eight hours per day, without injury, and can readily exert a pull of 600lb. for a short distance.

It would be interesting to hear how M. Galliot's tricyles pass one another on the towing-path; if the same delays occur as with horse haulage—at intervals of eight minutes from M. Galliot's data—there is little wonder that the (average?) speed does not exceed 1½ miles per hour!

The pull on the tow-rope equivalent to 6 effective horse-power, at a running speed of two miles per hour, is 1,125lb.; a much greater pull is necessary when getting up speed, so that the weight of the tricycles and the wear and tear on the tow-path must be very great. Also, a driver is indispensable on M. Galliot's system.

In conclusion, permit me to point out what M. Galliot has apparently overlooked—that the system I described is the invention of Messrs. Thwaite and Cawley; that my estimates were based on a yearly traffic of 30,000 barges, carrying three million tons, as compared with M. Galliot's 17,000 barges, carrying five million tons; and that the greater the traffic the less would be the cost per ton-mile on the Thwaite-Cawley system, which is particularly well adapted for heavy traffic.

—Yours, &c., A. H. ALLEN.

Wandsworth, Nov. 8, 1898.

* *Philosophical Magazine*, August, 1888.

LEGAL INTELLIGENCE.

In re an Arbitration between South and the Mayor, &c., of Bedford.

This case came before the Court of Appeal (Lords Justices A. L. Smith, Rigby and Collins) on Monday, on the appeal of the Mayor and Corporation of Bedford from an order of Mr. Justice Phillimore in Chambers, by which he appointed an arbitrator under Sec. 5 of the Arbitration Act, 1889, under the alleged terms of an agreement made on July 24, 1897, between Mr. Harry South, electric light contractor, Garrick-street, London, and the Mayor and Corporation of Bedford, by which Mr. South agreed to execute certain works at the Newnham sewerage pumping station, Bedford, and provide motors coupled direct to two vertical spindle centrifugal pumps, the pumps to be capable of raising 750 gallons of sewage per minute.

Mr. ABEL THOMAS, Q.C., for appellants, said the matter first came before the Master in Chambers when he dismissed the summons. Mr. Justice Phillimore, however, on appeal by Mr. South reversed the decision of the Master, and made an order appointing an arbitrator. Under the contract or agreement Mr. South undertook to do the work for £600, 40 per cent. to be paid when the plant was put in, 40 per cent. when the work was completed, 10 per cent. six months after completion of the works, and the remaining 10 per cent. on the expiration of a period of maintenance. Disputes arose between Mr. South and Mr. Hope-Johnston, engineer to the borough of Bedford. One of the disputes was as to whether Mr. South was entitled to the second 40 per cent. on completion of the work. The answer to Mr. South's demand was that the works did not come up to the efficiency test, and, therefore, that Mr. South was not entitled to the £240.

Mr. NEALE said there was this further question—Mr. South said the plant was thoroughly efficient and up to the guaranteed efficiency, but Mr. Johnston said it was not.

Mr. THOMAS replied that it seemed to him that the only question their Lordships would have to decide was whether under the contract which was entered into between Mr. South and the Mayor of Bedford, Mr. Johnston was the arbitrator for the purpose of deciding that very question. The agreement provided that Mr. South was to execute the work in a good and workmanlike manner, and to the satisfaction of the borough engineer, and that each motor and pump should be capable of lifting 750 gallons of sewage a minute through the pipes. Another stipulation was that the waste of electrical power was not to be more than 40 or 50 per cent. "at full load." Exhaustive tests of the plant were to be made by the engineer or his representative at the contractor's expense, and such tests were to be carried out at such times as the engineer should decide, the contractor finding, if necessary, instruments and labour for the purpose of these tests. The contract further provided that the work was to be carried out under the direction or control of the engineer duly appointed by the local authority, and "to his entire satisfaction." A clause gave the Corporation power (if, in the opinion of the engineer, the work was not carried on properly or with due diligence) to serve the contractor with seven days' written notice to remedy defects, &c., with power at the expiration of that time to call in and employ another contractor to do the work left undone by the original contractor. Mr. Thomas said tests had been taken by Mr. Johnston, Mr. South having a representative present at the time, and the results of those tests were sent to Mr. South. Mr. Johnston, in the natural order of things, informed the Corporation of what had been done, and on May 18 formal notice was sent to Mr. South by the town clerk, who informed him that the plant had failed to pass the standard of test guaranteed in the con-

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tract. Mr. South did nothing under the notice, and long after the expiration of the seven days the work was put in the hands of another contractor, and Mr. South had not been paid. Mr. South had, however, written to the Corporation several times, claiming that the work was of sufficient efficiency.

Lord Justice SMITH: Where is the clause that the engineer is to be arbitrator?

Mr. THOMAS: "The contractor will forthwith perform and execute the work in a good and workmanlike manner, and to the satisfaction of the engineer."

Lord Justice SMITH: That does not make him abitrator.

Mr. THOMAS: Well, if the work is to be done to his satisfaction he can decide whether it is to his satisfaction or not. That is conclusive, I submit.

Lord Justice COLLINS: "Arbitrator" is hardly the word for that.

Mr. THOMAS: Well, perhaps not; but he is "to decide and determine."

Lord Justice COLLINS: There is no power of appeal from his decision.

Mr. THOMAS: No, none.

Lord Justice SMITH: The point is this. You want it to go to the engineer?

Mr. THOMAS: It has been to him, and he has decided against Mr. South. My point is that Mr. Justice Phillimore was wrong when he ordered anything to be sent to arbitration. We say it is all decided. The learned counsel, continuing, said that the contract provided also that if any of the work or part of the works failed to pass the tests specified, the engineer might totally reject such work or part of the works. He could also during the progress of the works reject any of the materials brought on the site if, in his opinion, they were objectionable.

In answer to a question from the Bench, Mr. NEALE stated that what took place before Mr. Justice Phillimore when he made the order was this. The learned judge asked Mr. Jones, representing the Corporation, if his clients would reject the plant wholly or in part, and adjourned the hearing for a fortnight for an answer. Mr. Jones then informed the learned judge that his clients would not reject the machinery, but were acting under Clause 11, giving power to the Corporation to give notice of defects.

Mr. THOMAS said that had there been any other differences outside the power given to the engineer he agreed that the order of Mr. Justice Phillimore would be a right one. But there were no differences except as to the payments, and that was a point to be determined by the person agreed upon between Mr. South and the Corporation of Bedford, viz., Mr. Johnston. Mr. Johnston had not given his certificate.

Lord Justice SMITH: That is not the point. The question is whether it is to go to arbitration.

Mr. THOMAS: I submit there is nothing to arbitrate about.

Lord Justice SMITH: If my brother Phillimore's order stands what will be referred?

Mr. THOMAS: To ascertain, I suppose, the amount payable to Mr. South.

Lord Justice SMITH: No, that cannot be, because he has not got a certificate. That is no good to him. I suppose it will have to go to the arbitrator to decide whether the Corporation have broken the contract by taking the matter out of his hands.

Mr. DAVID JONES followed on the same side, and contended that nothing could be referred which was within the jurisdiction of the engineer under the contract, and that as the matter in dispute was within the jurisdiction of the engineer, Mr. Justice Phillimore's order was wrong, and ought to be set aside.

Mr. NEALE (on behalf of Mr. South) said that the words in the contract were not meant to apply to the contract as a whole, but to special powers by the contract given to the engineer, such as objection to materials, and so on.

Lord Justice SMITH: You have got to get within the arbitration clause. The engineer has to take the tests. What does he take them for?

Mr. NEALE: He has to satisfy himself that the machine is in good working order. But here is another difference. We are to supply machinery of good material and to execute the work in a workmanlike manner, to the engineer's satisfaction. The whole thing has been done under his supervision, and all the material passed through his hands on delivery.

Lord Justice SMITH: That may be; but they will not work.

Mr. NEALE replied that no objection was taken to the materials or machinery supplied or to the work done until the whole thing was completed, when Mr. South was entitled under the payment clause in the contract to have the certificate at once.

Lord Justice SMITH: If you perform your part of the contract, and the engineer says so, yes. But supposing he says you have not?

Mr. NEALE submitted that as soon as the work was completed and the machinery was ready to run, Mr. South was entitled to have the second 40 per cent. of the contract price. The remaining 20 per cent., which was due, was retained until the engineer had tested the efficiency of the plant. He (counsel) was instructed that no test had been made under specified conditions. The proper remedy under the contract was for the engineer to reject; there being a special clause providing for that contingency.

Lord Justice RIGBY: Do you mean to say that if he does not exercise the power of rejection there is no power at all?

Mr. NEALE said it seemed that if they got the goods and their engineer did not reject them, that they had no remedy. The plant was made up of different motors, &c., any one of which the engineer could have objected to and turned away. Mr. South had to obtain these things from different people and was, of course, liable to pay for them if not returned. They were bought by Mr. South under guarantees from the makers to perform the work. The proper course was to have a test made to see if the plant worked up to the guaranteed efficiency. Assuming even that Mr. South was wrong and that the plant would not work up to the guaranteed efficiency, if the Corporation elected to keep the goods, they must pay something for them, surely.

Lord Justice SMITH: Then sue them.

Mr. NEALE: We cannot in face of this arbitration clause. We took the only step we could in taking out this summons for arbitration. Here are things which Prof. Silvanus Thompson, or Prof. Kennedy, or any electrical expert could decide in half-an-hour.

Lord Justice SMITH: Will you take the decision of Prof. Silvanus Thompson?

Mr. NEALE: Yes, certainly.

Lord Justice SMITH: What do you say, Mr. Thomas?

Mr. THOMAS replied that it was too late to do so now, as the work had been let to another contractor and he understood that the whole condition of things was altered.

Mr. NEALE said he understood that at present nothing had been touched. It was quite true that a contract had been entered into with another contractor, but the other side had given an undertaking not to alter the work until this question was decided.

Lord Justice SMITH said that they must decide the case on the law.

Lord Justice COLLINS (to Mr. Jones): You have refused to reject?

Mr. JONES: Well, at present we want to see what we can use and what we cannot use, and we have not up to now made any use of any part of the machinery.

Lord Justice SMITH: I understand now why Justice Phillimore said, "If you will not reject, I will send the case to arbitration."

After further discussion, Lord Justice SMITH, in giving judgment, said: The question here is whether a builder or contractor can force to arbitration under an agreement he entered into with the Corporation on July 24, 1897. Mr. South contracted with the Corporation to put up some electrical pumps which were to work up to a certain test of efficiency in the contract, which I need not discuss. There was an engineer appointed by the contract who was to be the engineer of the works and to be the engineer of the Corporation of Bedford. Mr. South put up the pumps, and he was to be paid 40 per cent. of the contract price upon delivery of the things on the ground, 40 per cent. when the work was completed, and then afterwards the two remaining 10 per cents at the times specified. Mr. South was paid the first 40 per cent., and alleged that the second 40 per cent. had become payable because he had completed the work. The engineer, however, said it had not become due, because the work he had contracted to put up did not work up to certain tests, and, therefore, he would not give him a certificate for the second 40 per cent. Notice was given to Mr. South by the Corporation to go on with these works and make them efficient, but he had not done so. The Corporation then under the agreement had entered upon the works, and had entered into a contract with fresh contractors to complete the work to the satisfaction of their engineer. The engineer said that Mr. South had not completed the work according to the contract. Mr. South then said, "You have turned me out, pay me for the work I have already erected." He said, "You have taken these works over, pay me for what I have already put upon your premises." But the Corporation say no. "Well," says the plaintiff, "I will get an arbitrator appointed under the Arbitration Act, under this arbitration clause in the contract," and he gives notice to the Corporation to appoint an arbitrator. The Corporation decline to do so. He then goes to the Master, who declines to appoint any arbitrator, and then he appeals to Mr. Justice Phillimore, who did appoint the arbitrator. The Corporation said to the judge, "You cannot appoint an arbitrator, except as to disputes which are not within the jurisdiction of the engineer." Who is to ascertain the amount payable to Mr. South for the amount of work already done before it was taken out of his hands by the Corporation—perhaps, properly taken out of his hands? Why clearly not the engineer. There are certain matters in that clause which would be in the jurisdiction of the engineer, but not this matter. It seems to me, therefore, that there is a matter in dispute between Mr. South and the Corporation which does not come within the jurisdiction of the engineer, but is a matter of dispute on which the Court has jurisdiction to appoint an arbitrator, which my brother Phillimore has done. Mr. Justice Phillimore asked the Corporation if they would reject the plant, &c., which Mr. South had put up on this ground, and time was given to the Corporation to enable it to make up its mind. The Corporation turned round and said, "No, we will not," and then my brother Phillimore upset the Master, and set aside his order and ordered an arbitrator to be appointed. I think that that order was right under the circumstances, and that the appeal should be dismissed, with costs.

Lord Justices RIGBY and COLLINS fully agreed.

Mr. JONES: Will your Lordships specify the matter the arbitrator is to deal with!

Lord Justice SMITH: No (laughter).

BOOKS RECEIVED.

"The Official Gazette of the United States Patent Office," No. 5, Vol. LXXXV. Published by authority of Congress. (Washington: Government Printing Office.)

"Practical Telegraphy," a guide for the use of officers of the Victorian Post and Telegraph Department. By H. W. Jenvey. Published under the authority of the Postmaster-General of Victoria. Vol. I. Third edition. Vol. II. First edition. (Melbourne: R. S. Brain.)

"Annual Report of the United States Commissioner of Patents for the Year 1897." (Washington: Government Printing Office.)

"Quick and Easy Methods of Calculating": a Simple Explanation of the Theory and Use of the Slide Rule, Logarithms, &c. By R. G. Blaine. (London: E. and F. N. Spon). Price 2s. 6d.

"Metrical Tables." By Sir Guildford L. Molesworth. Third edition. (London: E. and F. N. Spon). Price 2s.

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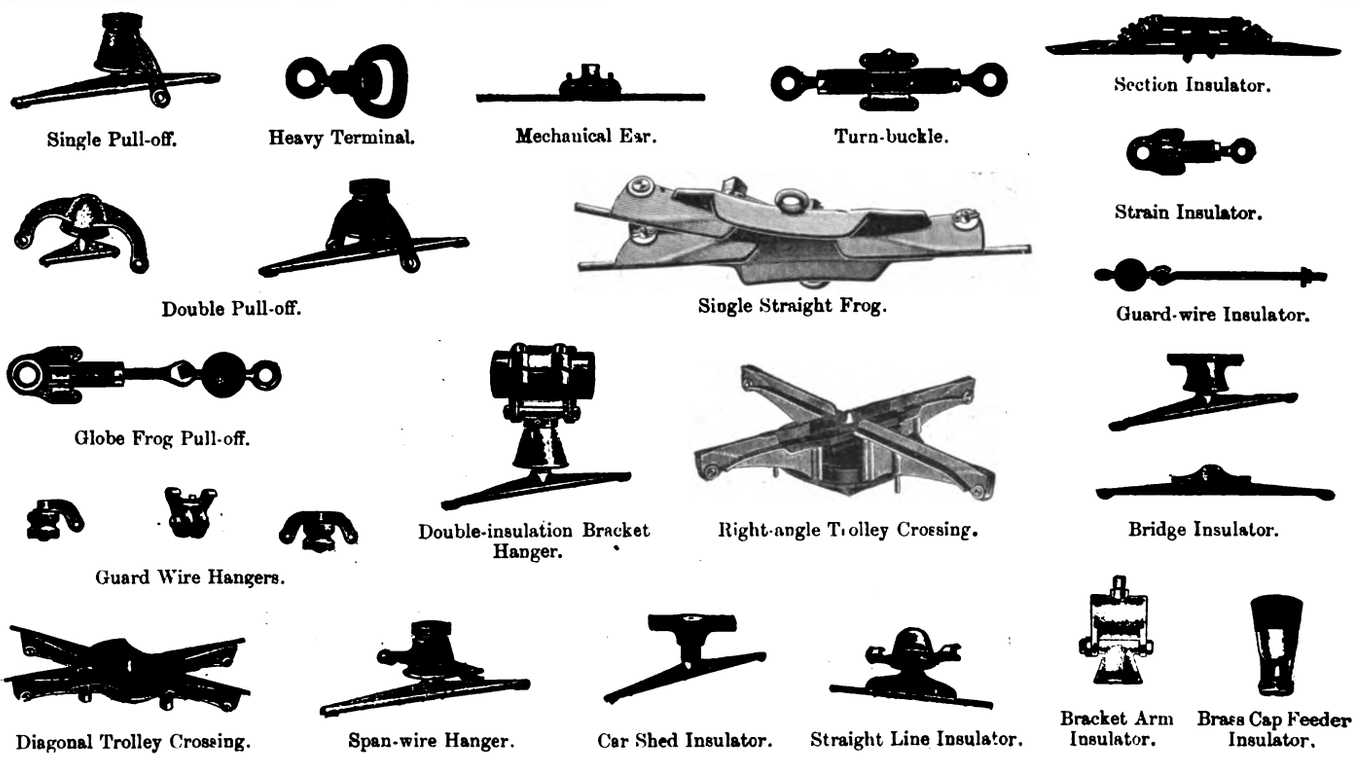
POSITION AND PROSPECTS OF ELECTRIC TRACTION IN THE UNITED KINGDOM.

The present position of the electric traction industry in the United Kingdom is decidedly one of great briskness, and the prospects are much more encouraging even than they were at the beginning of the year, and promise a long period of great activity in the construction of new electric tramways and railways. Some idea of the amount of work that has already been done in the United Kingdom may be gathered from the following list of complete lines in operation, which have been described in *The Electrician*:—

Brighton	Sept. 1, 1883	Bristol—Kingswood	Oct. 18, 1895
Giant's Causeway	Oct. 27, 1883	Coventry	Nov. 22, 1895
Blackpool	Sept. 10, 1886	Dublin—Dalkey	Jan. 17, 1896
Shoreham—W. Brighton	July 29, 1887	Douglas Head	Dec. 4, 1896
Ryde Pier	Feb. 15, 1889	Bristol—Eastville	Feb. 5, 1897
Carstairs	May 10, 1889	Leeds	Nov. 12, 1897
Birmingham — Bournbrook	July 25, 1890	Cork	Dec. 24, 1897
Southern Pier Elec. Ry.	Aug. 22, 1890	Dublin—Clontarf	Dec. 24, 1897
City & S. L. Railway	Nov. 7, 1890	Kidderminst'r-St'rp'rt	May 20, 1898
Guernsey	April 3, 1891	Hartlepool	June 19, 1898
Leeds	Oct. 30, 1891	Halifax	July 8, 1898
Liverpool Overhead Ry.	Feb. 10, 1893	Waterloo and City	July 15, 1898
Douglas—Laxey	Aug. 17, 1894	Middlesbro' — Stockton—Thornaby	July 29, 1898
Snaefell Mountain	Sept. 13, 1895	Douglas-Laxey-R'ms'y	Aug. 8, 1898

Overhead Trolley Equipment, Bonds, &c.—The overhead trolley system stands *facile princeps* among electric traction systems, and, indeed, claims the lion's share of the work. The number of British firms who undertake the manufacture of overhead trolley equipments, bonds, &c, is comparatively small, but among these we may mention the ubiquitous ROBERT W. BLACKWELL AND CO.; MACARTNEY, MCELROY AND CO.; and Messrs. W. F. DENNIS AND CO., who have all done a very large amount of this class of work.

Poles, Rails, Points, &c.—Although competition with British manufacturers is not altogether absent, contracts for these details remain largely in the hands of British makers. Among these Messrs. ASKHAM BROS. AND WILSON, the BARROW HÆMATITE CO., &c., are carrying out large contracts, and have done so in the past for rails, bonds and special work in tramways and light railways; and Messrs. JOHN SPENCER, Messrs. MACFARLANE AND CO., the MANNESMAN TUBE CO., the LEEDS STEEL WORKS, HADFIELD'S STEEL FOUNDRY CO., and Messrs. MORRIS, TASKER AND CO. have supplied many thousands of centre and side poles for various systems of overhead trolley construction.



OVERHEAD TROLLEY DETAILS.

In order to show the enormous amount of work that is being done in connection with electric traction at the present time, and to give some idea of the great variety of industries affected, and the large number of firms who are engaged in this work, we have prepared below some account of the various departments of electric traction constructive work:—

Complete Railways and Tramways.—The number of British and American firms who have actually undertaken complete equipments for railways and tramways in the United Kingdom is considerable, and is increasing every month. Among these we may notice Messrs. MATHER AND PLATT, who supplied plant for the City and South London Railway, the Fleetwood inter-urban line, the Douglas (Isle of Man) line, &c.; the ELECTRIC CONSTRUCTION CO., who were prominently connected with the equipment of the Liverpool Overhead Railway and several later electric tramway projects; Messrs. SIEMENS BROS. AND CO., who built the earliest locomotives for the first underground railway in London, as well as for the Waterloo and City Railway; Messrs. CROMPTON AND CO., who from the earliest were connected with both underground and surface work; the BRUSH CO. at Dover and Kidderminster; the THAMES IRONWORKS; besides the following firms associated with American manufactures, viz., the BRITISH THOMSON-HOUSTON CO., the WESTINGHOUSE CO., and Messrs. R. W. BLACKWELL AND CO. We must not forget to mention the BRITISH ELECTRIC TRACTION CO., who are actively engaged in the promotion of new electric tramways and railways all over the country, although not actually engaged in manufacturing and construction work.

Cars and Locomotives.—There is a considerable opening for British industry in the special manufacture of electric cars and locomotives, either the complete vehicle, the car body, or the special form of truck which electric traction renders necessary. Among British makers engaged in this work we may mention SIEMENS BROS. AND CO., CROMPTON AND CO., the BRUSH COMPANY, MATHER AND PLATT; and the ELECTRIC CONSTRUCTION CO., for locomotives and motor cars; and MILNES AND CO. and DICK, KERR AND CO. for tramcars. In this country the short double deck rigid truck car is more popular for tramways than the Pullman type of American car on double bogies, but this latter is gaining ground, and with the inevitable increase in the volume of traffic to be handled by electric lines will, we think, become increasingly popular here. The trucks commonly used on both kinds of car are exemplified by the Peckham cantilever and bogey trucks shown in the accompanying illustrations.

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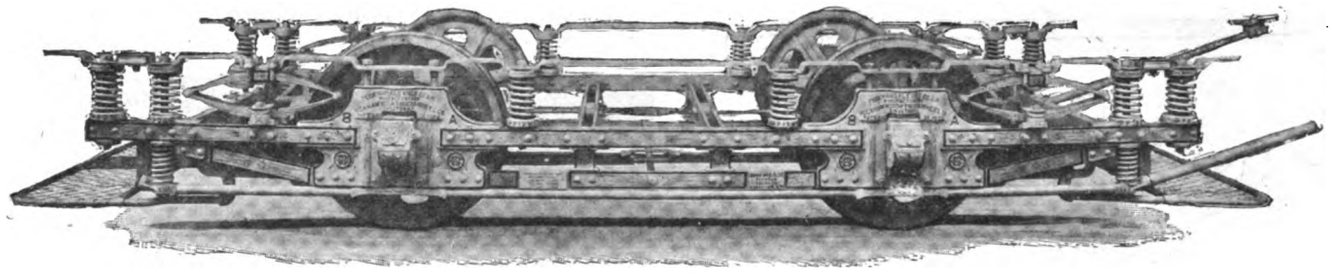
Car Motors.—Electric traction has developed a distinct type of electric motor, partly from the necessity of withstanding the heavy wear and tear, and partly in order to provide a motor without any external field, since heavy stray fields would be objectionable on account of their effect on passengers' watches, &c. Among the English firms who have supplied railway and tramway motors are Messrs. SIEMENS BROS. AND CO., CROMPTON AND CO, the ELECTRIC CONSTRUCTION CO., the BRUSH COMPANY, MATHER AND PLATT, while from America we obtain the THOMSON-HOUSTON, WESTINGHOUSE, and WALKER types of motors. The gearless motor for tramway work has not yet arrived, and it is doubtful if it ever will, but for heavy railway work ungeared motors have been very successfully used in this country.

Cables.—In British traction work, cables are usually provided both for the supply and return. Notwithstanding that the return current is thus provided with an insulated conductor, care has to be taken to keep down electrolytic and other objectionable effects of stray currents. In connection with this branch we may mention that the BRITISH INSULATED WIRE CO. has recently introduced an ingenious system of laying cables for tramway work, the object being to do away with the electrolytic action of return currents on the tramway cable and its lead covering. The lead-covered cable is laid in earthenware troughing of substantial section, the troughing being provided with small bridge pieces at intervals to keep the cable clear at the bottom of the troughing, which is then filled up with a pitch composition, and a substantial cover securely fastened on the top. In this system, therefore, there is copper, paper and lead in the cable itself, with pitch and earthenware as a protection, which renders the job practically imperishable. The CALLENDER CO. are doing extensive work in laying cables for tramways in this country, and are introducing a variety of systems adapted to various classes of work and to varied local conditions. Their work is so well known among electrical engineers and to the general public, that a detailed account of these systems would be superfluous. Other leading firms supplying cables of excellent quality for traction work, and whose manufactures may be thoroughly relied upon, are Messrs. SIEMENS BROS. AND CO., the TELEGRAPH MANUFACTURING CO., the SILVERTOWN CO., HENLEY'S TELEGRAPH WORKS CO., W. T. GLOVER AND CO, W. F. DENNIS AND CO., CONNOLLY BROS., JOHNSON AND PHILLIPS, and the SOCIÉTÉ D'EXPLOITATION DES CABLES ELECTRIQUES.

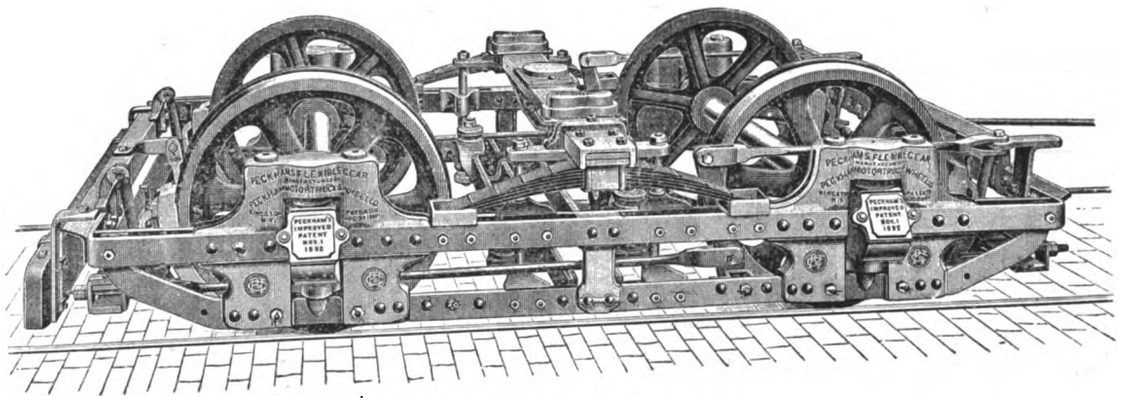
Cable Conduits.—Some cables go in conduits, others are buried by the "undertakers." Where a conduit is to be provided engineers cannot do better than employ one or more of the following firms, viz., Messrs. DOULTON AND CO., whose excellent stoneware conduits are largely in demand; Messrs. JOHNSON AND PHILLIPS, who have a well-known "BROOKS" system of oil insulation conduits; Messrs. CROMPTON AND CO., who laid bricks in the form of conduits in the early days and have successfully stuck to the practice ever since; also the BRITISH INSULATED WIRE CO., whose latest and undoubtedly excellent conduit we describe in the previous paragraph; and the CALLENDER CO.

Batteries.—Engineers are divided as to the advantages of using batteries on tramway circuits, but there is no doubt that they have been used with great success on many lines. The E.P.S. COMPANY'S battery at Liverpool is one of the largest in the world for tramway work. The CHLORIDE SYNDICATE have constructed a large number of storage batteries, notably at Leeds and the Isle of Man. The TUDOR ACCUMULATOR CO'S. battery is also a well-tried accumulator for this class of work, and other makers are the D.P. BATTERY CO., Messrs. PRITCHETTS AND GOLD, and the HART SECONDARY BATTERY SYNDICATE.

Dynamos.—Upon the reliability of the tramway generator the success of a tram line must depend as much as upon any other detail, if not more. Indeed, reliability must be placed in front of economic working. Manufacturers everywhere have paid special attention to the construction of railway generating plant. Among the firms who have done this are SIEMENS BROS. AND CO., MATHER AND PLATT, ELECTRIC CONSTRUCTION CO., the BRUSH COMPANY, P. R. JACKSON AND CO., CROMPTON AND CO. and THOMAS PARKER (Limited); while, of course, the generators from America supplied by the WESTINGHOUSE and BRITISH THOMSON-HOUSTON CO.'S are also well known. There is a considerable opening for polyphase generators in regard to long traction lines in the future, and it is probable that great development in this class of generator will shortly have to be recorded.



"Peckham" Cantilever Rigid Truck.



"Peckham" Bogey Truck.

Steam Engines.—A considerable variety of type of steam engine is in use for tramway work. These may be divided into high speed engines, of which Messrs. WILLANS AND ROBINSON, Messrs. BELLISS AND CO. and the BRUSH COMPANY have supplied large numbers, and low speed engines, either geared or direct-coupled. Among makers of low speed engines we may name Messrs. GALLOWAYS, JOHN FOWLER AND SONS, MARSHALL, SONS AND CO., PLENTY AND CO., MCLAREN AND CO.; the MIRRLEES, WATSON AND YARYAN CO., Messrs. CLARKE, CHAPMAN AND CO, ALLEY AND MACLELLAN, BUMSTED AND CHANDLER, CLAYTON AND SHUTTLEWORTH, DAVEY, PAXMAN AND CO., RANSOMES, SIMS AND JEFFERIES, W. H. ALLEN, SON AND CO., ROBEY AND CO., RUSTON, PROCTOR AND CO, RICHARD HORNSBY AND SONS, ALEX. SHANKS AND SON, CLENCH AND CO. and BROWETT, LINDLEY AND CO. are also manufacturing high speed engines suitable for traction work. The Westinghouse engine is also being used in the United Kingdom. Messrs. ROBERT W. BLACKWELL AND CO. have introduced here the horizontal direct-coupled steam engine of MACINTOSH, SEYMOUR AND CO. and the ALLIS engines, the last named being also made in the vertical pattern. A well-known rotatory form of

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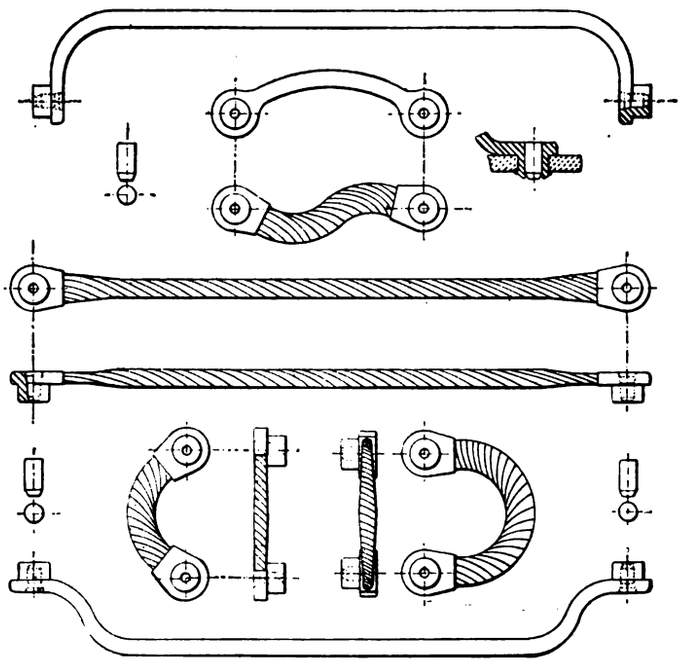
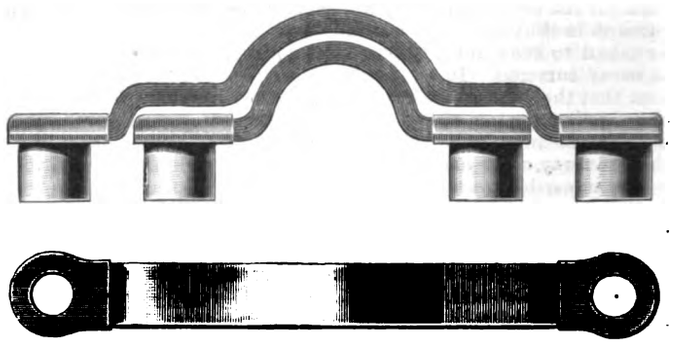
steam engine is manufactured by C. A. PARSONS AND CO., and is largely used in power stations.

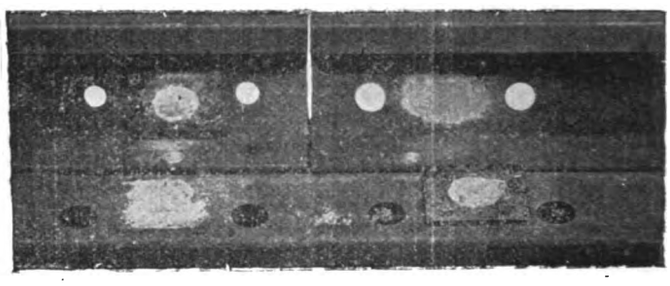
Boilers.—Steam generation is a problem which had been fairly well threshed out by electric light engineers in this country before the advent of electric traction, and the types of boiler employed are very similar in the two cases. The Babcock-Wilcox water-tube boiler is largely used, as also is the "Economic" boiler of Messrs. DAVEY, PAXMAN AND CO., while Messrs. RUSTON, PROCTOR AND CO. manufacture a form of return tube boiler which is doing good service in power stations. Some engineers prefer the Lancashire type of boiler, as having a greater capacity for steam generation, and among the firms who are working this type of boiler for traction work we may mention Messrs. ROBEY AND CO., of small details, and Messrs. HOLDEN AND BROOKE are doing good service in supplying first-class equipments of steam traps, steam dryers, and anti-primers, purifiers and auxiliary plant of all descriptions. Plant for producing forced draught in the boilers is a matter of great importance where rapid steam production at short notice is required, a condition which is often to be met with in tramway power stations. The centrifugal type of fan is extensively patronised, and it will be seen in the article describing the Chicago railway that the Sturtevant fan is used there. This particular make of fan is also being largely adopted for British power stations, and is supplied in this country by the STURTEVANT ENGINEERING CO. The CROSBY STEAM GAGE CO. supply high-class details of steam auxiliary plant of all descriptions, including valves,



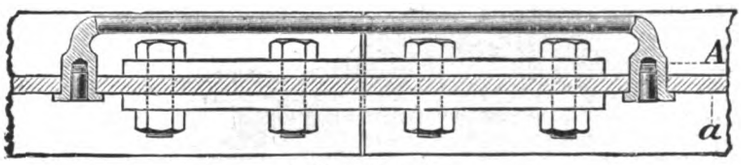
"Crown" Bonds.



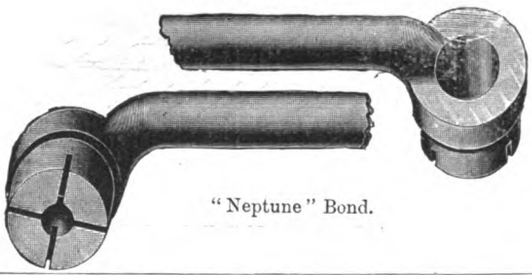
"Crown Leaf" Bond.



Plastic Bond.



"Chicago" Bond.



"Neptune" Bond.

Cast Weld Joint.

RAIL BONDS.

YATES AND THOM, GALLOWAYS, JOHN FOWLER AND CO. (Leeds), TINKERS (LIMITED), and CLARKE, CHAPMAN AND CO.

Auxiliary Steam Plant.—There is much variety in the auxiliary steam plant necessary in a modern electric power station. The practice of driving pumps by steam is not always resorted to, many engineers having a preference for the electric pumps manufactured by the ELECTRIC CONSTRUCTION CO., while others adopt the direct duplex form of pump manufactured by the WORTHINGTON PUMPING ENGINE CO., the BLAKE AND KNOWLES STEAM PUMP WORKS, the popular type supplied by the PULSOMETER ENGINEERING CO., and W. H. WILLCOX AND CO. Considering the immense importance of supplying to the boilers constant feed which is not liable to break down, the advantage of adopting reliable steam or electrically-driven feed pumps is of greatest importance, and engineers should invariably adopt the manufactures of the best firms in this class of business. The success of steam plant not infrequently depends upon the smooth working gauges, &c. Lubricators and general engineering stores are a feature of the business of Messrs. W. H. WILLCOX AND CO., and the UNITED ASBESTOS CO., both of which firms, with Messrs. ENGELBERT AND CO. and Messrs. SNOWDON, SONS AND CO., supply lubricants to the majority of power stations.

Condensers.—The economy of condensing has led to the adoption of condensers in the majority of power stations. Of the various types of surface condensers those made by the WORTHINGTON PUMPING ENGINE CO., Messrs. LEDWARD AND CO., Messrs. KIRKALDY AND CO., the WHEELER CONDENSER AND ENGINEERING CO., Messrs. CLENCH AND CO., and Messrs. W. H. ALLEN, SON AND CO. are extensively used. The "Ejector" condenser, owing to its compactness and efficiency, is also very largely used, the favours being distributed between the "Ejector" condenser of Messrs. LEDWARD and that of Messrs. KÖRTING BROS.

Gas Engines.—In this department of electric power work, the names of Messrs. CROSSLEY BROS. stand pre-eminent. Other firms

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include Messrs. Robey and Co., Tangyes (Limitbd), Dick, Kerr and Co, and J. E. H Andrew and Co. The Dowson Economic Gas and Power Co. supply gas-generating plant for these engines.

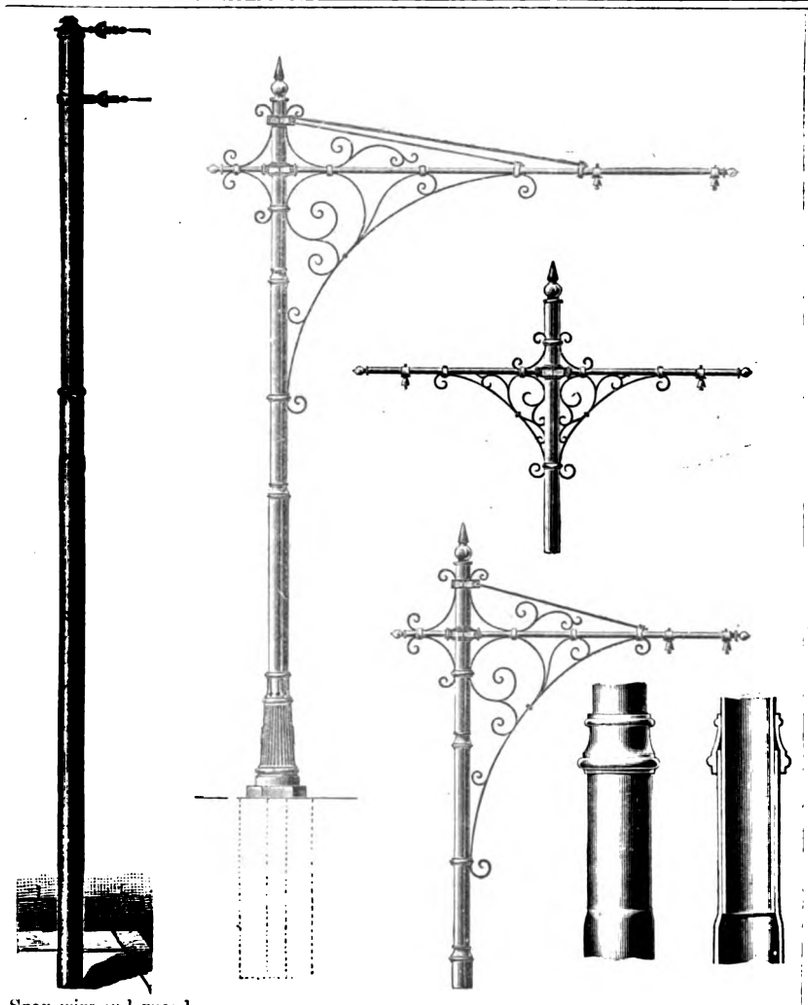
Turbines and Water Wheels.—Water power is not extensively available in this country, but for localities favoured with this source of power, engines are supplied by the following firms:—Messrs. Gilbert Gilkes and Co., Carrick and Ritchie, F. Nell, S. Howes, Fraser and Chalmers, and W. Gunther and Sons.

Switchboards, Instruments, &c.—While many manufacturers contract for the supply of entire switchboards, others manufacture only the switches and instruments which are mounted upon them. Among the firms supplying instruments, switches and complete equipments in this class of plant may be mentioned the Telegraph Manufacturing Co., the Electric Construction Co., the Edison-Swan Co., the Silvertown Co., Messrs. Siemens, Bros. and Co, Crompton and Co., Dorman and Smith, Nalder Bros. and Co., Eversbed and Vignoles, O. Berend and Co., Nalder Bros. and Thompson, Elliott Bros., Drake and Gorham, J. H. Holmes and Co, James White, Williamson and Joseph, the General Electric Co, H. M. Salmony and Co., J. Davis and Son, Spagnoletti and Crookes, A. P. Lundberg and Verity's, Limited; also the Electrical Power Storage Co., the Brush Co., the Westinghouse Co. and the British Thomson-Houston Co.

Meters.—It frequently happens that the power station is owned by a body different from that owning the tramway, and power is metered out from the station to the line. The types of meter extensively used for this purpose are somewhat varied, and include the well-known meters of Ferranti, Thomson, Aron, Chamberlain and Hookham and Schallenberger.

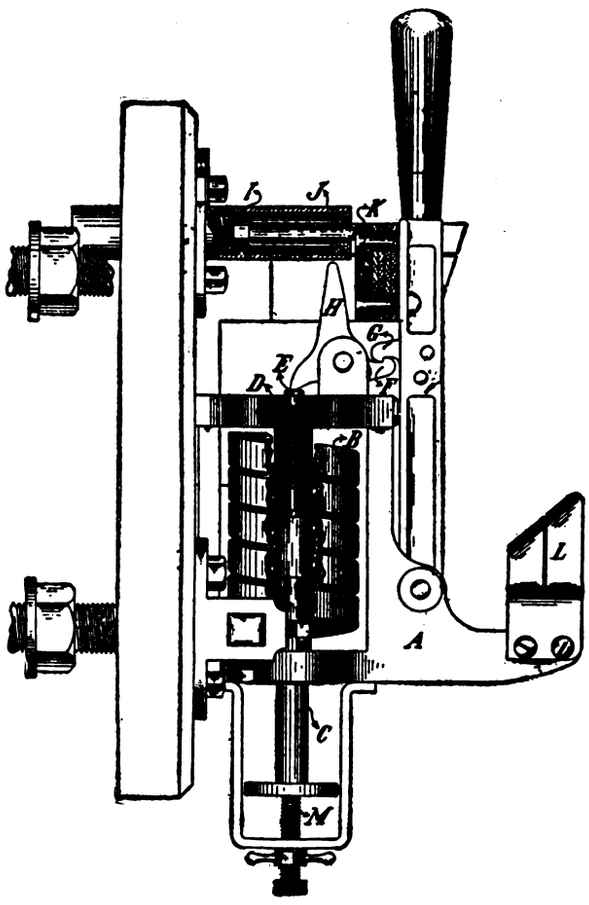
Auxiliary Electrical Plant.—Besides the plant and apparatus directly required for traction work, there is a good deal of electrical apparatus that is used contingently, such, for instance, as where arc lamps are placed on trolley poles. The enclosed arc lamps of the Davy Electrical Construction Co. and the Jandus Company are being largely used in this connection, as also are the open types of arc lamp manufactured by Messrs. Crompton and Co., the Brockie-Pell Co. and Messrs. Johnson and Phillips. For the interior of cars and power stations, &c., glow lamps are more commonly used, the Ediswan, Sunbeam, Stearn, Robertson, Pope and similar lamps of high candle-power being in general favour. It is one of the blessings of electric traction that it enables cars to be lit with a profusion of good light instead of by dingy oil lamps, a blessing that is specially appreciated by the public who ride in tramcars.

While the foregoing summary of the work which is being done in connection with electric traction enterprise in this country does not pretend to give a complete account of all the firms who are engaged in this work it may be taken as fairly representative of the various departments and of the leading firms engaged in these. There are naturally a large number of non-electrical industries which from lack of space we are unable to mention, and as the applications of electricity for traction work, both on rails and on ordinary roads, become more and more extended the number of firms working in each department, as well as the number of these departments, must inevitably increase. We can conclude this short *resumé* by assuring our readers that at no time in the history of electrical engineering have the prospects of any department been brighter than they are to-day.



Span-wire and guard-wire Side Pole.

Centre and Side Trolley Poles with Double and Single Brackets.



Circuit-Breaker.

"Modern Opera Houses and Theatres."—This portentous work, of which Mr. Edwin O. Sachs is the author, is in three large volumes, 23in. by 16in., containing in all 450 pages of text, 220 plates and 1,050 diagrams, is announced as now ready. The work, which contains special matter relating to lighting, heating and ventilation of theatres and public halls, is published by Mr. T. Batsford, 94, High Holborn, W.C.

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TRADE NOTES AND NOTICES.

[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London :—

NOW READY.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. The Author hopes that, besides Telegraph and Telephone Engineers, it may, perhaps, also prove of service to those in charge of cables for the transmission of light and power. The localisation of faults has been very fully investigated, including the different degrees in which the various methods are affected by the presence of a second fault or of general leakage.—*Extract from Preface.* Demy 8vo, fully illustrated. 10s. 6d., post free; abroad 11s.

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d.

"The Students' Guide to Submarine Cable Testing."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition ready in November.*

"Practical Notes for Electrical Students."—By Messrs. A. E Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"Laboratory Notes and Forms."—With the above title we have ready the New Edition of a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves."—By Dr. O. J. Lodge, with many original illustrations. *Enlarged Edition,* 2s. 6d. net, 2s. 9d. post free.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"The Manufacture of Electric Light Carbons."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated. price 1s. 6d.; post free, 1s. 9d.

"The Bibliography of X-Ray Literature and Research, 1896-97.' A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. Prospectus on application.

"Electrical Engineering Formulæ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. A fine large paper edition with wide margins for notes can also be supplied. Price 12s. 6d.; post free, 13s.; abroad, 13s. 6d. *New Edition in the press.*

"The Alternate Current Transformer," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *New Edition.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"The Electrician" Primers.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth 2s. 9d. Single Primers, 3d. each, post free.

"Electromagnetic Theory."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"The Electrician" Electrical Trades' Directory and Handbook.—An important announcement in connection with the 1899 issue of the "Big Blue Book" will be found in an advertisement on another page of the present issue, to which our readers will please refer.

TENDERS INVITED.

Extension of Time.—The *Salford* Electric Lighting committee invite tenders for the supply and erection of the following: (1) boilers, (2) engines, (3) dynamos, (4) boiler feed-pumps, (5) mechanical stokers, (6) superheaters, (7) economisers, (8) condensers, &c., (9) steam and water pipes, (10) cranes and weighing machines, (11) tanks, &c., (12) switchboards, and (13) booster. Further particulars are given in an advertisement in another column, and specifications, forms of tender, &c., may be obtained from the borough electrical engineer (Mr. C. L. Turner), Walness-road, Broughton. Tenders, addressed to the chairman of the Electricity committee, must be delivered at the offices of the town clerk (Mr. Samuel Brown), Town Hall, Salford, *by Dec. 15, not Dec. 1, as originally advertised.*

Tenders are invited by the *Board of Control, Dublin,* for the supply of the necessary plant, wiring, &c., for the electric lighting of Richmond District Lunatic Asylum. Plans and specifications can be seen at the offices of the electrical engineer, Mr. Walter Leake, 51, Victoria-buildings, Manchester, and of Mr. W. H. Byrne, 20, Suffolk-street, Dublin. Further particulars are given in our advertisement columns, and tenders addressed to the secretary (Mr. H. Williams), Custom House, Dublin, must be in by 10 a.m. of Dec. 5.

The *Beckenham* District Council invite tenders for the supply of the following electric lighting plant:—(*a*) Water-tube boilers and economiser; (*b*) steam alternators, transformers and switchboard; (*c*) pipework, feed pumps, overhead tank, feed-water heater, &c.; (*d*) arc lamps, lamp posts, &c.; (*e*) cables and street work; and (*f*) travelling crane. Specifications, &c., can be obtained after the 21st inst. from the consulting engineers (Messrs. Wilson and Story), 66, Victoria-street, London, S.W. Further particulars are set out in an advertisement elsewhere, and tenders must be sent to the clerk to the council (Mr. F. Stevens) by noon of Saturday, Dec. 17.

The *Shanghai* Council also invite tenders for a concession, for a period of 30 years, for the exclusive right of establishing and working a telephone system in Shanghai. Further particulars are set out in an advertisement on another page, and plans may be seen, and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary Axe, London, E.C. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, whose telegraphic address is "Dynamo Shanghai." Tenders must be sent to the secretary (Mr. J. O. P. Bland), Shanghai, by noon of Friday, March 31.

The *Shanghai* Municipal Council invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system in the streets of Shanghai. Tenderers can obtain particulars on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary Axe, London, E.C., and all further information can be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, China. Tenders have to be sent in to Mr. J. O. P. Bland, secretary, not later than noon of Wednesday, March 15, 1899. Some further particulars will be found in an advertisement on another page.

As announced in our advertisement columns, the Directors of the *Great Northern Railway Co.* invite tenders for the supply of new, and the purchase of old, stores for 12 months from Jan. 1. The list of contracts and separate forms of tender for each may be obtained on application to Mr. Weeks, Stores Superintendent, Doncaster, by whom all information will be furnished. Patterns will be exhibited at the Stores Department, where they may be inspected from 21st inst. to 5th prox. inclusive. Tenders, addressed to the Stores Committee, must be sent to the Company's offices at King's Cross, London, N., by 10 a.m. on Tuesday, Dec. 6.

The *Glasgow* Corporation invite tenders for supplying switchboards and instruments at the new electricity works, Port Dundas. Tenders to town clerk (Sir J. D. Marwick) by Dec. 5.

The *Glasgow* Corporation also invite tenders for the supply of about 800ft. of cast-iron pipes (21in. diameter) and certain cast-iron pipes (22in. and 29in. diameter), with special castings, for the Port Dundas electricity works. Tenders to town clerk by 22nd inst.

The Corporation of *Blackpool* invite tenders for trolleys, trolley wire and other material in connection with the conversion of their present conduit to the overhead system. Tenders by Nov. 22.

The *Dublin* United Tramways Co. invite tenders for the supply of general stores, including electrical supplies, car fittings, ironmongery, &c., for the year 1899. Tenders to the chairman of the Company, 9, Upper Sackville-street, Dublin, by 5th prox.

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The Electric Lighting committee of the borough of *Middlesbro'* require tenders for the supply and erection of the following plant:—(*a*) Lancashire boilers and accessories, mechanical stokers, feed pumps, injector, economiser and electric motor; (*b*) slow speed steam dynamos and accessories; (*c*) condensing plant and pipe work; (*d*) overhead travelling crane; (*e*) switchboard and instruments; (*f*) accumulators; (*g*) trenching, cables, &c.; (*h*) meters. Tenders to Mr. Geo. Bainbridge, Municipal Buildings, Middlesbro', by Nov. 29.

The *Leatherhead* District Council invite offers from persons willing to take over their Electric Lighting Order (1898). Offers to Council Offices, Leatherhead, by Nov. 21.

The *Great Northern Railway Co.* (*Ireland*) require tenders for the erection of an electric power station, brick chimney, &c., at Sutton, Co. Dublin. Tenders to secretary by Dec. 5.

The *Waterloo-with-Seaforth* (*Lincs.*) District Council require tenders for the supply of 16 arc lamp columns and carriers. Tenders to Town Hall, Waterloo, by noon 26th inst.

The *Wincanton* (*Bath*) Parish Council require tenders for public lighting, with gas or other illuminant, for one year from Nov. 30. Tenders to clerk by 26th inst.

Tenders are invited by the municipal authorities of *Aurich* for the erection of an electricity supply station, coal, gas or acetylene gas works in the town. Plans and tenders to Der Magistrat der Stadt Aurich, Germany.

The municipal authorities of *Anzin* (*Nord*) invite tenders until the 28th inst., for the concession for the lighting of the town by electricity or gas for 40 years. Tenders to La Mairie d'Anzin (Nord), France.

TENDERS RECEIVED AND ACCEPTED.

The *Bournemouth* Corporation have received the following tenders and schemes in connection with the requirements recently advertised. Mr. F. W. Lacey, M.Inst.C.E, is borough engineer and surveyor:—

1. For the supply and fixing of a steam pump, donkey pump and surface condenser:—

Goddard, Massey and Warner (simple condensing engine) (*accepted*)	£515
Ditto (compound condensing plant)	1,027
Worthington Pumping Engine Co. (compound condensing)	648
Ditto (triple expansion condensing)	698
Pulsometer Engineering Co. (compound condensing)	580
Tangyes, Limited (simple condensing)	530

2. For forced draught to existing boilers at Bournemouth pumping station:—

Goddard, Massey and Warner (*accepted*) £120 10

3. For the supply of steel masts for arc lamps for the square and pier approach:—

	⅝in. metal, each.	½in. metal, each.
John Spencer, Limited (*accepted*)	£120	£130
McDowall, Steven and Co. (Limited)	230	245

The *Rathmines and Rathgar* (*Dublin*) Township Commissioners, on the recommendation of the consulting engineer (Mr. R. Hammond), have accepted the following tenders for the plant for the township electricity works:—

Boiler House Plant (three 30ft. by 80ft. Lancashire boilers and accessories, mechanical stokers, feed pumps, injector, economiser, electric motor).—R. Taylor and Sons, £2,924.

Engine House Plant (one 300 kw. and one 150 kw. high-speed steam dynamos, and accessories, motor transformer, spare parts, &c.)—Mather and Platt, £6,386.

Crane (10 ton overhead travelling crane).—Higginbotton and Mannock, £264.

Switchboard and Instruments.—James White, £1,181.

Accumulators.—Tudor Accumulator Co., £1,958.

Underground Work (trenching, cables, &c.).—British Insulated Wire Co., £14,123.

Meters.—S. Z. de Ferranti (Limited), £500.

Messrs. Gray and Palmer's tender for wiring the jetty shelters, at *Gt. Yarmouth*, for £29. 12s. has been accepted by the Town Council.

The *Tunbridge Wells* Town Council have accepted the tender of Mr. T. Ashby Wood, for wiring the new offices of the electrical engineer, sanitary inspector, &c., at £21. 12s.

The *Winchester* Guardians have accepted the tender of Messrs. Dicks and Son for wiring the workhouse, for £166. There will be 162 lights, and current is to be taken from the mains of the local electric light company.

The Electricity committee of the Hull Corporation have accepted the tenders of Messrs. Thomas Parker (Limited) for the supply and erection of switchboards, transformers and motor generator at £3,350, and that of Messrs. Siemens Bros. and Co. (Limited) for cables, &c., at £10,654. 16s. The contract for the supply of condensers and steam, water and exhaust pipes has been given to Messrs. Barker and Aspey, at £915. 15s. 4d. All the contracts are in connection with the East Hull extension. Orders for the supply of a 750 I.H.P. steam engine and a 450 kilowatt dynamo have been placed with Messrs. W. H. Allen, Son and Co. and Thomas Parker (Limited) respectively.

APPOINTMENTS VACANT AND FILLED.

A technical instructor is required for the Thomason Engineering College, Roorkee, India. Further particulars are given in our advertisement columns, and applications must be sent in, on forms to be obtained from the Director-General of Stores, India Office, Whitehall, London, S.W., not later than 28th inst.

The Vestry of St. Mary, Newington, London, require a resident electrical engineer to take charge, under the superintendence of the consulting engineers (Messrs. Kincaid, Waller and Manville), of the erection of the machinery at their electricity generating station. Salary £250 per annum. Further information is given in an advertisement in another part of the present issue, and applications must be sent to the clerk (Mr. L. J. Dunham), Vestry Hall, Walworth-road, S.E., by Friday, Dec. 2.

The Holborn Guardians require an engineer capable of managing an electric lighting installation, steam laundry machinery, &c. Salary, £2. 5s. per week. Further particulars are given in an advertisement elsewhere, and applications, on forms to be obtained from the Master of the Workhouse, Shepherdess-walk, City-road, N., must be sent in by Wednesday, 23rd inst.

Mr. F. G. Holden, B.A., has been appointed resident engineer to the Scarborough Electric Supply Co. (Limited). There were 51 applicants. Mr. Holden, since serving his time with Messrs. C. A. Parsons and Co., has been four years with the Cambridge Electric Supply Co., as first improver and subsequently as assistant general manager. Mr. E. P. Harvey, B.A., has been appointed to the vacancy on the Cambridge staff.

Mr. E. E. Hoadley, chief assistant engineer at the Worcester Corporation electricity works, has been selected out of some 70 applicants for the post of electrical engineer to the Barking (Essex) Urban District Council. Mr. Hoadley has previously held appointments at the electricity supply stations at Islington (London), Eastbourne and Chatham.

Mr. Charles Stanley May has been appointed assistant-engineer at the new electric light station, Gibraltar. Mr. May served his apprenticeship with Messrs. Davey, Paxman and Co., at Colchester.

Mr. S. E. Sanders, of Ealing, has been appointed assistant engineer at the Bedford electricity supply station.

BUSINESS NOTICES.

Mr. John S. Raworth notifies that his address for professional purposes is now 2, Queen Anne's-gate, Westminster, S.W., and that his telephone numbers are 678 Westminster and 16 Streatham.

Mr. James Swinburne, consulting engineer, has removed from 66, Victoria-street, to Grosvenor Mansions, 82, Victoria-street, London, S.W. (Telephone No. 292 Westminster.)

The Blackman Ventilating Co., in consequence of their increasing business in the Midlands and the West, have opened new showrooms and offices at 1, Colonade-passage, Birmingham.

In consequence of increase of business it has been necessary to extend the premises of Messrs. Cox Walkers, electrical engineers, Darlington. The works at Feethams and Houndgate are being reconstructed.

The partnership of Messrs. Höfler, Raum and Co., art metal workers and designers, 18, Berners-street, London, W., has been dissolved so far as regards Mr. Wm. Höfler.

Messrs. Mosses and Mitchell, of 68-71, Chiswell-street, London, E.C., desire us to state that they are now connected with the National Company's telephone system, their number being 437, London-wall.

BANKRUPTCIES, LIQUIDATIONS, &c.

The petition presented by the Sussmann Electric Miners' Lamp Co. (Limited) for the winding up of the Electric Exploitation Co. (Limited) will be heard at the High Court on 23rd inst.

A petition has been presented by Messrs. Lander and Larsson for the compulsory winding up of the United Ordnance and Engineering Co. (Limited), and will be heard at the High Court on 23rd inst.

The final meeting of the shareholders of the Morecambe Electric Light and Power Co. (Limited) was recently held. The report of the liquidator showed that the gross assets had realised £3,423. 5s. 7d., the bulk of which had gone in payment of debenture bonds and interest, and the rest in law costs, rents and wages. No assets were available for either unsecured creditors or Ordinary shareholders.

Claims against E. W. Mayner and F. J. Hanford (trading as Mayner, Handford and Co.), electrical engineers, &c., 42 and 44,

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James-street, Westminster, and Brighton Works, Redhill, are to be in by 30th inst. Mr. R. J. Ward, 2, Clement's-inn, London, W.C., is trustee.

It has been resolved to wind up Dutton and Co. (Limited) voluntarily for the purpose of reconstruction, and Mr. G. W. Bull, Worcester, has been appointed liquidator. Any claims against the company should reach Mr. Bull by Dec. 31. Particulars of the registration of the new company were given in our last issue.

The first meeting of creditors in the failure of Claude Vautin, electro chemist and metallurgist, late of 3, Upper Hamilton-terrace, St. John's Wood, N.W., and 66, Old Broad-street, E.C., was held on Friday last at the Bankruptcy Court, Carey-street, London. Mr. J. J. Saffery, C.A., 14, Old Jewry, E.C., was appointed trustee. The liabilities are given at £69,785. 14s. 10d. approximately.

Mr. R. Charubin, of 110, Cannon-street, London, E.C., has been appointed receiver and manager of the Mannesmann Tube Co. (Limited and Reduced). The appointment was made by order of Mr. Justice Stirling on behalf of the debenture holders, and Mr. Charubin will in future conduct the business of the company on their behalf. Future communications for the company should be addressed to 110, Cannon-street, and not to Landore.

Personal.—Mr. H. G. Barnett has joined the staff of Mr. Lloyd Wise, chartered patent agent, as technical electrical assistant.

Plant for Sale.—As announced in our advertisement columns, Mr. Wooller Jennings, 66, Thornton-road, Bradford, and George-street, Halifax, will sell by auction on Monday, the 21st inst., at 11 a.m., the whole of the machinery, utensils, stock-in-trade and effects of an electrical contractor's plant. Catalogues may be had of the auctioneer, and the plant may be seen four days prior to the sale.

"Sunbeam" Lamps.—A well got-up catalogue is issued by the Sunbeam Lamp Co., of Gateshead-on-Tyne, and 50, Fenchurch-street, London, E.C., in which many types of the Sunbeam Lamp are illustrated, described and priced. Tabulated particulars relating to all sizes and voltages of these lamps are given. Copies of the catalogue can be obtained free by post.

Watch Making Record.—In 1884 there was established at Kew an observatory for the examination and verification of scientific instruments with a special reference to watches. As evidence that the public have recognised the value of this important step, there is a large and increasing number of watches submitted to Kew, and a steady and marked improvement in the quality of the watches now offered to the public by the leading makers. In 1885, 110 watches out of 302 submitted for Class A, passed the test, while in 1897 out of 680 submitted, 492 passed. Competition for supremacy amongst the great firms became very keen after 1884, and this led to the institution of a system of calculation of merit, and a maximum of 100 marks was awarded: 40 for absence of variation from correct time of the watch while in various positions, 20 for absence of variation in changes of temperature from 40°F. to 90°F., and 40 for absence of variation of daily rate while in changes of position and temperature. The highest possible would consequently mean that no deviation from correct time was observed. Any watch performing within a limit prescribed by the Observatory authorities is classed "A," and for superior merit is awarded marks up to 80, and on obtaining this number is classed "A, especially good." Messrs. S. Smith and Son, of 9, Strand, London, have from the first been most successful in these tests, and in 1884 submitted a watch obtaining this highest distinction. From that time to the present strenuous efforts have been made to surpass this achievement, and after 14 years of incessant work, Messrs. Smith and Son have this month submitted a watch for test which has secured the extraordinarily high number of 88·1 marks. The watch is a gold, keyless, all-English chronometer, and the award establishes a record for English pocket chronometers. It can be seen at 9, Strand, and we are authorised to state that the mechanism of this watch and other watches of its class, will be willingly explained to those interested in the subject. In *The Electrician* for July 8th. we decribed the revolving escapement designed by this firm, and it is to the accurate measurement of time by this ingenious device that Messrs. Smith and Son attribute the high excellence obtained with their watches. It is felt, and reasonably so, that this success establishes a great advance in English horological science, and aids materially in elevating the English watch trade, which, although it has lost a large proportion of the demand for cheap watches, more than holds its own in watch movements of the highest class. A copy of a handsome catalogue of all-English watches, &c., will be supplied by Messrs. S. Smith and Son free of charge.

"Buffalo" Automatic Injector.—We have received from Messrs. Green and Boulding their latest catalogue of injectors, ejectors, metallic packings, boiler tubes, scrapers, air exhausters, &c.

Electric Fittings Catalogue.—Messrs. Jas. Guthrie and Co., 9, Leather-lane, Holborn, E.C., forward a catalogue of electric fittings in hammered iron, copper, and plain polished and scratched brass.

Engineers' Diary.—We have received from the *Indian and Eastern Engineer* a useful diary for 1899. The diary contains a mass of statistical information useful to engineers, and is a reference book upon many subjects. It is well printed and forms a useful desk companion.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Nov. 9 to Nov. 15, with the ports of destination:—

Australasia—Brisbane, £40; Canterbury, £24; Freemantle, £678: Melbourne, £143; Perth, £38; Sydney, £2,461; Wellington, £361. *Belgium*—Brussels, £110; Ostend, £45. *Brazil*—Rio Janeiro, £853 (including £808 telegraph material). *British Guiana*—Demerara, £25. *Canada*—Santos, £68. *Canary Islands*—Las Palmas, £15. *Ceylon*—Colombo, £33. *Chili*—Boca, £37. *Denmark*—Copenhagen, £70. *Egypt*—Alexandria, £120. *France*—Boulogne, £39. *Germany*—Hamburg, £120. *Holland*—Amsterdam, £210; Flushing, £10. *Hong Kong*—£1,737. *India*—Calcutta, £111. *Italy*—Naples, £13. *Japan*—Moji, £1,700: Yokohama, £1,290. *Madeira*—£12. *Norway*—Christiana, £406 (including £391 telegraph cable). *Russia*—St. Petersburg, £358 (including £103 telegraph material). *South Africa*—Cape Town, £141; Durban, £107; Port Elizabeth, £410. *Spain*—Santander, £20. *Sweden*—Gothenburg, £40. *Uruguay*—Monte Video, £27. *West Indies*—Trinidad, £26. Total, £11,898 against £8,922 in the corresponding week last year (Nov. 10 to Nov. 16).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Bangor (Ireland).—The Drake and Gorham Electric Power and Traction Co. have brought forward a proposal for the construction of an electric tramway between Bangor and Donaghadee.

Basingstoke.—The four applications recently received by the District Council for consent to a provisional order have been refused, and the Council itself will apply for powers.

Bradford Tramway Disaster.—Major Cardew has reported to the Board of Trade upon the recent fatal tramway accident which occurred on the Great Horton section of the Bradford tramways on Sept. 19 last. The report states that the Great Horton section is a new line recently equipped for electrical working. It is 2·8 miles in length, partly single and partly double line, with passing places and a continuous ascent, the average gradient being 1 in 24·16, the steepest 1 in 14·24. There are two sharp curves, one of 50ft. radius (where the accident occurred) and one of 46ft. radius. This line was inspected on behalf of the Board of Trade on Aug. 23, 1898, by Major Cardew, and in his report on that occasion attention was called to the steep gradients and sharp curves, and the necessity of an efficient brake power being provided. Major Cardew also advised that the trailer cars should not be used on this section, but to this the Bradford Corporation objected, and the formal certificate of the Board of Trade for the working of the line has not (says Major Cardew's report under review) yet been granted. The report states that the accident occurred to reserve car No. 16 on the driver's first down journey that day, and the rails were greasy or slippery at the time. The driver had been a conductor on the steam trams, and commenced driving the electric car on Aug. 29 last, and had acted as driver a fortnight before the accident; the trolley pole was disconnected from the wires before the accident, and the hand-brake was found hard on the wheels badly flatted, and the electric brake not applied. So much was established by undisputed evidence. Conflicting evidence was given as to the usual speed of the cars, and the driver's statement was to the effect that before he lost control the cars had a speed of five miles per hour. Evidence on the subject of the position of the reversing lever and the controller was given by two electrical engineers well acquainted with electrical equipment of the car, who declared positively that the lever was at the "reversed" position, while the tramway manager, whose evidence was supported by the driver of the car, asserted that it was "forward." It is pointed out that this matter is of some importance, because if the lever was at the "reversed" position the electric brake would be inoperative. A very important question (the report continues) was raised as to the sufficiency of the brake-power provided on this line of tramway, and certain tests were carried out by an expert. In these tests two cars were coupled together, and were allowed to run freely for a distance of 72 yards down a gradient of 1 in 14·24. They were then stopped by the application of brake-power on one car only in distances, from the point of application, of 91 yards for the hand-brake kept on, 70 yards for the hand-brake applied intermittently, and 68 yards for the electric brake. Afterwards similar experiments were made with one car alone, when the hand-brake brought the car to a standstill in 36yds. 1ft., and the electric and hand-brake in combination in a distance of 25yds. 1ft., and at a second test of 21yds. 1ft. The car was

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afterwards run down the gradient under control, the electric brake being used on the second point of adjustment, which is what the drivers have been instructed to use, and was stopped in nine yards. These tests appear to Major Cardew to indicate very efficient brake power. Under the conditions the car must have acquired a velocity of about 20 miles an hour, and to stop it on the incline in 21yds. 1ft. requires a force of nearly one-quarter of the whole weight, applied in the opposite direction to the motion. This, he considers, about the maximum retarding force that can be expected from any braking arrangement which depends upon friction between the wheels and the rails. Later a slipper-brake test was made under similar conditions to the above, the results being as follows :—Car allowed to run free on grade of 1 in 14·24 for a distance of 72yds. was then stopped—

By slipper-brake alone in		178½yds.
By hand	ditto	64½yds.
By electric	ditto	37yds.

The car allowed to travel down the grade with electric brake on at second point stopped in about half its length, or, say, five yards. From these tests it appears that the slipper-brake alone, as now fitted, is the least effective of all as an emergency brake, to some extent due to the flat pitch of the screw by which the brake is applied ; but, considering the small fraction of the whole weight of the car that can be possibly brought to bear upon this brake, Major Cardew doubts greatly whether it can be made as effective an emergency brake as the other brakes which act upon all the wheels, and which, therefore, bring into play as a retarding force a friction due to the whole weight of the car. It has, however, an advantage in that it applies a surface of wood to the steel rail, the co-efficient of friction between wood and iron or steel being generally greater than that between iron and iron. The fact is that if a car be allowed to acquire such a speed as 20 miles an hour on a steep gradient, no brake acting by friction on the running rails will stop it in a distance that could be considered safe. There appears to be an impression that a slipper-brake is quite without influence upon the wheel brakes. This is not the case ; whatever proportion of the weight of the car is utilised for the slipper-brake must be lost for the wheel brake, and it will be found that the wheels skid more easily on the application of the hand-brake if the slipper-brake be pressed down. Moreover, to the extent to which the slipper-brake relieves the weight on the wheels it tends to increase the risk of the wheels leaving the rails at curves and facing points. The real advantages of the slipper-brake appear to be found in the use of a block of wood pressing on the rails, whereby a greater co-efficient of friction is secured, and the destructive action inseparable from the dissipation of energy by means of friction is to a great extent concentrated upon a cheap and easily replaceable fitting. The addition of this brake to those already provided also adds one more to the method of retardation available. There are, however, three methods available without it, viz., the hand-brake, the electric brake, and the reversal of the motors. Finally, Major Cardew is of opinion that the accident was due to the following causes :—

1. That the cars were not run within the limit of speed of not exceeding six miles an hour on the down journey.

2. The unfortunate combination of a driver with very little experience ; a conductor with none at all, but with a little knowledge which is proverbially a dangerous thing ; a slippery road ; and extra pressure on the traffic, the driver certainly used the brake power provided in an injudicious manner. The conductor put on the hand brake, and thus deprived the driver of the full control of the brake power ; and he also caused the trolley to be disconnected, thus depriving the driver of the power of reversing, which might have prevented the accident. The brake-power was ample, and by means of the graduation of the electric brake the speed can be regulated with ease and certainty, provided that a speed of six miles an hour be not exceeded. He approves of the addition of a slipper brake—not, however, as an emergency brake, but as a brake to be continuously in use, since by it also exact regulation of speed can be obtained, and its use diminishes the strain on the motors and the excessive wear of the wheels.

He adheres to the opinions expressed in his report of inspection that the speed on the down journey should not at any point exceed six miles an hour, and that trailer cars should not be allowed on this line, and, if the requirements of that report are complied with, he recommends that the line should be certified by the Board of Trade as fit for traffic.

Under the Council's proposed tramway bill lines are to be constructed to Clayton and Queensbury, and from Foster-square along Kirkgate to Whetley Hill and Toller-lane.

Bristol.—Mr. Geo. Pearson has been re-elected chairman of the Electrical committee for the ensuing year. At the last meeting of the committee it was explained that the whole of the plant required for the extensions at Temple Back had not yet been obtained, and that further machinery would be needed to meet the increased demand for electric current. The number of customers to date was 893. The equivalent number of 8-c.p. incandescent lamps applied for was 66,027. The number of customers actually connected was 870, with a total of 59,689 lamps.

Calcutta.—The negotiations between the Corporation and the Calcutta Tramways Co. regarding the introduction of electric traction are at a standstill, as the Company refuse to accept the Corporation's conditions as to length of lease and ultimate purchase of the undertaking.

Canterbury.—The question of extensions to the electric lighting plant and mains has already been forced upon the Town Council, although they will not be in a position to supply current before January. At the last meeting the Electric Lighting committee submitted a report from Mr. R. Hammond recommending the expenditure of a further £8,000 in extensions. The chairman (Ald. Mason), however, explained that, owing to the increased demand for current, the original extension scheme was deemed insufficient, and Mr. Hammond has been instructed to submit a more comprehensive scheme which would entail an expenditure of about £12,000.

Chelsea (London).—The Vestry has instructed Mr. Sydney Morse to make application on its behalf for a provisional order for the Kensal Town portion of the parish.

Colchester.—The official opening of the electricity supply works is to take place the first week in December. Orders are in hand for an equivalent of about 2,000 8-c.p. lamps.

Colwyn Bay.—The electric lighting of the promenade has been discontinued until next season. A public meeting is to be held to consider the advisability of putting down plant for the permanent lighting of the streets.

Crewe.—Messrs. Hopkinson and Talbot, successors to the consulting business of the late Dr. J. Hopkinson, have been retained as consulting engineers by the Town Council in connection with their proposed electric lighting scheme.

Dudley-Sedgley Tramways.—The British Electric Traction Co. took over the control of these tramways on Friday last. It is proposed to reconstruct and equip the lines electrically as promptly as possible. The Company are applying to the Light Railway Commissioners for an order to lay down connecting tramlines to effect a junction with the Dudley and Stourbridge line. In the event of no unreasonable obstacles being put in the way by the Dudley, Sedgley, Coseley, or Wolverhampton local authorities, the Company propose to push forward the work of reconstruction without waiting for the order from the Commissioners to be issued.

Electric Power Plant.—In the new machinery sheds at the yards of Sir James Laing and Sons, Sunderland, electric motors are employed for driving the machinery.

Electric Traction Notices.—The Devonport and Dundee Corporations notify that they intend to apply for powers to construct and lease tramways and to employ mechanical traction.

Exhibition.—A motor car exhibition is, it is reported, to be held at the Agricultural Hall, London, from July 3 to 15.

Finchley (Middlesex).—The District Council will apply for a provisional order.

Fraud.—At the Devon assizes Mr. Justice Kennedy sentenced Ernest John Thomas, electrical engineer, to twelve months' hard labour for obtaining credit from various electrical and engineering firms by means of false pretences and fraud.

Glasgow.—At the meeting of the Tramways committee, on Wednesday, the manager (Mr. John Young) presented a report on the results of the recently-inaugurated Springburn-Mitchell-street electric tramway. He stated that during the past fortnight the working cost per car mile was 6½d., while the receipts were 1s.4½d., leaving a margin of 8d. to meet interest on capital. That result had been secured, notwithstanding the fact that they had not yet had the full use of the engines. He estimated that to convert the 28 miles of lines in the city to the conduit system of electric haulage would cost £347,000 more than to equip them on the overhead system. At the same time, the saving as compared with horse traction would be considerable. He estimated that the underground system would cost 5½d. and the overhead 5d. per car mile. Nine miles of rails would not require to be altered, but the remainder, which were laid on the old shallow pattern, would have to be replaced. The committee resolved to withdraw the recommendation to construct the overhead system *via* High-street to Govanhill, and to consider whether part of the route might not be utilised for an experiment with the conduit system.

Government Office Lighting.—The electric lighting at the Colonial Office, Downing-street, S.W., has been completed.

Great Yarmouth.—The Town Council are seeking powers to construct electric tramways to Gorleston and Southdown.

Guayacan (Chili).—A small private electric lighting installation exists at the smelting works in Guayacan, near Coquimbo, and there is also an isolated installation at a large dairy farm in the same vicinity. There are, however, no persons or firms engaged in electrical construction work in this part of the west coast of South America.

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Heckmondwike.—The Board of Trade notification has been given to the District Council that the period of the provisional order has expired.

Hull.—The Corporation are committed to the following expenditure during the next two years:—Electric lighting, £90,000; electric lighting for East district (powers applied for). £26,000; electric tramways, &c. (estimated), £300,000; technical schools, about £18,000.

Ilkeston.—The District Council have decided to establish electricity supply works and to construct a system of electric tramways in the town, at an estimated cost of £80,000. Provisional orders are being applied for.

Islington (London).—The Vestry objects to the proposal of the National Company for placing their wires underground. The company are, therefore, applying to the County Council for permission to retain certain overhead wires in Islington with spans exceeding the length allowed under the London Overhead Wires Act. If this permission is withheld it is stated that one of the exchanges will have to be closed.

Italian Machinery Industry.—An article in the *Italia*, published at Rome, reviews the Italian machinery industry, which during the past 15 years has developed to a remarkable extent. Whereas in the early 80's Italy obtained her engines, boilers and iron and steel supplies from abroad, she is now able to provide for all her ordinary requirements by home manufactures, including naval and railway construction. In the latter department considerable exports of locomotives are made. Development is, however, most marked in connection with electric machinery and apparatus, which is now exported in large quantities, not only to the South American markets, but to European countries, including England.

Japan.—A Chicago correspondent reports that the Siemens and Halske Electric Co., of America, is negotiating with the Japanese Government to form in Chicago a syndicate, with a capitalisation of about $10,000,000, to install and operate the electric street car lines and electric light and power plants to be established in Japan, but especially in the towns of Tokyo, Yokohama, Nagasaki and Osaka. A limited liability company, which has obtained a monopoly of the trolley-trams, is about to be promoted at New York.

Kingswood (Bristol).—The District Council will apply for sanction to borrow £2,100 for electric lighting purposes.

Leeds.—The City Council will promote a bill for the construction of a tramway to the boundary of Bradford, to be equipped electrically.

Leigh (Lancs.).—The District Council have received the sanction of the Local Government Board to borrow £10,216 for the establishment of electricity supply works.

Leith.—The burgh electrical engineer (Mr. W. A. Bryson) has been asked to report, in the event of electric traction being adopted on the Leith tramways, and the Edinburgh Corporation continuing to use the cable system, what mechanical arrangements are practicable to admit of the interchange of traffic from the mutual boundary at Pilrig, so as to obviate changing carriages there, and also to report on the method of crossing the harbour by the new swing bridge.

Light Railways.—Notice is given that an application is to be made to the Light Railway Commissioners by Mr. B. M. Kilby for an order to construct a light railway from Blyton to Frodingham (Lincs.)

The Camborne District Council have conditionally approved the proposal to construct a light electric railway between Camborne and Redruth.

The Llandudno District Council will oppose the confirmation of the order granted to the Llandudno and Colwyn Bay Light Railway Co. for the construction of a light (electric) railway in the Llandudno district.

London County Council.—The Council have at last consented to the application of the National Telephone Co. for the erection of new offices on the Victoria Embankment.

We refer elsewhere to the deadlock at Islington owing to the National Company being unable to place its wires underground, and, at its last meeting, the County Council discussed this question. The Highways committee now recommend that permission be granted for the retention of certain overhead wires, the spans of which exceed the length allowed by the London Overhead Wires Act. The recommendation, however, was opposed, and the matter stands over for a week.

Manchester.—Ald. Higginbottom has been re-elected chairman of the Electricity committee. At the meeting of the City Council on Wednesday a report from the committee was presented on the introduction of electric traction on the local tramways. Ald. Higginbottom held that the committee were justified in adopting the overhead trolley system. They had to take into consideration the local condition of the streets and the state of the rails, as well as the capital cost of the overhead and conduit systems, their efficiency and working cost. There were 67 miles of tramway track in the city. The rails weighed 96lb. per yard, and were quite suitable for electric traction. Nothing was required to be done except the bonding, which was already being done, at a cost of £135 per mile. They would have, in addition, to renew the crossings with steel crossings, and this work was being done by the committee without any interruption of the traffic. The capital cost of the undertaking, if the overhead system were adopted, would be about £600,000, and Ald. Higginbottom was of opinion that within a few years of the tramcars beginning to run electrically there would be a net annual profit in aid of the rates of about £70,000. If the conduit system were adopted and the extra capital expenditure of £629,807 incurred, the interest and sinking fund alone on this extra capital would be about £38,000, and the net profit would therefore be reduced by this amount. There were two important points to be considered, viz., the efficiency and working cost of the two systems. The difference was ½d. per car mile in favour of the overhead system. The report was adopted.

Merthyr.—The District Council have decided to sanction the British Electric Traction Co.'s application for electric lighting powers, provided the Company include in their proposed order the whole parish of Merthyr; that at first and within two years of obtaining the order they should lay mains to light the district within half-a-mile of their proposed tramway, and that within three years they should lay mains to any portion of the parish as required by the Council; the price to be charged for current not to exceed 4d. per unit.

Musselburgh.—A committee, with power to consult an electrical expert, has been formed to consider the question of establishing municipal electricity supply works.

Nationalisation of the Telephones.—Mr. Edward Rae, writing from Liverpool and expressing the views of the Council of Associated Stock Exchanges, advocates the nationalisation of the telephones. Mr. Rae thinks

"it is clear that the attitude adopted by the Post Office towards the National Telephone Co. will have one effect—that is, the prohibition of that development on the part of the company which ought to meet the growing and imperative demands for its services. It is scarcely possible to expect a threatened company to embark fresh capital in order to meet such requirements. On the other hand, any attempt at a Government local service in competition with the National Company might easily result in a disastrous loss to the Post Office. . . . . Assuming a Government purchase based upon the average market prices, high and low, of the company's stock and shares during the past three years, taking into consideration the reduced interest, charges and economy of working, and crediting the business with nothing beyond its normal progressive development, the result, so far as I can estimate it, would be that the surplus profits and royalties, if placed to a cumulative sinking fund, would at the expiry of the licence (13 years hence) practically suffice to extinguish the purchase money. Surely this would satisfy the most prudent Chancellor of the Exchequer. The adoption by the Government of the National Company's system and its prompt development under the guidance and co-operation of the Company's present administration offer, in my judgment, the only assurance of a widespread and perfect system of telephones for the present generation of business men."

Newington (London).—The Vestry has decided to at once take up the first instalment (£10,000) of the electric lighting loan of £50,000 granted by the London County Council.

Norway.—India-rubber vessels for galvanic materials are admitted free of duty under the modifications of the Norwegian Customs tariff, to come into effect from April 1 next. A duty of 2d. per kilo is proposed on motor carriages.

Paddington (London).—The Vestry have been asked by the Metropolitan Electric Supply Co. to put in writing their proposals with regard to the purchase of that portion of the Metropolitan Co.'s undertaking which serves the Paddington district. This request was discussed at the last meeting of the Vestry, but there seemed a difference of opinion as to the course adopted by the Electric Lighting committee. One member asked whether it would not be advisable to have an expert's assistance in the negotiations but the chairman of the committee did not consider such a course necessary.

Paisley.—The electricity works will be opened early in January.

Poplar (London).—A communication from the Board of Trade notifying that the time had arrived for them to consider whether the Poplar provisional order should be revoked has been referred to the Electric Lighting committee.

Provisional Order Notices.—Official notice of intention to apply for provisional orders has been given by the following:—Bethnal Green (St. Matthew) Vestry and the Lewisham District Board of Works (London); the Glossop, Ilkeston, Keighley, Newcastle-under-Lyme, Ryde and Wednesbury Corporations; the Brentford, Castleford, Darfield, Erith, Mexborough, Mirfield, Teignmouth and Winsford District Councils, the Inverness Police Commissioners; the Electric Works Co. for Walton-on-Thames and Weybridge and the Kelvinside Electricity Co. for Partick.

Ramsey.—The Isle of Man Tramways and Electric Power Co. and the local gas company have been invited to submit tenders for the better lighting of the promenades.

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Reading.—Power is being sought by the District Council to construct additional tramways in the town and to introduce electric traction on the entire system.

Rochdale.—During the coming year electricity supply works are to to be inaugurated, the tramways taken over, and other municipal improvements carried out.

Salford.—In the bill promoted by the Salford Corporation power is being sought to construct and work additional tramways and to introduce electric traction.

Shanghai.—We would draw our readers' special attention to two announcements of the Shanghai Municipal Council which appear in our advertisement columns this week.

Shoreditch (London).—At Tuesday's meeting the Lighting committee submitted the accounts of the electric light undertaking and refuse destructor works for the complete year to June 24. The total income from sale of current for the period amounts to £8,254. 2s. 1d., "sale of current to dust destructor" is put at £536. 5s. 8d., miscellaneous receipts £120. 4s. 7d., and "sale of stores to other departments" £130. 8s. 4d., making the total credit £9,041. 0s. 8d. Debits amount to £3,214. 14s. 7d., interest and redemption £2,641. 16s. 2d., leaving a net balance or surplus for the year of £3,184. 9s. 11d. The committee express their satisfaction at the result, especially as it has been obtained in the face of a loss of £500 during the first quarter of the year. The amount set aside for interest and redemption is stated to be more than sufficient to provide for depreciation of the undertaking. The dust destructor accounts show a debit balance of £1,758, which the Committee state is represented by steam used in the lighting station and library. If the debit balance is charged against the surplus of the electricity works the result would be as under :—

Credit balance on electricity undertaking	£3,184	9	11
Add saving on previous expenditure of barging refuse	1,253	5	1
	4,437	15	0
Deduct debit balance on destructor	1,758	14	6
Net profit and saving...	£2,679	0	6

Mr. H. E. Kershaw moved the adoption of the report, which Mr. Hodder, although believing that the lighting scheme was bound ultimately to succeed, opposed, and Mr. Hodder's views were supported by Mr. Freeman and others, Mr. Winkler expressing the view that the Vestry had been bamboozled by persons who desired to make a name for themselves. Mr. Kershaw took exception to this statement and replied generally to the remarks made by previous speakers. Ultimately it was agreed by 30 votes to 11 to receive the report, and to refer it back to the committee to allocate the disposal of the profits.

Slough.—An electrical expert is to be engaged to prepare a report as to establishing electricity supply works.

Stretford.—The District Council propose to acquire so much of the undertaking of the Manchester Carriage and Tramways Co. as lies within the district of the Stretford Council. Mr. R. P. Wilson: of Westminster, has been engaged as consulting engineer at a fee of 40 guineas to prepare an electric lighting scheme for the district.

St. Anne's (Lancs.).—The District Council has decided to establish municipal electricity works.

St. Pancras (London).—A curious state of affairs has arisen in relation to the supply of electric current in one of the main thoroughfares in this district—Brecknock-road. It appears that the houses in this road are in St. Pancras, whilst the roadway is under the control of the Islington Vestry. The electric lighting department of St. Pancras is consequently unable to lay a main for supplying current to the houses in question. The Board of Trade are to be asked for sanction to erect overhead wires for the purpose.

Sunderland.—The Town Council have resolved to promote a bill for powers to take over and work the tramways, to introduce electric traction, and to extend the electric lighting system.

Telephone Municipalisation.—The Edinburgh Town Council have decided to make application for a telephone licence and to obtain powers to establish a telephone exchange system.

It is currently stated that in view of the proposed action of the Government next session, in dealing with the report of the Telephone Select Committee, the Manchester Corporation will not proceed further with the clauses of its new General Powers Bill which relate to the establishment of a local exchange under licence from the Postmaster-General.

Tobermory (N.B.).—Mr. R. F. Yorke explained his scheme for the electric lighting of this district to a meeting of ratepayers last week. Water power is to be used, and in the event of the scheme being carried out by the Burgh Commissioners, the Laird of Aros offers to give water rights free of charge. The total outlay entailed by the scheme is put at about £2,000.

Tramway Traction.—Mr. J. Allen Baker forwards a copy of an article from the current issue of an American journal on the subject of "Comparative Costs and Profits of Cable, Electric Conduit and Horse Tramways in New York City." Mr. Baker calls attention to what he describes as "the remarkable figures given as the result of a year's working of the Metropolitan Street Railway Co, of New York," and he claims that these figures fully comfirm his recommendation of the electric conduit system of traction for the district controlled by the London County Council. Mr. Baker says: "An economy in operating that I believe has never been equalled by trolley or any other system is now proved in New York, and, no doubt, London and other large cities in this country will profit by the lessons to be learned from our American cousins." The pamphlet under notice includes a transcript of the private costs sheets and other records of the Metropolitan Street Railway Co., by which it is stated a true comparison of the relative costs of cable, horse, and electric railway working, in a single city, under substantially the same conditions, is available. The Metropolitan Company's service deals with 250,000,000 passengers per annum.

Tunbridge Wells.—The Local Government Board have given their consent to the borrowing of a further sum of £15,000 for electric lighting purposes. The new offices of the electrical engineer are to be wired and put in telephonic communication with the Town Hall.

Vaynor and Penderyn (Glam.).—The British Electric Traction Co., which is about to construct a light (electric) railway between Merthyr, Dowlais and Cefn, has offered to supply electric current for public and private lighting in this district. The council are considering the offer.

Water Power Utilisation in the Highlands.—In the *Edinburgh Gazette* of the 15th inst. notice is given of intention to promote a bill next session for the incorporation of a company for utilising water power in the generation of electric current, and for the erection of stations at or near Loch Leven, in Inverness-shire.

Whitechapel (London).—The District Board of Works have decided to purchase Messrs. Ind, Coope and Co.'s premises in Osborn-street for £18,250, as a site for an electricity supply station.

Windsor Castle.—The Queen's private chapel has been wired and fitted for the electric light.

Works Lighting.—The cement works of Messrs. Martin, Earle and Co., at Wickham, Rochester, have been provided with electric lighting plant. Current is supplied to twelve 2,000 c.p. arcs and about 200 16 c.p. incandescents. The work of installation was carried out by Messrs. A. E. Bennett and Co.

Wrexham.—A London company has arranged to take over and electrically equip the Wrexham-Johnstown tramway from the Wrexham and District Tramway Co.

Electro-Harmonic Society.—A "ladies' night" entertainment will be given at the St. James's Hall, Regent-street, W., on Friday, Nov. 25, at 8 o'clock.

COMPANIES' MEETINGS AND REPORTS.

Western and Brazilian Telegraph Co. (Limited).

The thirty-sixth ordinary general meeting of this Company was held at Winchester House, Old Broad-street, on the 11th inst., under the presidency of Mr. W. S. ANDREWS.

The SECRETARY (Mr. E. Steer Hodson) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN then said: At the corresponding period in 1897, when we met, I was obliged to lay on the black paint. It was about the very worst period that we had had to suffer under, and things were not at all wearing an appearance of cheerfulness. At the same time, although the accounts came out badly, we were enabled to feast you a little upon prospects—not always a satisfactory thing, unless they are real. We told you that the revenue was continuing to increase and that the expenses were continuing to diminish, and, therefore, you went away in a comparatively cheerful state of mind. I am pleased to say that our forecast in both those respects has turned out to be correct. The present accounts do show a great improvement over those of the corresponding period of the previous year. The receipts have continued to increase and the expenses have continued to diminish. The earnings, as a fact, exhibit a considerable improvement, having reached £72,692 as compared with £59,754, an increase of no less than £12,938; and in addition to this we are fortunate to have received over £10,000 from the Platino Company in the half-year against £11,000 in the whole of the year 1897. The expenses show a satisfactory diminution, as foreshadowed. They amount to £39,376 as compared with £44,575—a decrease of £5,199. The decrease is mainly under shipping, in spite of higher prices of coal and the ships being more at sea, the great point being that at the corresponding period last year we had a ship on hire, while in the period under review we had our own ship, which did the whole of the work. The other expenses show so little difference that it seems to me that I should be only wasting your time if I went into them, for there are a large number of items and the whole difference is only between £200 and £300. We bring down a balance, after deducting expenses, of £33,316. Adding the amount brought over last year, £1,428, and the Platino dividend of £10,169, we have a total of £44,914. From this balance we have to deduct debenture interest, £8,041; debenture stock redemption fund,

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£1,078; amount added to reserve, £8,000; and income tax, £2,016, making altogether £19,136. This leaves us £25,777, and enables us to recommend a dividend of 5s. per share. This will require £24,349 and leave us with a balance of £1,428 to carry over for the benefit of the current half-year. Now, when you remember that in the corresponding period of last year we had to withdraw £7,500 from our reserve fund in order to enable us to declare a dividend of 3s. per share, whilst this half-year we pay 5s. per share and add £8,000 to the reserve fund, I think you will feel that on the whole it is not such a bad result, and I think it fully justifies the few expressions of a sanguine character which we ventured to indulge in in the corresponding period of last year. Gentlemen, you are aware that the requisite number of Western and Brazilian shares having been sent in for exchange for Brazilian Submarine shares, the agreement between the Companies has become operative. As you know—but I think it is necessary to emphasise it—this agreement is not for an amalgamation, but is confined to what promises to be a very successful effort to unify our interests. The independent organisation and working of the companies under their concessions, and with unimpaired privileges and obligations, remains identically the same, and in order to secure the objects we had in view—namely, the harmonious working of the undertakings for a common end, recourse has been had to similar measures to those adopted in the case of the Platino Co., with which you are all perfectly well acquainted, and which have worked so well—that is, an exchange of shares for those who cared to make it, unification of Boards to secure identity of action, and an executive acting under the direction of the Boards for all the companies. The objects of all this solicitude, besides the protection of the shareholders' property, were the employment of funds as and when required for the improvement of the systems under proper provisions, the unification of the working from end to end of the lines, and thus the establishment of a service calculated to prove adequate, progressive, and satisfactory alike to the Brazilian Government and people, as well as to all interested in telegraphic communications with the South American continent. The Directors, therefore, have been made interchangeable, and they have done me the honour to make me chairman of the Brazilian Submarine Co., partly, I suppose, on account of my grey hairs. Seniority is rather an unpleasant kind of claim, but sometimes it is brought forward. It is not proposed to appoint any managing director, but Mr. Axworthy has been made the joint manager of these concerns. The secretaries of the Brazilian Submarine Company and this Company have each of them retired after 25 years of service, and Mr. Hodson, an old servant in the traffic department of this Company, has been made joint secretary. Practically this comprises all the staff measures at home, and I am pleased to say that abroad the great abilities and long and able services of Mr. Reidy, who is our agent and representative out in Brazil, have been recognised by his having been appointed to the same position in the Brazilian Submarine Company that he has long held and fulfilled so satisfactorily with us. You see, in point of fact, that we have endeavoured to carry out one principle all the way through—to make as little alteration as we possibly could, and to identify as closely as we could the three Companies. It is rather early days, of course, but still we have now had some actual experience—not much, it is true—of the results that it was anticipated would accrue from the homogenity of management and working, and this experience encourages us in the opinion that we have made no mistake, and that our institutions working together will be able to secure the public advantages that have been so strong a motive with us all the way through. I do not want you to think that I am trying to persuade you that there is no selfish motive in all this. Of course, there is. We are selfish because we want to benefit you, but what we did for you is this—we felt that there is only one method by which we might bring about the best results—namely, that we must have the best lines; we must ensure promptitude and certainty, and these things, as a fact, there is, no doubt, do encourage the traffic. Every facility that might be prudently conferred leads to increased user, and the more the needs of the Government and of commerce are met, the more these respond, and the greater becomes the remunerative character of the results ensured. Therefore, we are selfish if you like, but at the same time you may call it, if you please, an enlightened selfishness. We only hope to get what we want—namely, the highest scale of remuneration for the shareholders by dint of something which we give pretty well broadcast to the Governments and the people, to whom we ensure, I believe, the largest benefit of this operation. There is practically nothing further to which I can draw attention profitably, and I will, therefore, propose the following resolution:—

"*That the Report and Accounts to 30th June last, now submitted, be and the same are hereby approved and adopted, and that a dividend of 5s. per ordinary share, or at the rate of £3. 6s. 8d. per cent. per annum, free of income tax, for the six months ended 30th June last, be and the same is hereby declared.*"

Lord RICHARD H. BROWNE seconded the motion.

Mr. GEORGE ENNIS, after congratulating the Directors of the two Companies on the way in which they had carried out the arrangement entered into between them, remarked that they were all exceedingly pleased at the appointment of Mr. Andrews as Chairman of the Brazilian Submarine Company. He must make one criticism on the accounts. He thought that the Directors had erred on the side of excessive generosity to the reserve fund. They already had a fund amounting to over £63,000, and the Board now proposed to add £8,000 additional. He thought that they would have been better advised and have been more in accord with the views of the shareholders if they had paid a dividend of 5s. 6d. instead of 5s. This would have given the deferred shareholders 1s. more, or nearly double the amount paid to them, and while doing this the Directors would have still had over £6,000 to transfer to the reserve fund. He was afraid that they were rather suffering from the Directors' anxiety to pile up the reserve fund.

Major COTTON said that they were all very grateful to the Directors for the way the arrangement between the two Companies had been carried out, but, as a large deferred shareholder, he thought that there was a great deal in what Mr. Ennis had said. He did not think that they had got all that they might have had, but that was in the past. He asked the solicitor of the Company whether it was in the power of the shareholders to increase the dividend recommended by the Directors. If it could be done he thought it would only be fair to give more to the deferred shareholders, who had borne the heat and burden of the day so long. The income tax had always been paid on the preferred shares by the Company, and it was a very moot point whether the Company should do this. The payment came out of the deferred shareholders' pockets. He regretted that the auditor was not present to answer this point, but he had called on him and knew his views, and he rather thought that the auditor was with him in the matter. As he had said, they all congratulated the Directors on the arrangement which had been carried through. He had been very glad to notice that the Directors had seen their way to make some recognition of the past services of Mr. Cunningham. He was also very glad that their traffic accountant had been appointed to the position mentioned by the Chairman.

The SOLICITOR stated that by Clause 133 of the Articles of Association no larger dividend could be declared than that recommended by the Directors, but a general meeting might, if they liked, declare a smaller dividend.

The CHAIRMAN: I may say that we have considered very carefully the amount of dividend that should be declared. We thought that we were proposing a very big rise on the dividend declared at the corresponding period of the previous year; but, of course, in matters such as this there is always a little give-and-take, and there are also considerations that have to be brought in as material. We saw that the Brazilian Submarine Co. added very largely to their reserve fund—very much more materially than we are proposing to do now. That, and other reasons, we believe, make our proposal very much in the interests of the shareholders. We thought that if we paid 5s. a share and added £8,000 to the reserve fund we should be doing a wise thing. I mention this because I do not want to justify myself by mere technicalities; I want to show the shareholders that we do consider these things, and that we do what we do because we believe we are right. He then put the motion, which was carried unanimously.

A SHAREHOLDER enquired whether it was proposed eventually to have a full amalgamation with the Brazilian Submarine Co.

The CHAIRMAN: We must be guided by circumstances. It would be premature to make any forecast now.

Mr. COLEMAN said that the Chairman had not touched on the question of the purchase of this Company's undertaking by the Brazilian Government. He thought that this matter had been referred to on one or two occasions by the Directors, and his object in attending the meeting that day, was to hear something about it. He gathered that there was an understanding, an arrangement, but not an amalgamation, with the Brazilian Submarine Co., but he desired to know in what position the Western and Brazilian Co. stood, with respect to the Brazilian Government. He had consented to carry on his interest in the Brazilian Submarine Co., in which he had also been a shareholder for some years, but if he had been under the impression that there was not going to be an amalgamation he might have continued his interest in the Western and Brazilian and the Brazilian Submarine Companies as heretofore.

Major COTTON enquired the number of shares or the percentage of shares that had been interchanged.

The CHAIRMAN: It is a large number, but I did not propose to go into that matter. The honorable proprietor (Mr. Coleman) says that on one or two occasions reference was made in our reports to proceedings taken by the Brazilian Government with respect to the purchase of this Company's line. I think it appeared not only on one or two occasions but on a good many more. The Brazilian Government, I take it, did at one time intend to purchase the line, and if they had had the money, I believe that they would have done so. There were great disturbances in Brazil, however, and the financial position of the country certainly did not encourage the Government to undertake large ventures of any sort. We continued in our reports to refer to the state of things in Brazil, but in the end we thought that that course was getting stale, and we gave it up. There did not appear to be any prospect of anything coming of it, and instead of that being done, we have done something else which should certainly be equally satisfactory to the shareholders, and do away with what might otherwise have been felt to a certain extent as a disappointment—that the purchase business had gone off. Then, I am asked, how does this arrangement affect the Government supposing that they still desire to purchase our line. My impression is that they will not, but supposing that they did the matter does not affect them. We go on, as I have said, with the same privileges and obligations, and the Government have, of course, precisely the same rights as they have had all the way through. That is the essence of this arrangement. Had we wished to do so we could not have interfered with the *status* of the Government with regard to ourselves, or of ourselves with regard to the Government. With respect to the shares, those who exchange their shares in this Company for shares in the Brazilian Submarine Co. do not remain shareholders in this Company, while those who retain their shares retain their membership and their interest in this concern. There is no other way of bringing about an arrangement of this sort. Nominally the amount of the capital remains the same. The Western and Brazilian Company still continue to have the same capital, and, if I may say so, still continue to have the same motives to endeavour to pay a good interest on it; but at the same time I feel bound to add that, although the Western Company's receipts do show, as you have all seen, a very satisfactory improvement, it so happens that our business is in such close relation that where we benefit 6d. in our concern, I should say that the Brazilian Submarine Company would benefit about 8d. There is, therefore, no reason why any shareholder in the Western Company should hesitate to exchange his shares, because if he does so he will see a still larger improvement in his property.

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A SHAREHOLDER: If two-thirds or a half or a quarter of this capital is transferred to the Brazilian Submarine Company, how can the capital of this Company be the same?

The CHAIRMAN: The capital of the Company remains the same—it is only differently distributed. It is not the capital that is transferred, but only the certificates.

Mr. ENNIS said he thought it would be well if shareholders had any doubt on points such as this for them to address the secretary, who could explain them.

The CHAIRMAN: That is a very good suggestion.

The proceedings then terminated with a vote of thanks.

Cuba Submarine Telegraph Co. (Limited).

The report of the Directors of this Company for the half-year to June 30 last states that the total receipts amount to £33,504. 2s. 8d., and the gross expenditure to £8,091. 11s. 3d., leaving £25,412. 11s. 5d., which, added to £3,254. 8s. 11d., brought forward, leaves £28,667. 0s. 4d. to credit of revenue. The traffic receipts show an increase of £7,916. 13. 1d. compared with the corresponding period of last year, mainly due to the continuance of the insurrection followed by the Spanish-American war. £15,553. 8s. 10d. has been added to reserve, which, after deducting £7,550. 15s. 0d., balance of cost of the Manzanillo-Santiago cable, and £4,002. 13s. 10d. for cable repairs, now stands at £110,000. The dividend on the preference shares will absorb £3,000, and leave £10,113. 11s. 6d., out of which the Directors recommend the payment of a dividend at the rate of 6 per cent. per annum, and a bonus of 2s. per share on the ordinary shares, both free of tax, £3,713. 11s. 6d. being carried forward.

The cable between Manzanillo and Santiago was successfully completed in February last, and the broken Cienfuegos-Santiago section joined up at Cape Cruz, thus restoring communication between Cienfuegos and Santiago by the 1881 cable.

The Directors regret that owing to the operations of the war considerable damage was done to the Company's property, but the board are pleased to report that since the termination of hostilities the broken cables have been repaired, with the exception of the Cienfuegos-Casilda section, and the 1891 cable between Cienfuegos and Batabano, which will be put in order as soon as possible. Notwithstanding these interruptions, the Directors are glad to state that the through communication has been continuously maintained, the staff remaining at their posts under very trying circumstances.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Oct. 13, 1898). Price of silver 28d. per oz. (Nov. 17). Consols (2¾ per cent.) 110¼—110⅜ for money, 110⅜—110½ for account; 2½ per cent. 104¾—105¼ (Nov. 17), Stock Exchange Settling Days: Consols, Dec. 1; Stocks and Shares Continuation Days, Nov. 28 and Dec. 13; Ticket Days, Nov. 29 and Dec. 14; Pay Days, Nov. 30 and Dec. 15; Mining Share Carry-over Days, Nov. 26 and Dec. 12.

CHELSEA ELECTRICITY SUPPLY CO. (LIMITED).—Letters of allotment and regret for the recent issue of £40,000 Four and a-Half Per Cent. Debenture Stock have been posted.

EASTERN AND SOUTH AFRICAN TELEGRAPH CO. (LIMITED).—In another page will be found the numbers of 441 Five Per Cent. £100 Mortgage Debentures drawn for payment at par on Jan. 2 next at Messrs. Barclay and Co.'s, 54, Lombard-street, E.C.

EDISON AND SWAN UNITED ELECTRIC LIGHT CO. (LIMITED).—During the week the London Trust Co. offered for subscription at 99 £150,000 Four Per Cent. Debenture stock of this company.

R. HORNSBY AND SONS (LIMITED).—The directors recommend the payment of dividend on the Preference stock to Sept. 30, including arrears, at 6 per cent, and a dividend of 6s. per share on the Ordinary shares, free of tax, for the year ended Sept. 30, placing £5,000 to reserve. In 1895-96 only a dividend on account was paid, and the year closed with a debit balance of £10,784. So severely were the effects of the engineers' strike felt in 1896-97 that no dividend was paid on even the Six per Cent. Preference, but the debit balance was reduced to £8,189. The directors are, therefore, to be congratulated upon the success of their efforts during the past year.

POTTERIES ELECTRIC TRACTION CO. (LIMITED).—During the week subscriptions were invited on behalf of this company, which has a share capital of £400,000, for 20,000 Five per Cent. Cumulative Preference and 13,334 Ordinary shares of £10 each.

THE PROPOSED AMALGAMATION OF GERMAN ELECTRICAL FIRMS.—The provisional agreement for the amalgation of the undertakings of the Schuckert Co. and the Ludwig Loewe Co., particulars of which were given in our last issue, has been cancelled.

WESTERN AND BRAZILIAN TELEGRAPH CO. (LIMITED).—This company's traffic receipts for the week ended Nov. 11 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Co., Limited) were £3,124.

WEST INDIA AND PANAMA TELEGRAPH CO.—Subject to final audit the directors have decided to recommend a dividend of 6s. per share on the first and second Preference shares, and 1s. 6d. per share on the Ordinary shares for the six months ended June 30 last; the Ordinary share dividend free of tax.

WILLANS AND ROBINSON (LIMITED).—The registers of the Debenture stockholders and of transfers of this company are closed from 16th to 29th inst. inclusive.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	AGGREGATE. Amount.	AGGREGATE. Inc. or Dec.
	1898	£	£		£	£
*Birmingham Tramways.	Nov. 12	4,036	+ 431	...	...	...
Blackpool Corporation...	...	...	...	...	...	...
Blackpool and Fleetwood Co.	„ 12	229	...	18	13,365	...
*Bristol Trams & Carriage	„ 11	2,608	+ 110	19	59,049	+ 7,410
City & South London Ry.	„ 13	1,056	− 25	20	19,360	+ 699
Dover Corporation	„ 12	161	+ 62	32	6,151	...
Dublin United (Southern)	„ 11	789	+ 377	19	19,262	+ 6,139
Liverpool Overhead Rly.	„ 13	1,436	+ 153	20	31,680	+ 2,967
*Sheffield Tramways.....	„ 13	1,141	+ 165	...	...	...
*South Staffs. Trams.....	„ 11	661	+ 63	45	28,548	− 182

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Nov. 9.		Price Wednesday, Nov. 16.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Week Ending Nov. 16.	
			ELECTRICITY SUPPLY COMPANIES.					£ s. d.		Highest	Lowest
6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	10	10⅛	10¼	10⅜	..	—	10⅜	10¼
6,000	10	4/3.5/6	Do. 4½ per Cent. Cumulative Pref.	10¾	11¼	10¾	11¼	4 0 0	—	..	—
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	11	12	11½	12½	2 16 0	February & August	12	—
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6½	6	6½	3 9 3	" "	—	—
£34,000	5	2/6	Chelsea Electricity Supply Ordinary	8	9	8	9	3 6 8	March	8¼	8⅜
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	113	115	113	115	3 18 3	June and December	—	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red)	103	105	103	105	4 15 3	..	..	..
50,000	10	5/0	City of London Elec. Lighting Ord. 40,001 to 90,000	23½	24½	24	25	5 0 0	February & August	24⅜	24
10,000	10	1/9	Do. Ordinary 90,001 to 100,000	23	24	23½	24½	..	..	..	..
40,000	10	6%	Do. 6% Cumulative Pref.	15½	16½	16¼	16½	3 13 9	January and July ..	15⅜	—
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	127	131	127	132	3 18 1	June and December	—	..
20,000	10	—	County of London & Brush Prov. Ord. (fully paid)	12½	13½	12½	13½	—	—	—	—
10,000	10	..	Do. (£8 paid)	10	11	10	11	..	..	..	—
20,000	10	6/0	Do. 6% Cumulative Preference	14½	15½	14½	15½	4 0 0	March & September	15½	—
15,660	5	2/6	House-to-House Electric Lighting Supply Ord.	9	10	9	10	2 0 0	..	9⅛	—
17,000	5	3/6	Do. 7 per Cent. Preference	9½	10½	9½	10½	3 6 8	March & September	9⅛	—
15,000	5	10%	Kensington and Knightsbridge Ord.	13	14	13	14	3 18 7	..	..	—
10,000	5	6%	Do. 6% 1st Pref.	7⅞	8½	7⅞	8½	3 12 9	January and July ..	..	—
110,000	3	—	London Electric Supply Ordinary	3¾	4	3¾	4	—	—	..	—
48,050	5	..	Do. Preference	6½	6⅞	6½	6⅞	—	—	..	—
62,400	10	5/0	Metropolitan Electric Supply Ordinary	15½	16½	16	17	3 10 7	April and October ..	17	16½
£320,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	121	117	121	3 14 9	June and December	—	—
6,452	10	6/0	Notting Hill Electric Ordinary	15	16	15	16	3 15 0	March	..	—
275,000	1	—	Rand Electric	⅞	1⅛	⅞	1⅛	..	—	..	..
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb	88	93	83	93	5 8 1	—	—	..
150,000	$100	$2	Royal Electric Company of Montreal Shares ..	155	160	155	160	5 0 0	—	..	—
130,900	100	4½%	* Do. 4½% 1st Mort. Debs.	104	106	104	106	4 5 0	April and October	..	..
31,980	5	5/0	St. James and Pall Mall Electric Ordinary	16	17	16½	17½	4 11 5	February & August	17⅜	17
20,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	" "	9½	9
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.)	105	108	105	108	3 15 6	June and December	..	—
65,000	5	..	South London Electric Supply Ordinary (£3 paid).	2⅞	3⅛	2⅞	3⅛	..	..	2⅛	..
79,900	5	5/0	Westminster Electric Supply Ordinary	15	16	16	17	3 16 6	March & September	16¼	15⅛
18,848	5	5%	Yorkshire House-to-House	7⅞	8	7⅞	8	3 2 6	February and July ..	—	—
18,626	5	5%	Do. (£4 paid)	5¾	6¼	5¾	6¼	3 18 5	February and July ..	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Nov. 9.		Price Wednesday, Nov. 16.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 16.	
			TELEGRAPHS					£ s. d.		[illegible]	[illegible]
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	100	104	100	104	3 17 4	January and July	..	..
25,000	10	..	Amazon Telegraph	5	6	3½	4½	..	..	..	..
£125,000	100	5%	Do. 5 per Cent. Debentures	92	95	92	95	5 5 3	..	..	..
£905,560	Stock	15/0	Anglo-American	61	64	63	66	4 11 3	Feb., May, Aug., Nov.	64	62
£3,047,220	Stock	30/0	Do. Preferred	112½	113½	114	115	5 4 10	" "	115	114
£3,047,220	Stock	..	Do. Deferred	14½	14⅝	15½	15⅝	..	..	15⅞	14 13/16
130,000	10	5/0	Brazilian Submarine	15½	15⅝	15½	15⅝	4 15 3	Mar., June, Oct., Dec.	15⅝	15 5/16
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	111	115	111	115	4 8 0	June and December	..	..
10,000,000	$100	$13½	Commercial Cable Capital Stock	180	190	180	190	4 4 3	Jan., Apr., July, Oct.	..	..
£918,297	Stock	4%	* Do. 4 per Cent. Debenture Stock	104	106	104	106	3 15 6	" "	..	..
16,000	10	..	Cuba Submarine Ordinary (Deferred)	8½	9½	10	11	..	February and August	10⅜	10
6,000	10	..	Do. Preference 10 per Cent.	16	17	16½	17½	..	" "	17⅛	16 15/16
12,981	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October	..	..
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	..	..
£80,000	50	4½%	Do. 4½ per Cent. Debentures	104⅞	107⅞	104⅞	107⅞	4 4 8	January and July	..	..
60,710	20	3/0	Direct United States Cable	11½	12	11½	12	5 8 4	Jan., Apr., July, Oct.	12	11⅞
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	101	104	101	104	4 7 5	..	..	..
400,000	10	6/6	Eastern Ordinary	172	177	172	177	3 19 4	Jan., Apr., July, Oct.	176	172
£1,295,000	Stock	17/6	Do. 3½ per Cent. Pref. Stock	104	107	104	107	3 5 5	" "	106	104⅜
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	124	123	124	128	3 2 6	May and November	127	125¼
£89,900	100	5%	* Do. 5 per Cent. Debentures, 1899	100	103	101	104	4 17 0	February & August	..	..
£500,000	Stock	8/9	Do. Provisional Certificates 50% paid	52	55	53	56	..	..	..	..
250,000	10	2/6	Eastern Extension	17½	17⅝	17½	17⅝	3 18 11	Jan., Apr., July, Oct.	17⅝	17 7/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	129	125	129	3 2 4	February & August	..	..
£16,200	100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900 (reg.)	100	104	100	104	4 16 10	January and July	102	..
£64,400	100	5%	Do. (Bearer)	101	104	101	104	4 16 10	" "	..	..
£35,100	100	5%	*Eastern and S. African 5 p. c. Mor. Deb., 1900 (reg.)	100	104	100	104	4 16 10	" "	..	..
£46,500	100	5%	Do, (Bearer)	101	104	101	104	4 16 10	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102	105	102	105	3 16 4	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	102⅞	105⅞	102⅞	105⅞	3 16 2	May and November	..	..
180,227	10	1/9	Globe Telegraph and Trust	12	12½	12	12½	4 2 0	Jan., Apr., July, Oct	12½	12½
180,042	10	6/-	Do. 6 per Cent. Preference	16½	17	16½	17	3 10 7	" "	16 15/16	16⅝
150,000	10	5/0	Great Northern of Copenhagen	28½	29½	28½	29½	3 7 10	January, April, July	..	..
£150,000	100	5%	* Do. 5 per Cent. Debs., 1883 issue Series "B"	100	103	100	103	4 17 10	March & September	..	..
£97,800	100	4½%	Halifax and Bermuda Cable 4½% 1st Mort. Deb. (red)	101	104	101	104	4 7 0	June and December	..	..
17,000	25	12/6	Indo-European	53	56	54	57	4 7 9	May and November	56	55
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	109	112	109	112	5 7 7	March & September	..	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red)	105	108	105	108	3 14 3	June and December	..	..
11,889	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October	..	..
3,381	£100 Cert.	6%	Submarine Cables Trust	133	138	133	138	4 6 11	" "	133	..
15,609	10	..	West African Telegraph	..	..	..	..	..	..	..	..
£100,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	4 18 0	March & September	..	..
30,008	2½	..	West Coast of America	½	¾	½	¾	..	..	..	..
£150,000	100	4%	* Do. 4 per Cent. Debentures	104	107	104	107	3 15 2	June and December	..	..
88,321	10	0/6	West India and Panama	1½	1⅝	1½	1⅝	..	May and November	..	..
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½	9⅞	9½	10	6 0 0	" "	9½	..
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7	9	7	9	6 13 4	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures	106	109	106	109	4 12 10	January and July	..	..
64,269	15	6/9	Western and Brazilian Ordinary	12½	12⅝	12½	12⅝	3 16 6	May and November	12⅝	12⅝
33,129	7½	6/0	Do. 5 per Cent. Preferred Ordinary	8	8½	8	8½	4 8 2	" "	..	..
33,129	7½	0/9	Do. Deferred Ordinary	4	4½	4	4½	..	" "	4 15/16	..
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	107	110	107	110	3 13 1	June and December	103½	107
1,168,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	..	..	..	..	6 7 10	Feb., May, Aug., Nov.	..	..
£158,100	100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	98	103	98	103	5 16 6	March & September	..	..
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	2⅛	3⅛	2⅛	3⅛	6 8 1	August	..	..
224,850	10/0	1½d.	Consolidated Telephone Const. & Manufacturing	1/16	1/16	1/16	1/16	6 7 0	July	..	..
28,000	5	4/0	Monte Video Telephone 6 per Cent. Preference	..	..	..	..	7 5 6	October	..	..
484,597	5	3/0	National	5½	5½	5½	5½	5 9 1	February & August	5⅜	5 3/16
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	12	14	12	14	4 5 9	" "	13	12⅛
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	12	14	12	14	4 5 9	" "	13⅛	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	5⅛	5⅜	5⅛	5⅜	4 13 0	" "	5 1/16	..
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	100	103	100	103	3 6 8	June and December	102⅛	101½
171,504	1	0/4	Oriental	⅝	¾	⅝	¾	6 13 4	April and October	..	..
58,000	5	6/0	United River Plate	4½	4⅝	4½	4⅝	6 6 5	July	..	..
£151,788	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	106	103	106	4 14 4	June and December	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	2	1/2⅜	Brush Electrical Engineering	1⅝	1⅞	1⅝	2	3 0 0	—	1⅞	—
90,000	2	1/2⅜	Do. 6 per Cent. Pref. Non-Cumulative	2	2½	2⅛	2⅜	5 1 1	—	2½	—
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	109	113	109	113	4 0 4	February & August	..	..
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102	105	103	105	4 7 0	June and December	..	..
£20,000	5	5/0	Callender's Cable Construction	9½	10½	9½	10½	6 8 7	" "	9⅜	—
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	110	113	110	113	4 0 6	November and May	..	..
300,000	1	9/8	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	..	..	..
50,000	1	—	Chadburn's Ship Telegraph Ordinary	1½	1⅝	1½	1⅝	—	—	..	..
50,000	1	7/5	Do. 6 per Cent. Cumulative Pref.	1	1⅛	1	1⅛	4 16 0	—	1 1/16	—
32,098	3	..	Crompton and Co. (Nos. 1 to 32,098)	1½	2	1½	2	..	..	..	—
£82,850	100	5%	* Do. 5% First Mort. Deb. (red.)	91	96	91	96	5 5 10	January and July	..	—
99,261	5	2/1½	Edison and Swan United ("A" Shares) (£3 paid)	2½	2⅝	2	2½	7 4 0	February & August	2 1/16	—
17,139	5	3/1½	Do. (£5 paid)	4	5	4	5	6 0 0	" "	..	—
£194,023	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	100	102	99	101	4 0 5	June and December	..	—
17,400	5	5%	Edmundson's Electric Corporation Ord (fully paid)	5	5⅛	5	5⅛	4 10 11	Half-yearly	..	—
110,000	2	1/2⅜	Electric Construction Co. (Limited)	2⅛	2⅜	2⅛	2⅜	4 16 10	February & August	2 1/16	—
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Pref.	2⅜	3⅛	2⅜	3⅛	4 6 2	August	3⅛	3
£111,100	Stock	4%	Do. 4% First Mortgage Deb. (red.)	105	107	105	107	3 16 2	..	..	—
91,196	1	—	Elmore's Patent Copper Depositing	⅛	¼	⅛	¼	..	—	..	—
12,500	10	8/0	Henley's Telegraph Works Ordinary	20⅛	21¼	20	21	6 3 10	February & August	21⅛	—
3,000	10	7/0	Do. 7 per Cent. Preference	18	19	18	19	3 13 8	" "	..	—
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 3	" "	118⅜	—
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	22	23	22	23	4 7 0	" "	22 1/16	23⅛
£00,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	102	106	102	106	3 15 6	March & September	105⅛	..
37,350	12	12/0	Telegraph Construction and Maintenance	37	41	37	41	4 6 2	March and July	39	38
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	104	107	104	107	4 14 9	January and July	—	—
£20,000	5	4/0	Willans and Robinson Ordinary	7⅜	8⅛	7⅜	8⅛	4 17 0	April and October	8 3/16	8
£30,000	5	3/0	Do. 6% Cumulative Preference	6⅜	7⅛	6⅜	7⅛	4 2 9	" "	7⅜	7
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	108	110	108	110	3 18 8	May and November	—	—
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	..	Blackpool and Fleetwood Tramways	15½	16½	15½	16½	..	—	—	—
25,000	10	6%	Bristol Tramways and Carriage	21⅜	22	21½	22	2 14 7	—	—	—
25,000	10	6%	Do. (£7. 10s. paid)	18⅜	18⅝	18⅜	18⅝	1 14 1	—	—	—
£90 410	Stock	4%	Do. 4% Debenture	121	123	121	123	3 5 1	—	—	—
80,000	10	..	British Electric Traction Ordinary	16½	17½	16½	17½	..	—	17½	17
10,000	10	2/4 7/8	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm.pd.)	13	14	13	14	4 5 9	—	13½	—
£35,250	10	3/0	Central London Ordinary	10	10½	10	10½	2 17 2	June and December	10½	10 3/16
178 303	10	1/9⅜	Do. (£6 paid)	5⅜	6½	5⅜	6½	2 16 6	" "	6½	..
£630,000	Stock	2½%	City and South London Railway Con. Ordy.	69	70	69	71	2 16 8	January and July	69½	..
22,500	10	..	Do. Ordinary (£4 paid)	3½	4	3½	4	..	..	—	—
9,251	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	3 4 6	January and July	—	—
£137,701	Stock	4%	Do. 4% Perpetual Debenture	134	138	134	133	2 18 10	May and November	..	—
20,000	10	6%	Imperial Tramways Ordinary (old £6 shares)	16⅛	16⅜	16⅛	16⅜	2 3 9	March & September	..	—
10,000	10	6%	Do. 6% Preference	15	15½	15	15½	3 18 8	" "	..	—
37,500	10	3%	Liverpool Overhead Railway Ordinary	10 7/16	10 9/16	10 7/16	10 9/16	3 1 6	February & August	..	—
10,000	10	5%	Do. 5% Preference	15½	16	15½	16	3 2 6	" "	..	—
125 000	Stock	4%	Do. 4% Debenture	108	110	108	110	3 13 1	January and July	—	—
20,000	5	3/3⅛	New General Traction 6% Cumulative Pref	4⅜	5⅛	4⅜	5⅛	—	—	—	—
£540,000	Stock	3%	Waterloo and City Ordinary	106	111	107	112	2 14 11	June and December	111½	110½

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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CONTENTS OF THE CURRENT NUMBER.

NOTES	143	Electricity Works Accounts	156
Meetings of Scientific Societies.	146	BRITISH PATENT LAW	158
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe	147	Reviews	159
Currents in Branched and in Mutually Inducing Circuits produced by Harmonically Varying Electromotive Forces. By Prof. T. R. Lyle. Illus. Concluded	148	Running Shunt Dynamos in Parallel. By A. Philip, B.Sc. Illustrated	161
The Long-Schnatter Prepayment Meter. Illustrated	151	Rotatory Converters. By Prof. Silvanus P. Thompson. Illustrated. Continued	162
The Theory of the Rotary Transformer. By G. Kapp. Illustrated. Continued	152	The Rapid Development of Electrical Engineering during the Present Year	165
On the Influence of the Thickness of Air-Space on Total Reflection of Electric Radiation. By J. C. Bose, M.A., D.Sc. Illustrated	154	Report of the American Association for the Advancement of Science Committee on Standards of Measurement	167
		Legal Intelligence	168
		Trade Notes and Notices	169
		Companies' Meetings & Reports	175
		City Notes	177
		Companies' Share List	178

NOTES.

PROF. FORBES had a mixed audience of engineers, students and laymen at the Society of Arts on Wednesday evening to hear his Paper on "Long Distance Transmission of Electric Power," and what probably aroused most interest among the listeners was his "simple financial transaction which copper merchants or others would willingly make, and which may avoid the huge capital hitherto required by those who transmit the power, and will increase the dividends on money spent on transmission"—in a case, given as example, increasing the net income from 9 to 40 per cent. The financial scheme comes simply to this: the capital is divided into two parts, the major part is represented by copper and is a 4 per cent. mortgage on the transmission line, while the smaller part spent on hydraulic and electric machinery will produce a net income equal to 40 per cent. of this part of the capital when the interest on the mortgage has been paid. Although Prof. FORBES may be only an amateur financier he must surely know that, with the same capital, revenue, and working expenses, the same total profit or loss will be made whether the capital is divided merely into ordinary shares or into ordinary shares and a mortgage. Consequently, taking the first-mentioned 9 per cent. investment as a basis, if the ordinary shares, with a possible return of 40 per cent. on a speculative undertaking, be a sounder investment than this, the mortgage bonds must have a lesser value; and if, on the other hand, the 4 per cent. mortgage on the security of some copper cable strung up in another continent be a better security, the ordinary shareholder will be the sufferer. Is not Prof. FORBES' "simple financial transaction" merely the one known as robbing Peter to pay Paul, with, perhaps, an element of uncertainty thrown in as to who is to be Peter and who Paul?

CHINA would seem to offer a good field for the development of electrical engineering enterprise. From an article by Messrs. J. S. FEARON and E. P. ALLEN, in the November number of the *Engineering Magazine*, we gather that the country is rich in coal, iron and other minerals, and that the natives possess a highly developed civilisation, and are industrious and peace-loving. To demonstrate what can be done with native labour, it is mentioned that an arsenal has been in operation near Shanghai for nearly 30 years under British superintendence, and that the 2,000 Chinese workmen who are employed there have developed a very satisfactory skill. The telegraph is stated to be the only institution of modern science which has obtained any considerable foothold in China proper:—

> Peking is connected by wires with Tientsin and with Manchurian points up to the Russian frontier, whence connection is continued by Russian Siberian lines to Europe. The capital is also connected with all the treaty ports and principal cities in China proper, and these again with each other. Canton has connection also through Yünnan with Burma. China learned the value of the telegraph in the war with France, and it has long since been admitted to have "become indispensable." The telegraph, however, s under Imperial control, and there is probably little opportunity for its extension as a private enterprise. Chinese writing being not alphabetic but syllabic, and there being as many characters as there are words in use, the telegraphic messages are sent in a number cypher. For transcribing messages received a double-ended type is used; on one end is the character, and on the other the corresponding number. When a message is received it is set up by the numbers, and then printed from the reverse or character, end.

SHOULD, however, any of our readers contemplate the starting of an enterprise in the Celestial Empire, it is as well to remind them that, in spite of his "highly-developed civilisation" and his "industrious and peace-loving" disposition, the Chinaman "has some force of character, and resents most strongly the encroachment of the 'barbarian,' as he terms all outlanders—resents it not merely as the savage African does, but with patriotic feeling and a natural desire to owe his progress to no one but himself." This being the case, we should advise electrical engineers to confine their operations, for the present at any rate, to those parts of the country which fall within the British sphere of influence.

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THE interest in the recent breakdown at Brighton appears wide-spread, and various opinions are being expressed as to the means which should be employed to prevent the recurrence of such an accident, many central station engineers being of opinion that the minimum cut-out should be suppressed. In another column we publish an article by Mr. ARNOLD PHILIP, offering some further suggestions as to the possible cause of the mishap. The experiment described was, of course, merely on a laboratory scale, and hardly conclusive; for the arrangement of a hedgehog transformer and a battery does not represent precisely the same conditions as the field coils and armature of a shunt dynamo running on a load. Nor need we look to the armature reaction of the disabled machine only, but to that of all the machines, as a cause contributing to the reduction in the dynamo pressure; this has already been pointed out by us. Our contributor's article, however, helps to put some of the properties of paralleled shunt machines in a clear light, and his suggestion, that the short circuit of the 'bus-bars by the disabled armature might have brought the machines to the unstable condition represented by the lower limb of a shunt characteristic, merits more than passing consideration.

THE following letter, signed by the Chairman of the Electricity Committee and the resident engineer, has been sent to electric light consumers in Edinburgh :—

Sir or Madam,—We respectfully and earnestly appeal to you in the present unfortunate crisis in the electric lighting undertaking of Edinburgh, hitherto so successful. Relying on promises of plant delivery, which were not fulfilled, new consumers were connected up in large numbers during summer and autumn, and we are now unable to deliver current at the standard pressure during the hours of heaviest load, from 4 p.m. to 7 p.m. The consumers can help us in this difficulty by arranging to light only two-thirds of the lamps usually required during the above hours. If this is done more light will be got from the remaining lamps than if they were all on, as the full pressure can be maintained. If the switches do not suit, the necessary lamps can be unshipped. As soon as we can get the plant in sufficient order due intimation will be given. We trust to your complying with this request, assuring you that every effort is being made to put the plant in a more satisfactory condition, and with the least possible delay.

While sympathising with the supply authorities in their difficulty, we cannot but think that their position is somewhat undignified, and not altogether blameless; for, although the contractors are as usual chiefly in fault, the supply authority might have safeguarded itself by the exercise of a little ordinary business foresight. An assumption of "masterly inactivity" a few months ago, in the matter of making house connections, might have averted the present crisis.

IN another column will be found several items of interest with regard to the telephone situation. At Glasgow an unexpected difficulty has cropped up, the town clerk (Sir JAMES MARWICK) refusing to have anything to with the Glasgow Bill, in course of preparation, for powers to establish and work a municipal telephone exchange. Sir JAMES justly considers it illegal for the "Common Good" to be included as a guarantee for the scheme, and that the rates only could be used for that purpose; and as the Committee will not be influenced by his opinion, he has decided to take the course indicated above. In the meanwhile the National Telephone Co. have made a counter-move, offering the Glasgow Corporation a new scale of rates for all subscribers on the basis of a reduced minimum charge for a maximum of 500 conversations per annum, with a supplementary charge for each conversation above that number. This offer is made on condition that the Corporation grant those facilities and wayleaves so often asked for but refused. It will be instructive to see how the Glasgow municipality will view this alternative to embarking the ratepayers' money in and guaranteeing by the "Common Good" an undertaking which must be terminated in twelve years' time. We notified last week that Manchester had decided to abandon its intention of applying for a telephone licence.

THE proceedings in the London County Council on Tuesday were also noteworthy. A member who had evidently taken cognisance of Mr. GAINE'S letter to *The Times*, published in abstract in our last issue, and asked whether 900 persons in London were actually unable to get telephonic connection owing to the Council's refusal to allow the Company to lay underground wires. Mr. BENN'S statement to the effect that the prime cause was the Company's refusal to concede equitable terms should be compared with the statements in the letter alluded to.

THE accounts of the Shoreditch electricity works having been referred back to the Lighting Committee "to allocate the disposal of the profits," we will defer for the present our promised examination until the Committee's further report is presented.

King's College, London.—The Council have appointed Mr. Ernest Wilson, M.I.E.E., Professor of Electrical Engineering, in succession to the late Prof. John Hopkinson.

Royal Society.—Among the Papers down for reading yesterday was one by Mr. C. T. R. Wilson, "On the Condensation Nuclei produced in Gases by the Action of Röntgen Rays, Uranium Rays, Ultra-Violet Light and other Agents."

Cable Interruptions and Repairs.—

	Date of Interruption.	Date of Repair.
St. Louis and Noronha	Oct. 17, 1898 ...	—
Pernambuco–Ceara	Oct. 19, 1898 ...	Nov. 22, 1898
Ceara–Maranham	Nov. 15, 1898 ...	—

Personal.—The Berlin correspondent of the *Daily Chronicle* hears that Prof. Röntgen, of Würzburg, has received a flattering invitation from the University of Leipzig to fill the chair which is about to be vacated by Prof. Wiedemann. Prof. Röntgen has the matter under consideration.

The Röntgen Society.—The President of the Röntgen Society and Mrs. Charles Mansell Moullin gave a conversazione at St. Martin's Town Hall, Trafalgar-square, on Monday night. The company numbered nearly 1,400, and included a number of the leading lights of the medical profession, besides several eminent physicists.

Light Railways; Important Decision.—The Board of Trade have intimated to the British Electric Traction Co. that they cannot confirm the order of the Light Railway Commissioners to construct an electrically-driven light railway between Coatbridge and Airdrie "because of the effect the scheme would have on the Caledonian and North British Railway Co.'s undertakings."

Society of Arts.—Among the recipients of the Society's medals for Papers read during last Session are :—Capt. B. F. S. Baden-Powell, for his Paper on "Kites: their Theory and Practice;" Prof. J. A. Ewing, for his Paper on "Linde's Method of Producing Extreme Cold and Liquefying Air;" and Prof. Silvanus P. Thompson, for his Paper on "Telegraphy Across Space."

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Students of the Institution of Electrical Engineers.—The students' annual general meeting was held on the 16th inst., when a vote of thanks was passed to Mr. S. S. Grant, the students' honorary secretary, and the following gentlemen were elected to serve on the students' committee for the ensuing session:—Messrs. M. R. Gardner, F. S. Muller, L. R. Morshead, R. Pope, W. G. Royal-Dawson and M. Solomon (Hon. Sec.).

African Telegraph Lines.—A Reuter's telegram states that the Berber-Suakin telegraph having been completed, telegraphic communication is now open between Cairo and Suakin and Kassala over the Egyptian and Suakin military lines. Information has also been received by the Church Missionary Society to the effect that the telegraph line from the coast to Uganda is now open to the public for a distance of over 300 miles into the interior.

Salomons Scholarship.—The Scholarship founded by Sir David Salomons in connection with the Institution of Electrical Engineers, and annually bestowed on the recommendation of a Committee of the Institution, has this year been awarded to Mr. H. J. Tomlinson, a student in the Pender Electrical Laboratory at University College, London. By the conditions of the Scholarship the holder is required to spend a third year in study or research, and the successful candidate will continue to work in the Pender Laboratory under Dr. Fleming.

The Hopkinson Memorial at Cambridge.—The Engineering Laboratory Syndicate, says *Nature*, have lost no time in proposing a plan for the Hopkinson Memorial Building. The new wing will adjoin the present laboratory, and provide a lecture room, three laboratory-rooms, and small rooms for students engaged in research. For the completion of the plan some £500 will be required, in addition to the £5,000 generously given by Mrs. Hopkinson and her children. It is expected that the building will be ready for occupation in October, 1899.

Lord Armstrong's Experiments on Electric Discharge.—Prof. Stroud, of the Durham College of Science, gave a lecture on the 9th inst. on "Lord Armstrong's Experiments on Electric Discharge," in the theatre of the Newcastle Literary and Philosophical Society. The lecture was illustrated by numerous experiments with a 16-plate Wimshurst machine, driven by a motor; this machine, together with other apparatus, having been presented by Lord Armstrong to the Durham College of Science for the purpose of continuing the experiments on electric discharge which he had initiated.

Death of Sir John Fowler, Bt.—The death of this eminent engineer, which occurred at Bournemouth on Sunday last, after a prolonged illness and in his 81st year, creates a blank in the higher ranks of the engineering profession not easily made good. His name has been prominently before the country in connection with almost all the triumphs of railway construction throughout the British empire during the present century. Although not an electrical engineer, Sir John Fowler was associated as consulting engineer with the City and South London Railway and with the Central London Railway now in process of construction.

Falcon Works Engineering Society.—Mr. Percy Sellon delivered the Presidential Address to the above Society at the Inaugural Meeting of the present session on the 17th inst., at Loughborough. After referring to current and prospective developments in the electrical industry, Mr. Sellon passed on to consider the position of the British manufacturer of electrical produce in the face of competition from the Continent and America, and contrasted the conditions as regards labour, materials, and supervision of the respective systems in present operation in Great Britain, Germany, Switzerland, and the United States. Mr. Sellon concluded by referring to the changes and extensions which have been, and are now being, introduced at the Falcon works, including the introduction of the single-break day, the growth of the piece-work system, the Company's profit-sharing scheme, &c.

A Large Highland Water Power Scheme.—Parliamentary notice has been given of a bill for the purpose of carrying out an extensive water power utilisation scheme in the North of Scotland. It is proposed to erect a generating station near Loch Leven and utilise water power derived from the neighbouring river and lochs, as far as Loch Ericht. Dams are to be constructed to divert the waters of the Allt Glas into Loch Ericht, and for the purpose of raising the waters of Loch Ericht by damming the River Ericht where it flows out of the south end of the lake so as to submerge the neighbouring land. An aqueduct will be built as a communication with the two streams, Allt Coire a' Guibhais and Allt Dubh Garbh, and the waters of these streams will also be impounded. In a similar manner, by a series of dams and aqueducts, use will be made of all the small lochs and streams between Loch Ericht and Loch Leven.

A Temperature-Entropy Chart.—We are informed that Messrs. Frost and Sons, of Rugby, have been entrusted by Captain Sankey with the publication of the temperature-entropy chart devised by him. The basis of this chart is the water line and saturated steam line described by Mr. J. Macfarlane Gray in his Paper on "The Rationalisation of Regnault's Experiments on Steam" (*Proc.* Inst. Mech. E., July, 1889), and the space between these lines is closely divided by "constant pressure" and "constant volume" lines, which are extended into the superheated steam field; lines of constant dryness fraction are also given. There are scales giving total heat, water heat and internal energy, from which these quantities can be read off without interpolation. This chart embodies in a graphic form all the physical properties of steam used in thermodynamics from 100°F. to 400°F., and by its help thermodynamic problems can be graphically solved and the $\theta\ \phi$ diagram of a steam engine cylinder readily plotted from the indicator diagram.

Deaths from Electric Shock.—An unusual number of deaths from electric shock have taken place lately in America, judging by a long list published recently in the *Western Electrician*:—An employé of the Cedar Rapids (Iowa) Electric Light and Power Co. was killed recently while replacing a burned-out transformer with a new one in one of the Company's circuits. Another workman was killed while repairing a defective arc lamp in Beloit, Mich. He had been working on the switchboard during the afternoon, and, it is thought, failed to connect up the circuits properly before turning on the current. An unusual accident happened recently in Salt Lake City. The accident was caused by a telegraph wire, in course of erection, coming into contact with six big feed wires of the Union Light and Power Co. One of the workmen, who had hold of the reel of wire, received a fatal shock. Two men were killed by live wires at Baltimore during a heavy rainstorm. In one instance, the current was transmitted by the steel rod of an umbrella coming into contact with an arc light, and in the other case, the victim was bidding a friend good-bye, and rested his hand against an awning-pole, which had by some means become charged.

The Resistance of the Human Body.—At the instance of the Verband Deutscher Elektrotechniker Messrs. Siemens and Halske have been conducting a series of measurements of the electrical resistance both of their own workmen and of the men employed at the sugar factory at Oschersleben, where the recent fatal accidents occurred from low-pressure shock (see *The Electrician*, Vol. XL., p. 346). The range of the apparatus was from a few hundred to 150,000 ohms. Measurements were first made between the two hands of workmen employed at the Oschersleben factory, to see if the skin resistance was diminished by the chemicals used at the works. As values from 900 to 2,000 ohms were obtained, it was concluded that this was not the case. Measurements were then made between the hand and earth, the men in each case wearing the wooden shoes customarily worn by German workmen. Twenty-five of the men employed at ordinary work had resistances of over 150,000 ohms; in seven cases the resistance lay between 50,000 and 150,000 ohms, and in two other cases the values were 17,000 and 14,000 respectively. At the sugar factory

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much lower measurements were made. In the evaporating room the resistances were between 1,700 and 900 ohms, in the cooling house between 2,400 and 1,100, and in the boiler house 3,000 to 1,200. One man with new shoes in the repairing shop offered more than 150,000 ohms' resistance, and the remainder varied from 7,000 to 1,300. In the sugar separating room the limits were 50,000 and 3,000 ohms, and in the machine room six measurements of over 50,000 ohms were made, two over 20,000, and one over 10,000.

Electric Railway Signalling.—For some months past, according to the *Evening Standard*, a section of the Great Northern Railway, 25 miles in length, has been used for a series of experiments on an electrical system of railway signalling. It is the invention of Mr. Wynford Brierley, who has devoted considerable attention to devising a mechanical arrangement for ensuring communication between signalmen and engine drivers, even in the most foggy weather, when visual signalling becomes impossible. The driver receives the signal on his engine. A contact bar fixed to the rails in a rocking shaft is connected by a lever and wire with the ordinary signalling apparatus, so that when the danger signal is set in the box, the contact bar is raised in position to strike a lever fixed on the locomotive. This completes an electric circuit, and sets an alarum ringing on the engine, which works an indicator. An ingenious form of double volute spring holds the engine contact bar vertical, allowing it to preserve a horizontal position in either direction. After receiving the blow from the contact bar on the rail, it performs a few oscillations, and resumes its vertical position in readiness for the next contact. The contact bars, both on the engine and the rails, have two ends, one for danger and one for safety. The safety lever has its own independent electric circuit, and moves an indicator on the engine. The danger bell continues to ring until reset by a simple apparatus, which also acts as a bell tester. The safety bell rings for a couple of seconds, and shows the word "Safe" on the bell. The bell ceases to ring, in this case, as the lever ceases to oscillate, and the word "Safe" disappears. It will be seen that the driver receives a distinct signal as to whether the semaphore signals are or are not against him. In the former case, he would stop the train in the shortest possible time, and communication would be made to him by bell signal code from the signal box. Even in clear weather this apparatus would prevent the signal box being overrun, and the driver would not again move until a permissive signal had been received.

Subfluvial Conduits.—Drawn-in systems for underground cables have of late years found more favour in the United States than in this country, and have several advantages in the case of work executed in busy cities, but it is hard to see how the expense of such systems laid in the bed of rivers can justify their adoption in place of armoured cables laid directly in the water. Two conduits of this class have, however, recently been laid across rivers in Boston, and are described in the *Electrical World*, of New York, of Oct. 29. The one consists fundamentally of seven wrought-iron pipes 4in. in internal diameter and ¼in. thick, with tight screw couplings, each pipe being covered to prevent corrosion with alternate layers of Bermuda asphalt and cheesecloth to a depth of $\frac{3}{16}$ths of an inch. The seven pipes are maintained in a proper relative position by wooden diaphragms from 2ft. to 3ft. apart, 16in. in external diameter and about 4in. thick, with holes for the pipes and split into four pieces to allow assembling. The whole is enclosed in a wooden shell with a thickness of 4in. and an external diameter of 24in., the shell being a regular wooden water pipe sawed lengthwise into two sections, which are grooved and spiked together. These sections vary in length from 1½ft. on the curves to 6ft. on the straight runs. All the wood was carefully creosoted before use. The half sections are bound together and around the diaphragms by bands or hoops of ⅜in. by 2in. strap iron set up with bolts and nuts. The conduit is in the form of a large U or inverted siphon, with about 48ft. between risers and a length of about 126ft. over all. It was assembled on the draw pier, and with a heavy beam across the upper end of the U and many stays and ties, was lifted on to a lighter, as shown in one of the illustrations, and lowered into the stream. A trench about 5½ft. deep had previously been dredged in the clay and rock bottom, the rocks being removed by divers. Into this trench the U was sunk until the upper surface of the horizontal section was 4ft. below the level of the bottom of the channel and the trench was then filled flush. Lead-covered cables have been drawn into the ducts, and it is the intention to keep the interior dry. If moisture cannot be kept out, it will be filled with a heavy oil to prevent corrosion. The other conduit is a much larger one, and of a radically new type of construction. It belongs to the Boston Electric Light Co., which has now in course of erection a new generating station in South Boston, to take the place of its four older stations in other parts of the city. The transmitting system from the new station into the city consists of two double conduits, one of which crosses Fort Point Channel near the Congress-street bridge. Each of these double conduits carries 24 ducts in four layers of six ducts each, they being double in the sense that the 12 ducts on one side of a vertical plane through the centre of the conduit run through manholes entirely distinct from the 12 on the other side. The lead-covered cables will be drawn into ducts solely of wood, the six layers of ducts consisting of semi-circular grooves planed in the opposite sides of seven layers of timbers, each layer being 6in. thick. The timber is untreated green pine, except for the sections passing through the mud line at the two terminals of the conduit, which for a distance of 12ft.—6ft. each side of the mud line—are of oak. This is for the purpose of avoiding the attacks of insects, which, experience has shown, are only made at these points. The timbers are fastened together at frequent intervals by ⅞in. galvanised iron bolts with nuts and washers, and also with kiln-dried soft-pine dowel pins, the former being expected to have a limited life and the latter to be more permanent. The swelling of the latter on reaching the water will render them very tight. These bolts and pins are passed through horizontally and vertically at intervals, making, with the staggered joints of the timbers, a very substantial construction. The bolt holes are counter-bored on one side of the conduit, in order to give a smooth surface for the launching, which was done from sliding ways. The length of the 6in. timbers varies from 4ft. on the curves to 20ft. on the straight run. The sections were assembled in the yard complete, except for the dowel pins, and the ducts were tested by means of a 3¼in. plunger attached to a bamboo rod for the curved runs, any sticking being remedied by taking down the structure and gouging out the ducts. At the joints each duct is flared out slightly to prevent a shoulder occurring to catch the piping. After the ducts were thus carefully rendered of a uniform minimum cross-section, each of the six sections of the conduit was assembled, fitted with dowel pins and taken on rollers to the launching ways. The conduit weighs in air a ton for about every 8½ft., making for the whole length a weight of about 40 tons. The launching ways were heavily lubricated with axle grease, and the back end was tilted up with jacks until the section slid off into the water. Each section was fitted with a stepped joint, with steps each 2ft. in length for attaching it to the next. These were joined in the water, and the whole sunk with weights.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, November 25th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Papers to be read: (1) "On the Properties of Liquid Mixtures," by R. A. Lehfeldt; (2) "On certain Diffraction Fringes as applied to Micrometric Observations," by L. N. G. Filon.

MONDAY, November 28th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture II.—"Acetylene," by Prof. Vivian B. Lewes.

TUESDAY, November 29th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read: "The Effect of Subsidence due to Coal Workings upon Bridges and other Structures," by S. R. Kay.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Iron-Constantan Thermo Couples.—It appears that H. Rubens was not the first to use thermo couples of iron and constantan for measuring radiant heat. Such thermo couples were calibrated or used by Holborn and Wien, Fuchs, Kleiner, Troost and Van Aubel. The latter gives an account of all these researches, the earliest of which is that of Fuchs, who published a Paper at Graz in 1893 on the thermo-electric behaviour of some nickel-copper alloys. Fuchs used baths of boiling alcohol, water, xylol, aniline and nitrobenzol to obtain standard temperatures ranging from 70deg. to 200deg. Kleiner found that the temperature curve is very nearly a straight line. Holborn and Wien used this thermo couple for measuring low temperatures, including the fusing points of some organic liquids; Troost used it for finding the boiling point of liquid ozone, and Van Aubel himself for determining the thermal conductivities of various alloys.

[Van Aubel, *Archives Sc. Phys. Nat.*, Geneva, 103, 4.]

Determination of Dielectric Constants.—If C_1 and C_2 are capacities inserted in a primary and a secondary circuit respectively, and i_1 and i_2 the currents, J. A. Erskine proves that i_2 changes very rapidly with C_2 when C_1 has certain values. Hence, if a suitable current indicator is available, the mutual influence of two circuits may be used for comparing two capacities with great accuracy, and hence also for the determination of dielectric constants. Such an indicator the author found in a set of magnetised bits of steel wire only 1cm. long. The primary current consisted of the discharge of an influence machine. The secondary coil was not enclosed in the primary, but was placed a few centimetres away, with the axes coinciding. The unknown capacity was determined by measuring the distance between the plates of a Kohlrausch condenser, when that and the condenser of unknown capacity produced the same demagnetisation of the needle. The curve of demagnetisations for various positions of the condenser plates being known, it was easy to find the capacity corresponding to the demagnetisation observed with the condenser containing the liquid to be studied. In order to maintain the constancy of the discharge potential the primary condenser was always charged very rapidly, as recommended by Jaumann.

[Erskine, *Wied. Ann.*, No. 10, 1898.]

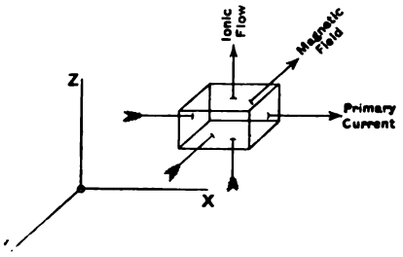
Crystallisation in a Magnetic Field.—The fact that any transparent, simply refracting, optically inactive substance, when placed in a powerful magnetic field, instantly acquires the property of rotating the plane of polarised light, and that the effect thereon is apparently of the same nature as that characteristic of certain specific atomic groupings in molecules, naturally raises the question whether, if the optically active molecular structure or aggregation were effected in a magnetic field, it would be influenced thereby to an extent sufficient to show an effect upon its final optical properties, which would seem probable, providing the interatomic or intramolecular forces are electro-dynamic. This question has been experimentally investigated by A. W. Wright and D. A. Kreider in the case of tartaric and racemic acids, sodium chlorate and ferrous sulphate. To determine the resultant optical activity of any crop of crystals, they were suspended in a mixture of alcohol and carbon bisulphide of the same refractive index, in a tube maintained in rotation by mechanical means. The results showed that even the strongest magnetic fields failed to control the direction of the resultant optical activity. But in the case of sodium chloride an excess of either dextro or lævo crystals was obtained, which indicated a kind of unstable equilibrium produced by the magnetic field.

[Wright and Kreider, *Am. Jour. Science*, November, 1898.]

The Constant of Gravitation.—The equation of gravitational attraction, $V = MM^1/d^2$, is not complete, as it requires the introduction of a constant depending upon the system of units adopted. That it is not complete may be proved in another way also. V is a force, and hence of the dimensions MLT^{-2}. The dimensions on the right-hand side are M^2L^{-2}. It is evident at once that the two sides are not dimensionally equivalent, and hence that other dimensions must intervene before the expression for the occurrence here represented is complete. If we put $V = KMM^1/d^2$, the dimensions of K necessary for a complete dimensional equation are $M^{-1}L^3T^{-2}$, a formula which is not yet interpreted. It depends, of course, upon the medium in which the gravitational action takes place. $M^{-1}L^3$ being the inverse of a density, the constant might be taken to signify the change in the rate of rarefaction of the medium in a given time. But before entering into speculations of this kind, it is better to determine the numerical value of the constant for C.G.S. units. F. Richarz and O. Krigar-Menzel have finished their long and laborious task at Spandau, and have found the constant to be $(6{\cdot}685 \pm 0{\cdot}011) + 10^{-8}$ $\frac{cm^3}{gr\ sec^2}$ by weighing a heavy mass at two different altitudes above the earth's surface. The corresponding density of the earth is 5·505, which accords fairly well with the value 5·527 found by Boys by means of his quartz-fibre torsion balance.

[Richarz and Krigar-Menzel, *Wied. Ann.*, No. 10, 1898.]

Hall Effect in Liquids.—F. G. Donnan calculates the much-controverted Hall effect in a binary electrolyte from the basis indicated in the diagram (*see* Fig.). The lines of flow of the primary current are supposed to be straight, and the magnetic field uniform. The effect of the ponderomotive forces on the moving ions in the magnetic field is to urge both positive and negative ions, with different velocities, in the positive direction of z. The stationary state is attained when the net flux of ionic matter in the positive direction of z is balanced by the flux of undissociated salt in the opposite direction. The author obtains transverse E.M.F.'s in a



$CuSO_4$ solution of the order of 10^{-7} volts, which would require a potential gradient of about 10,000 volts per centimetre to bring into measurable prominence. Hence, the conclusion is the same as that arrived at by Everdingen (see *The Electrician*, Vol. XLI., p. 488), viz., that Bagard's apparent Hall effect is due to other disturbing causes.

[Donnan, *Phil. Mag.*, November, 1898.]

Magnetic Deflection of Vacuum Discharges.—J. Henry has endeavoured to find the explanation of the change produced in the magnetic deflection of the discharge between a pair of electrodes in a rarefied gas, when the gas carrying the discharge is changed. The behaviour of such discharges closely resembles that of a flexible and elastic conducting string stretched between the electrodes. Such a string would be pulled aside while the magnetic force acted, and return to the straight line as soon as the magnetic force was removed. In order to avoid complications due to electrification of the sides of the tube, the author used a wide bell jar, closed by an ebonite plate, the electrodes being wires introduced through the neck of the jar and through the centre of the plate. The deflections were measured by photographing the discharges. The magnetic field was made vertical, and the deflection horizontal, thus avoiding distortions due to convection, at least on the photographic negative. It was found that, roughly speaking, the magnitude of the deflection increased with the density which the gas has at atmospheric pressure; in other words, with the molecular weight of the gas. As long as the current through the gas was kept constant, a change of pressure had little influence, if any. The potential difference between the electrodes was equally unimportant. The elements which determine the amount of magnetic deflection are exactly the same as those which determine the deflection by a blast across the electrodes, from whatever

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cause produced. These elements are: The rate of diffusion of the gas, the rate of recombination of its ions, the velocity of the ions under a given E.M.F., the duration of the discharge, and the relative resistance of the gas to the passage of electricity through it before, and after, a discharge has passed. When the discharge is abrupt, the path is straight. When it is gradual, the chain of ions is blown aside by the blast due to the magnetic field.

[HENRY, *Phil. Mag.*, November, 1898.]

Phosphorescence.—H. Jackson attempts to connect together all the phenomena of phosphorescence, or what is more appropriately termed luminescence, with a view of showing between them a likeness in kind. The sources of luminescence thus dealt with include light, heat, chemical combination, cathode rays and X-rays. The glow of phosphorus, the fluorescence of quinine, the sparkling of heated chlorophane, the luminosity of Balmain's paint, the light from lime in a vacuum tube, the glowing of barium platino-cyanide under the influence of X-rays—all these phenomena may be looked upon as outward evidences of a response on the part of these substances to rapid oscillations. To avoid circumlocution the original response may be described as the assumption of a statical charge. The release of this condition of strain is accompanied by oscillations which give rise to the visible undulations of the phosphorescent light. So far the author's theory. It must be confessed that it does not give us much additional aid towards the solution of this complex problem. But a remark at the end of his Paper deserves attention. He supposes that the clouds in the solar photosphere are made up of matter in a more condensed or complex state than that of the solar nucleus or the photosphere itself. As a rule these clouds are rendered luminous by the more rapid oscillations of the nucleus. Occasionally, in the case of sun spots, they fail to shield the earth from these rapid oscillations, and electric disturbances result.

[JACKSON, *Phil. Mag.*, October, 1898.]

Arc Vapours.—In experiments upon the discharge of negative electricity by light, the electric arc has usually been found to be the most satisfactory source of ultra-violet rays. But it was early recognised that electrified particles, thrown off from the hot carbon terminals, and proceeding to considerable distances from the arc, might be a serious source of error. E. Merritt and O. M. Stewart have carefully examined the behaviour of the electrified particles thrown off by various arcs. They find that the vapours from the carbon arc possess the power of discharging electrified bodies with which they are brought into contact. In general the electric properties of these vapours are similar to those of gases that have been acted upon by X rays, or to the gases from a flame. This discharging power is retained even after the vapours have passed through long tubes of glass or metal, and lasts for at least 10 seconds. After passing between two grounded conductors, these being only a short distance apart, the vapours are found to discharge a negatively electrified body more rapidly than one charged positively. This recalls the action of X rays. The explanation of the phenomenon is probably that suggested by Zeleny, namely, that the negative ions diffuse more rapidly than the positive ones.

[MERRITT and STEWART, *Phys. Rev.*, Sept.-Oct., 1898.]

Electric Power Transmission in Canada.—In the United States consular reports from British Columbia it is announced that the work on the power plant and transmission line from Sooke Mountains to Victoria has been completed. The current is used for lighting and street railway purposes. The water from the mountains starts 2,300ft. above the level of the sea, and is the highest fall in Canada. About 750ft. above sea level and 16 miles from Victoria, these waters form a lake covering 150 acres, into which empties Goldstream river, which is tapped three miles from its source by an artificial lake or reservoir, covering 7½ acres, 1,122ft. above sea level. From this reservoir the water passes through a steel pipe 33in. in diameter, 6,700ft. to the power house of the electric company, which is 460ft. above sea level, thus giving a fall of 1,000ft. from the main lake, developing 1,500 H.P.

CURRENTS IN BRANCHED AND IN MUTUALLY INDUCING CIRCUITS PRODUCED BY HARMONICALLY VARYING ELECTROMOTIVE FORCES.

(*Concluded from page 74.*)

BY PROF. THOMAS R. LYLE.

Example II.

Two points between which a P.D. E subsists are joined in parallel by two conductors having R, L, and K, and exercising mutual induction on each other; determine the R and L of a conductor equivalent to the two parallels. Applying Kirchhoff's extended laws,

$$E + mC_2 = r_1C_1,$$
$$E + mC_1 = r_2C_2,$$

where

$$r_1 = R_1 + \iota\omega L_1,$$
$$r_2 = R_2 + \iota\omega L_2,$$
$$m = \omega M e^{-\iota\frac{\pi}{2}} = -\iota\omega M.$$

Hence, at once,

$$(r_1r_2 - m^2)(C_1 + C_2) = (r_1 + r_2 + 2m)E,$$

or

$$E = r^1(C_1 + C_2),$$
$$= (\rho + \iota\omega\lambda)(C_1 + C_2),$$

where ρ and λ are the resistance and inductance of the conductor equivalent to the two parallels, and may be shown to be given by

$$\rho = \frac{R_1R_2(R_1 + R_2) + \omega^2\{R_1(L_2 - M)^2 + R_2(L_1 - M)^2\}}{(R_1 + R_2)^2 + \omega^2(L_1 + _2 - 2M)^2}.$$

$$\lambda = \frac{R_1^2L_2 + R_2^2L_1 + 2MR_1R_2 + \omega^2(L_1L_2 - M_2)(L_1 + L_2 - 2M)}{(R_1 + R_2)^2 + \omega^2(L_1 + L_2 - 2M)^2}.$$

Two points between which a P.D. E subsists are joined in parallel by a number of conductors, each having R, L, and

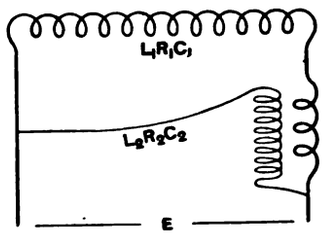

FIG. 5.

K. Determine the R and L of a conductor equivalent to the system and the phase difference of the currents in the several parallels.

If $C_n = c_n\cos(\omega t - \phi_n)$ be the current in parallel n, R_n its resistance and L_n its equivalent inductance, that is $\Sigma L - \frac{1}{\omega^2}\Sigma\frac{1}{K}$ in n, then putting r_n for $R_n + \iota\omega L_n$ we have,

$$E = r_1C_1 = r_2C_2 = r_3C_3, \text{ \&c.},$$
$$\therefore \Sigma C = \left(\Sigma\frac{1}{r}\right)E = \Sigma\left\{\frac{R}{I^2} - \iota\frac{\omega L}{I^2}\right\}E,$$
$$= (a - \iota\omega b)E,$$

where $a = \Sigma\frac{R}{I^2}$ and $b = \Sigma\frac{L}{I^2}$.

$$\therefore E = \frac{1}{a - \iota\omega b}\Sigma C = \frac{a + \iota\omega b}{a^2 + \omega^2b^2}\Sigma C = r^1C;$$

and as ΣC is the total current.

$$\frac{a}{a^2 + \omega^2b^2} = \text{resistance of equivalent conductor},$$

$$\frac{b}{a^2 + \omega^2b^2} = \text{inductance of equivalent conductor},$$

$$\text{also } \cos(\phi_p - \phi_q) = \frac{R_pR_q + \omega^2L_pL_q}{I_pI_q},$$

$$Sm(\phi_q - \phi_q) = \omega\frac{L_pR_q - L_qR_p}{I_pI_q},$$

where $\phi_p - \phi_q$ is the amount that C_q is *ahead of* C_p in phase.

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Corollary I. To get the reduction factor of a Wattmeter.—Let the constants of the external circuit and thick wire coil of the wattmeter be R_1L_1, and those of the fine wire coil shunted across the terminals of the generator be R_2L_2. Fig. 5 making the arrangement clear.

The indication of the wattmeter is proportional to the average value of C_1C_2, that is, to $\frac{1}{2}c_1c_2\cos(\phi_1-\phi_2)$, or to $\frac{1}{2}\frac{c_1c_2}{R_2}\cos(\phi_1-\phi_2)$, as R_2 is constant.

The latter expression is

$$=\tfrac{1}{2}\frac{1}{R_2}\frac{e^2}{I_1I_2}\frac{R_1R_2+\omega^2L_1L_2}{I_1I_2}=\tfrac{1}{2}\frac{R_1R_2+\omega^2L_1L_2}{R_2I^2I_2^2}.$$

The power put into the external circuit is the average value of EC_1, that is,

$\frac{1}{2}\frac{R_1}{I_1^2}e^2$. Hence the reduction factor is $=\dfrac{I_2^2R_1}{R_1R_2+\omega^2L_1L_2}$.

Corollary 2.—If there be only two parallels the condition that the currents in them may be in quadrature (*i.e.*, $\phi_1-\phi_2=\frac{\pi}{2}$) is $R_1R_2+\omega^2L_1L_2=0$, which shows, since R_1 and R_2 are essentially positive, that L_1 and L_2 must be of opposite sign, that is, that in the one inductance must predominate, and in the other capacity. If $L_2=-\dfrac{1}{\omega^2K_2}$ where K_2 is the equivalent capacity of parallel 2, then the above condition becomes

$$K_2R_1R_2=L_1.$$

Example III.

If the alternate poles of the stator of a rotary field motor are wound with a continuous conductor, to determine the winding and constants of the conductor for the remaining poles, which conductor when joined in parallel with the first will split a single phase alternating current so as to produce a circular rotating magnetic field. Let $R_1L_1n_1$ (number of turns) I_1 reter to given circuit, $R_2L_2L'_2n_2I_2$, refer to required circuit, L_2 being the inductance of the stator coils, and L'_2 the added external inductance, which I have shown must be such as to make the total inductance $L_2+L'_2$ negative; in other words, capacity must predominate in circuit 2, and the capacity K_2 required to be put in will be $=-\dfrac{1}{\omega^2L'_2}$.

In addition, let p be the number of similar poles on one circuit of the stator, and σ the magnetic flux due to 10 ampere-turns round any pole. Hence for quadrature, that is, $\phi_1-\phi_2=\pi/2$,

$$R_1R_2+\omega^2L_1(L_2+L'_2)=0. \quad . \quad . \quad . \quad \text{(I.)}$$

For equal amplitude of magnetic flux

$$n_1c_1=n_2c_2,$$

that is,
$$\frac{I_1}{n_1}=\frac{I_2}{n_2}=a, \text{ say}, \quad . \quad . \quad . \quad . \quad . \quad \text{(II.)}$$

remembering that $I_2^2=R_2^2+\omega^2(L_2+L'_2)^2$;

also
$$\frac{L_1}{n_1^2}=\frac{L_2}{n_2^2}=p\sigma=\lambda, \text{ say}, \quad . \quad . \quad . \quad \text{(III.)}$$

and, as we have a condition still at our disposal, let it be that the volumes of copper on the two circuits shall be equal.

This gives
$$\frac{R_1}{n_1^2}=\frac{R_2}{n_2^2}=\rho, \text{ say}, \quad . \quad . \quad . \quad . \quad \text{(IV.)}$$

In the above, as λ and ρ are known and connected by the equation $a^2=n_1^2(\rho^2+\omega^2\lambda^2)$, we will also represent by τ the known ratio $\dfrac{\omega\lambda}{\rho}$.

By simple elimination we get at once $n_2=\tau n_1$.

Hence
$$R_2=\tau^2n_1^2\rho=\tau^2R_1,$$
$$L_2=\tau^2n_1^2\lambda=\tau^2L_1,$$
$$\frac{1}{\omega^2K_2}=-L'_2=n_1^2\rho\frac{\tau(1+\tau^2)}{\omega}=R_1\frac{\tau(1+\tau^2)}{\omega};$$

or
$$\omega K_2=\frac{1}{\tau(1+\tau^2)R_1}.$$

The energy drawn from the mains and received by the stator by circuit 1 is the average value of EC_1, while that by circuit 2 is the average value of $E'C_2$, where E' is the P.D. between the extremities of the stator coils of circuit 2.

Now $E^1=(R_2+\iota\omega L_2)C_2$,

$$\therefore \quad E=\{R_2+\iota\omega(L_2+L'_2)\}C_2;$$

hence
$$\frac{e^1}{e}=\sqrt{\frac{R_2^2+\omega^2L_2^2}{R_2^2+\omega^2(L_2+L_2^1)^2}}=\frac{n_2}{n_1}$$

after a few simple reductions.

Hence average EC_1 = average $E'C_2$, or the two circuits draw from the mains equal amounts of power. As τ for any motor circuit will always be a fairly large number (50 to 100) the above proves that we get in circuit 2 a P.D. across its stator extremities very much greater than the originating E.M.F. I will return to this subject in Examples V. and VI.

Example IV.—To Split a Single Phase Alternate Current into Three, which shall Produce a Circular Rotating Magnetic Field.

It is not possible to separate the phase of a current from that of the producing E.M.F. by more than $\pi/2$, but as we can wind a coil either right or left-handed, we can produce a magnetic flux differing in phase from the originating E.M.F. by any angle. If circuit 1 be given, *i.e.*, $R_1L_1n_1\phi_1I_1$, there are three cases.

a. When ϕ_1 or $\tan^{-1}\dfrac{\omega L_1}{R_1}$ is greater than 30deg. In this case we can arrange a parallel R_3, $L_2L'_2n_2$ 60deg. ahead of 1 in phase, and another parallel $R_3L_3L'_3n_3$ 60deg. ahead of 2 in phase, and wind circuit 2 on the stator in the direction contrary to 1 and 2.

b. When ϕ_1 is less than 30deg. and greater than −30deg. In this case we can arrange a parallel, $R_2L_2n_2$, 60deg. behind circuit 1 in phase, and another, $R_3L_3L'_3n_3$, 60deg. ahead of 1, and wind circuit 1 on the stator in the direction contrary to 2 and 3.

c. When ϕ_1 is less than −30deg. Treatment obvious.

Case *b* can obviously be easily reduced to case 1 by changing the numbers specifying the circuits.

Case A.—With the same notation and explanation as in Example III. we have (assuming no K in circuit 1) for equal magnetic flux

$$\frac{I_1}{n_1}=\frac{I_2}{n_2}=\frac{I_3}{n_3}=a, \text{ say}, \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(I.)}$$

$$\frac{L_1}{n_1^2}=\frac{L_2}{n_2^2}=\frac{L_3}{n_3^2}=\rho\sigma=\lambda, \text{ say}. \quad . \quad . \quad . \quad . \quad \text{(II.)}$$

$$\frac{R_1}{n_1^2}=\frac{R_2}{n_2^2}=\frac{R_3}{n_3^2}=\rho, \quad . \quad . \quad . \quad . \quad \text{(III.)}$$

i.e., equal volumes of copper in coils.

And as
$$\phi_2-\phi_1=\pi/3,$$
$$\phi_3-\phi_2=\pi/3,$$
$$\phi_3-\phi_1=2\pi/3,$$

we have
$$R_1R_2+\omega^2L_1(L_2+L'_2)=\tfrac{1}{2}I_1I_2,$$
$$R_2R_3+\omega^2(L_2+L'_2)(L_3+L'_3)=\tfrac{1}{2}I_2I_3,$$
$$R_1R_3+\omega^2L_1(L_3+L'_3)=-\tfrac{1}{2}I_2I_3.$$

After a little simple elimination we find,

$$n_2-\frac{n_1}{2}=\pm\frac{\sqrt{3}}{2}n_1\tau,$$

$$n_3+\frac{n_1}{2}=\pm\frac{\sqrt{3}}{2}n_1\tau.$$

τ, as in Example 3, being $=\dfrac{\omega\lambda}{\rho}$), and

$$\left(n_2-\frac{n_1}{2}\right)\left(n_3+\frac{n_2}{2}\right)=\tfrac{3}{4}n_1^2\tau^2.$$

Obviously in the second of last three equations the positive sign must be taken and the third then determines that the positive sign must also be taken in the first. Hence

$$2n_2=(\sqrt{3}\tau+1)n_1,$$
$$2n_3=(\sqrt{3}\tau-1)n_1,$$

which contain the solution of the problem.

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Hence $$R_2 = \frac{(\sqrt{3}\tau + 1)^2}{4} R_1,$$

$$R_3 = \frac{(\sqrt{3}\tau - 1)^2}{4} R_1.$$

Similarly for L_2 and L_3.

Also $$\omega L'_2 = -\frac{(1+\tau^2)(3\tau + \sqrt{3})}{4} R_1,$$

$$\omega L'_3 = -\frac{(1+\tau^2)(3\tau - \sqrt{3})}{4} R_1.$$

In the same way, as in Example III., it can be shown that the powers drawn from the mains by the three circuits are equal.

Cases b and c.—In case *b* we can assume $R_2 L_2 L'_2 n_2$ given, and the above determines the constants of circuits 1 and 3; and in case *c* we can assume $R_3 L_3 L'_3 n_3$ given, and the above determines the constants of circuits 1 and 2. If the given circuit is without capacity, case *a* is the only one that would ever occur in practice.

Example V.

If a constant pressure alternating generator (E.M.F. = E) operate through leads with R and L into a condenser (cap. = K), it is possible to arrange the value of K so that the P.D. (= V) of the condenser plates may be greater than the originating E. In this case

$$E = rC \text{ where } r = R + \omega\left(L - \frac{1}{\omega^2 K}\right),$$

$$V = -\iota \frac{1}{\omega K} C.$$

Hence

$$\left(\frac{\text{amp. V}}{\text{amp. E}}\right)^2 \text{ or } \frac{v^2}{e^2} = \frac{\frac{1}{\omega^2 K^2}}{R^2 + \omega^2\left(L - \frac{1}{\omega^2 K}\right)^2} = \frac{1}{\omega^2 K^2 R^2 + (1 - \omega^2 LK)^2},$$

and it can be at once seen that $\frac{v}{e} > 1$ if ωK is less than $\frac{2\omega L}{R^2 + \omega^2 L^2}$, which $= \frac{2\tau}{R(1+\tau^2)}$, where $\tau = \frac{\omega L}{R}$.

Let $\omega K = \frac{2\tau}{R(1+\tau^2)} q$ where q is a positive number greater or less than unity, then $\frac{v^2}{e^2} = \frac{1+\tau^2}{1+(1-2q)^2\tau^2}$, from which we see that

$v < e$ when $q > 1$,

$v = e$ when $q = 1$,

$\frac{v}{e}$ a maximum $= \sqrt{1+\tau^2}$, when $q = \frac{1}{2}$, *i.e.*, when $\omega\kappa = \frac{\tau}{R(1+\tau^2)}$,

$v = e$ when $q = 0$.

The capacity of the condenser for maximum v is $= \frac{\tau}{R(1+\tau^2)}$.

Hence we see that if τ be a large number, and the capacity adjusted in accordance with the above, we can effect a multiplication of the P.D. in the ratio τqp. So by increasing τ and always adjusting K we can effect a multiplication of the P.D. to any extent we like. Now, τ being $= \frac{\omega L}{R}$, it may be increased by increasing ω or L or both. Hence if the rate of alternation $\omega/2\pi$ be alone increased and K correspondingly diminished, we can effect a high degree of multiplication.

For a fixed value of K there is a value of $\omega^2 = \frac{1}{KL} - \frac{R^2}{2L^2}$, which gives the maximum multiplication, and we can see that if K be very small, ω, and hence the multiplication ratio τ, may be exceedingly high. The following interesting problem is suggested by the above.

This problem must have an important bearing on most of the Tesla effects produced by currents of high frequency.

Example VI.

If two equal uniform leads are arranged between a constant pressure alternating generator and a condenser, as in Fig. 6, and if the resistance and inductance of these leads between the condenser and a point distant y from it be ρy and λy respectively, to find the value x of the amplitude of the P.D across the leads at the point y as a function of y. We have for the portion of the circuit between y and the condenser, including the condenser,

$$V - V_1 = \left\{ y\rho + \iota\omega\left(y\lambda - \frac{1}{\omega^2 K}\right) \right\} C,$$

and for the whole circuit

$$E = rC = \left\{ R + \iota\omega\left(L - \frac{1}{\omega^2 K}\right) \right\} C,$$

where $R = l\rho$, $L = l\lambda$, l being the length of the leads.

Hence we get the ratio of the squares of the amplitudes

$$\frac{x^2}{e^2} = \frac{y^2\rho^2 + \omega^2\left(y\lambda - \frac{1}{\omega^2 K}\right)^2}{I^2},$$

where I = impedance of whole circuit.

This immediately reduces to

$$\frac{x^2}{e^2} - \frac{\left(y - \frac{\lambda}{\omega^2 K}\right)}{\frac{I^2}{a^2}} = \frac{\rho^2}{\omega^2 K^2 a^2},$$

where $a^2 = \rho^2 + \omega^2\lambda^2$, the equation of a hyperbola. This can be represented in conjunction with the circuit, as in Fig. 5, by the curve ABD.

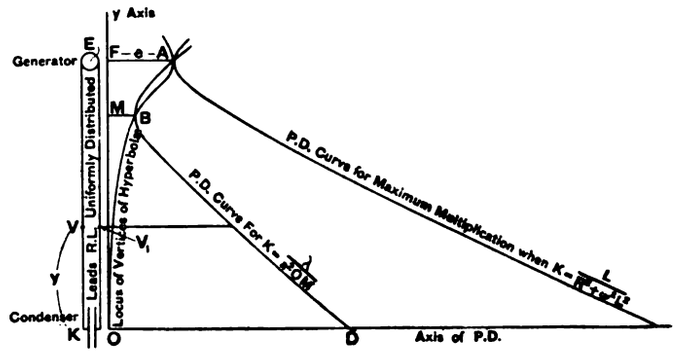

FIG. 6.

From the equation it is seen that the vertex of this hyperbola lies on the line $y = \frac{\lambda}{a^2 K}$, and it can be shown that the equation is satisfied by the point $x = e$, $y = l$ independently of the value of K. The P.D. at any point y is the abscissa between the corresponding point on the y axis and the curve, and it is seen that in the case which ABD represents that the P.D. at first falls on leaving the generator, reaches a minimum, and rises again. For each value of the capacity K there will be a corresponding hyperbola which will give the P.D. at all points along the leads. All these curves will pass through the point A, which represents the E.M.F. of the generator, and the vertices of them all will lie on a curve ABO, whose equation is

$$x^2\{(l-y)^2\tau^2 + y^2\} = e^2 y^2, \text{ where } \tau = \frac{\omega\lambda}{\rho},$$

the position of the vertex on this curve being given when K is given, as it has been shown, to lie on a line $y = \frac{\lambda}{a^2 K}$.

If the capacity, starting from a large value, be diminished, we see that at first when the vertices of the corresponding hyperbolæ lie between $y = o$ and $y = \frac{l}{2}$, which correspond to $K = \infty$ and $K = \frac{2\lambda}{a^2 l}$, that these curves cut off from the x axis a length less than FA, which means that when K lies between ∞ and $\frac{2\lambda}{a^2 l}$, or $\frac{2L}{R^2 + \omega^2 L^2}$, the P.D. at the condenser, is less than the E.M.F. of the generator; when B lies on $y = \frac{l}{2}$ OD becomes equal to FA, and for this $K = \frac{2L}{R^2 + \omega^2 L^2}$, as was shown

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in Example 5. As K is still further diminished, OD becomes greater than FA, until the vertex falls on FA, when OD assumes its maximum value, the correspoding value of K being $\frac{L}{R^2+\omega^2L^2}$. Any further diminution of K diminishes OD, and when K = 0, OD finally becomes = FA.

Example VII.

Wheatstone's bridge, with R, L, and K, in all branches, using a telephone in place of a galvanometer, and a harmonic generator in place of the battery. Let X represent in amplitude and phase the current through the telephone, Y the current through arm 4, and Z the current through arm 3, then, referring to Fig. 6 and using Kirchhoff's extended laws, we get $r_2(X-Y)+r_1(X+Z)+r_5X=0$;

that is, $(r_1+r_2+r_5)X-r_2Y+r_1Z=0$,

where $r_1=R_1+\iota\omega L_1$, $r_2=R_2+\iota\omega L_2$, &c.

L_1, L_2 being the equivalent inductances of the arms,

$$L_1=L'_1-\frac{1}{\omega^2K_1}.$$

Similarly, $-r_2X+(r_2+r_4+r_6)Y+r_6Z=E$,

and $r_1X+r_6Y+(r_1+r_3+r_6)Z=E$,

which equations may be solved for XYZ, as if they were purely algebraical, giving

$$\Delta X=(r_2r_3-r_1r_4)E,$$
$$\Delta Y=\&c.;$$

but it must be remembered that the result is a vector equation, and that the functions Δ, $r_2r_3-r_1r_4$, &c., of the r's are operators.

X, the current through the telephone, is thus determined in terms of E and the constants of the bridge. For X = 0 the interpretation of $r_2r_3-r_1r_4=0$ is given below. In this simpler case, where it is only required to find the conditions between the constants for a balance to obtain, we may proceed *ab initio* as follows. (Refer to Fig. 6.)

$V_1-V_2=r_1C_1$, therefore

$$C_1=\frac{1}{r_1}(V_1-V_2)=\frac{1}{r_3}(V_2-V_4). \quad . \quad . \quad . \quad (I.)$$

for if no current goes through the telephone,

$C_1=C_3$, similarly,

$$C_2=\frac{1}{r_2}(V_1-V_3)=\frac{1}{r_4}(V_3-V_4). \quad . \quad . \quad . \quad (II.)$$

Now from I. we have $V_1-V_2=\frac{r_1}{r_3}(V_2-V_4)$,

$$V_1-V_3=\frac{r_2}{r_4}(V_3-V_4),$$

and as $V_2=V_3$ the operation $\frac{r_1}{r_3}$ must be identical with the operation $\frac{r_2}{r_4}$;

but $\frac{r_1}{r_3}$ may be represented by $\frac{I_1}{I_3}\epsilon^{\iota(\phi_1-\phi_3)}$,

and $\frac{r_2}{r_4}$ may be represented by $\frac{I_2}{I_4}\epsilon^{\iota(\phi_2-\phi_4)}$,

and for identity $\frac{I_1}{I_3}=\frac{I_2}{I_4}$, ... (III.)

and $\phi_1-\phi_3=\phi_2-\phi_4$, ... (IV.)

but when $\sin(\phi_1-\phi_3)=\sin(\phi_2-\phi_4)$,

$\phi_1-\phi_3=\phi_2-\phi_4$,

hence from Example II.,

$$\omega\frac{L_1R_3-L_3R_1}{I_1I_3}=\omega\frac{L_2R_4-L_4R_2}{I_2I_4}. \quad . \quad . \quad (IV.)$$

So, combining this with III., we get

$$\frac{L_1R_3-L_3R_1}{L_2R_4-L_4R_2}=\frac{I_1I_3}{I_2I_4}=\frac{I_1^2}{I_2^2}=\frac{I_3^2}{I_4^2}.$$

Hence $$\frac{L_1R_3-L_3R_1}{L_2R_4-L_4R_2}=\frac{R_1^2+\omega^2L_1^2}{R_2^2+\omega^2L^2}=\frac{R_3^2+\omega^2L_3^2}{R_4^2+\omega^2L_4^2}. \quad . \quad . \quad (V.)$$

are the necessary and sufficient conditions, for no sound in the telephone L_1, L_2, L_3 and L_4, representing the equivalent inductances, *i.e.*, L_1, stands for $L_1-\frac{1}{\omega^2K_1}$ where K_1 is any capacity that may be in arm 1.

The sign of the first term of (V.) is important, and as the other two terms are essentially positive for a balance it must always be positive.

Many interesting particular cases of the bridge with LRK, &c., might be discussed, but the author thinks he has given sufficient illustrative examples for the purpose of the present

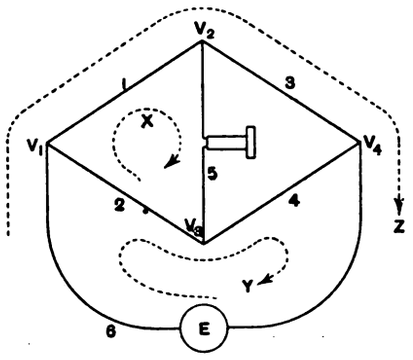

FIG. 7.

Paper; he hopes at some future time to return to the subject, and still further illustrate the convenience and power of the method brought forward.

THE LONG-SCHATTNER PREPAYMENT METER.

During the last two years there have been many workers at the problem of producing a cheap and reliable prepayment meter, but few of these inventors have up to the present succeeded in evolving instruments beyond the experimental stage. One of the main difficulties of the problem is that the meter must be capable of being manufactured and sold at a very low cost, and if frequent inspection or testing be needed this must be of the very simplest character; for it must be remembered that such apparatus are to be used by the smallest

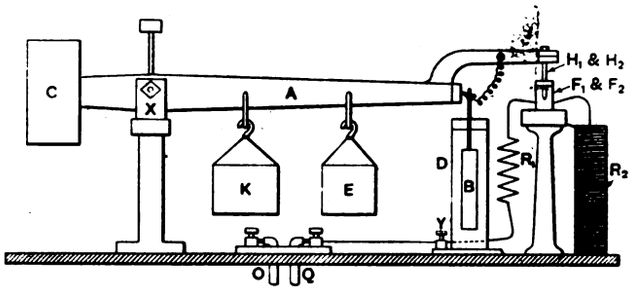

FIG. 1.—Diagram of Long-Schattner Prepayment Meter.

consumers, the revenue from whom would not justify the supply authority in making either a high capital expenditure or in spending any but a very small sum in maintenance. Another point, equally if not more important, which has to be observed by constructors of such meters is that an extremely low starting current is necessary; such meters must start at least when a single 8-c.p. lamp is switched on, *i.e.*, with a current of 0·15 ampere on a 200-volt supply network.

The electrolytic prepayment meter devised by Mr. F. M. Long, engineer and manager of the Norwich Electricity Co., in conjunction with his late assistant-engineer Mr. Schattner, and manufactured by Messrs. Schattner and Co., of Norwich, bids fair to fulfil these *desiderata*, and if its reliability is borne out by prolonged use it should prove a most serviceable instrument to the supply engineer. We understand that it is already used to some extent on the network at Norwich. Fig. 1 shows the principle diagrammatically. A is a lever

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pivotted at X. At the far end of the lever is suspended a copper plate B, which is immersed in a solution of copper sulphate. The box D is also of copper, aud forms the cathode. C is a weight to balance the other side of the lever. K and E are cups to hold respectively the coins and standard weights which the collector replaces instead of the coins. F_1 and F_2 are mercury cups, F_1, the front one, being filled with mercury; F_2, the back one, being half filled with mercury and filled up with creosote oil. H_1 and H_2 are contact pieces forming a bridge across the mercury cups, aud fixed on the lever. R_1 is a main resistance, across which the voltameter is connected as a shunt, and R_2 is a large resistance permanently bridging the mercury cups. A diagram of the connections is shown in Fig. 2.

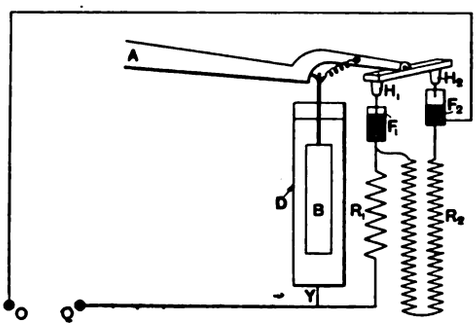

FIG. 2.—Diagram showing Connections.

Before the insertion of a coin the lever is in its higher position, and, the contact piece F_2 being out of the mercury, the current enters at the terminal O and passes through the resistance R_2 and out at Q to the lamps. When a coin is inserted the lever falls to its lower position, the resistance R_2 is short-circuited, and the lamps can burn at their normal brilliancy. It will be noticed that a low resistance R_1 is always in circuit, and it is to this that the copper voltameter is shunted. The anode being attached to the beam of the balance, as soon as a weight of copper has been removed equal to the weight of the coin dropped into the coin pan, the lever

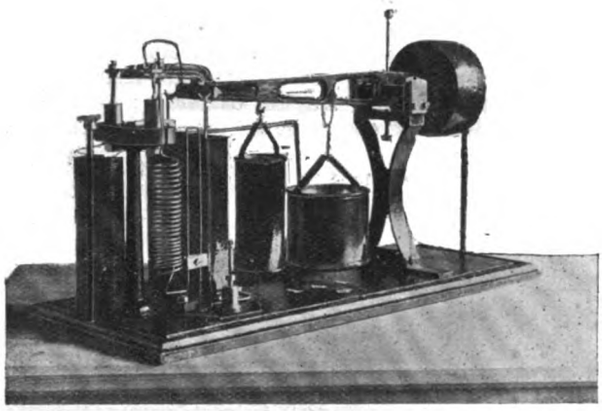

FIG. 3.—General View of Long-Schattner Prepayment Meter.

rises and the resistance R_2 is inserted, indicating to the consumer, by dimming the lamps, that he must either switch off or insert another coin. If the lamps are not switched off, and are left dim the company is not the loser as the voltameter remains shunted across the resistance R_1 and deposition of copper takes place, this being, so to speak, debited to the account of the next purchase of electrical energy. R_2 is calculated to produce a fall of pressure of about 70 volts when twenty 16 c.p. lamps are in use, but we think this is insufficient, for with a single 8 c.p. lamp the decrease of pressure by the insertion of this resistance would only be in the neighbourhood of two volts. True, if the decrease in brilliancy were not noticed, the extra energy consumed would be allowed for on the insertion of the next coin; and if attempts were made to cheat the meter in this way, the fact would be discovered by the inspector. Yet it would be best to avoid the possibility of such an occurrence.

The meter is designed for use with silver coins (3d., 6d. and 1s. pieces) whose weights vary approximately with their face values. Substitutes of baser metal would always be detected by the inspector, and there is no fear of loss by this means as in the case of an automatic meter in a public place, for of course the user of the instrument is responsible. The inspector who empties the coins from the meter is provided with a number of standard weights to replace them, and these compensate for any loss the consumer may have incurred by the use of worn coins, and at the same time afford a check on the inspector's takings. A new anode and cathode is needed every 700 units and these can be inserted without difficulty.

A uniform deposit of copper is ensured by leading the current to the top of the anode and away at the bottom of the cathode, and as a fairly low current density is employed, it is stated that there is no heating and no gassing even at higher loads. The creosote oil in the cup F_2 is said to be very effective in preventing sparking and preserving a clean contact at the break. A thin layer of ordinary machine oil is poured over the copper sulphate solution to hinder evaporation. Copper sulphate solution of 1·115 specific gravity is used, containing 1 per cent. of sulphuric acid. We are informed that the loss of pressure between the meter terminals is as follows:—

2 volts for 5 ampere meter, at 220 volts.
2 „ „ 10 „ „ „ 110 „
1 „ „ 5 „ „ „ 110 „

Fig. 3 is a general view of the instrument with the cover removed.

THE THEORY OF THE ROTARY TRANSFORMER.

BY GISBERT KAPP.

(COMMUNICATED BY LLEWELYN B. ATKINSON, A.M.I.C.E.)

(*Continued from page 116.*)

In the following investigations, Mr. Kapp assumes that the curves of E.M.F. and current are of sine form, stating that the effect of departure therefrom is not large. The case of single-phase converters both with and without phase displacement between E.M.F. and current is considered, and then the case of multiphase machines of 3, 4, and 6 phases.

Single-phase Rotary Transformer with Current in Phase.—In Fig. 3, the outer circle represents the winding, and d and f the

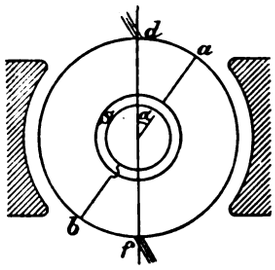

FIG. 3.

brushes for continuous current. The points a, b are connected to slip rings. The continuous current is taken as $2c$, so that each half of the armature has in it a current c. Assume that in the armature is an alternate current of effective value $2i$ and maximum value 2J. Let e be the E.M.F. of the continuous current, the effective value of the alternating E.M.F. will be $\frac{eK}{2}$, and the following equation shews the relation between the current input and output:

$$2i\,\frac{eK}{2} = 2ce,$$

given that

$$i = \frac{J}{\sqrt{2}}.$$

Then $\frac{2J}{\sqrt{2}}\,\frac{eK}{2} = 2ce$, whence $J = \frac{c2\sqrt{2}}{K}$, or $J = \eta c$.

The value of η depends on the ratio of the pole width to pole pitch, that is on the form and arrangement of the magnet fields, this ordinarily lying between $\frac{2}{3}$ and $\frac{1}{2}$. There is a

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further case of some theoretical interest, which Steinmetz has considered, where the field strength is of strictly sinusoidal value, and for these cases η assumes the values

In the theoretical case $\eta = 2$.
With pole with $\frac{2}{3}$ of the pitch $\eta = 1{\cdot}9$.
" " $\frac{1}{2}$ " $\eta = 1{\cdot}72$.

If d is the positive and f the negative brush, then, in the position shown in the figure, current enters at a and leaves at b, and when the armature is rotating synchronously the current is $2J \cos \alpha$. This current divides, and the current in each armature winding is $J \cos \alpha = \eta c \cos \alpha$. There is also superposed the armature current c, so that, taking the four sections, we have as the resultant current

in fa $\quad c(1 - \eta \cos \alpha)$,
" ad $\quad c(1 + \eta \cos \alpha)$,
" fb $\quad c(1 + \eta \cos \alpha)$,
" bd $\quad c(1 - \eta \cos \alpha)$.

If w is the ohmic resistance of the winding on unit angle of the armature $\left(\text{that is, } \frac{180^\circ}{\pi} = 57^\circ\ 19'\ 80''\right)$ the resistance of the sections of the half armature are $w\alpha$ and $w(\pi - \alpha)$ and the power lost in each section is

in fa and bd $\quad 2wc^2(1 - \eta \cos \alpha)^2 (\pi - \alpha)$,
ad and fb $\quad 2wc^2(1 - \eta \cos \alpha)^2 \alpha$.

In the time dt the heat developed is

$$dA = 2wc^2\{(1 - \eta \cos \alpha)^2(\pi - \alpha) + (1 + \eta \cos \alpha)^2 \alpha\} dt.$$

Taking the angular velocity as ω, the frequency as $\curvearrowright$, and the periodic time as T,

$$T = \frac{1}{\curvearrowright}, \quad \omega = 2\pi \curvearrowright, \quad \alpha = \omega t,$$

$$dt = \frac{d\alpha}{\omega}, \quad dt = \frac{d\alpha}{2\pi \curvearrowright}.$$

The energy lost in a half revolution is

$$\int_0^{\frac{T}{2}} dA.$$

The mean value of the lost power is

$$P_v \int_0^{\frac{T}{2}} \frac{2}{T} dA = \frac{\omega}{\pi} \int_0^{\frac{T}{2}} dA.$$

Substituting the value of dA, above obtained, and transforming the integral for the angle swept out in time $\frac{T}{2}$, we have

$$P_v = \frac{2wc^2}{\pi} \int_0^{\pi} (\pi - 2\pi\eta \cos \alpha + \pi\eta^2 \cos^2 \alpha + 4\eta d \cos \alpha)\, d\alpha.$$

The solution of this integral gives the following values for the quantities under the integral

$$\pi^2, \quad 0, \quad \frac{\pi^2\eta^2}{2}, \quad -8\eta.$$

Using these values, and working out for the values of η, before given, we obtain

For the theoretical limiting case, $\eta = 2$. $P_v = \frac{2wc^2}{\pi}\, 13{\cdot}66$,

$m = \frac{2}{3}$, $\quad \eta = 1{\cdot}9$ $P_v = \frac{2wc^2}{\pi}\, 12{\cdot}56$,

$m = \frac{1}{2}$, $\quad \eta = 1{\cdot}72$ $P_v = \frac{2wc^2}{\pi}\, 10{\cdot}71$,

m being the ratio of pole width to pole pitch.

Now the power which would be lost in the armature copper by the current $2c$ if the armature were mechanically driven is $2\pi wc^2$, so that taking the ratio of this quantity to the values here tabulated we obtain in each case the ratio between the output as a converter and as a mechanical generator thus:

In the limiting case $\quad \frac{c}{c_1} = \sqrt{\frac{\pi^2}{13{\cdot}66}} = 0{\cdot}85.$

when $m = \frac{2}{3}$ $\quad \frac{c}{c_1} = \sqrt{\frac{\pi^2}{12{\cdot}56}} = 0{\cdot}88.$

$m = \frac{1}{2}$ $\quad \frac{c}{c_1} = \sqrt{\frac{\pi^2}{10{\cdot}71}} = 0{\cdot}95.$

As the outputs are in these ratios, the losses remaining the same, it follows that the efficiencies in each are only the above fractions of the efficiencies of the machine as a mechanical generator. The above figures relate to the case where the E.M.F. and current of the alternating side are in phase. The effect will next be considered of their being out of phase, but it may be noted that it is always possible to regulate the phase by regulating the exciting current.

Single-Phase Rotary Transformer with Phase Difference between E.M.F. and Current.—Fig. 4 shows the case where the excitation is such that the maximum value of the current is

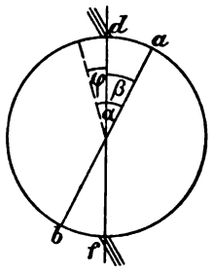

FIG. 4.

reached before the point of connection a has arrived at the brush d. If the angular displacement is ϕ, then $\alpha = \phi + \beta$.

The power in the alternate current is

$$\frac{2J}{\sqrt{2}}\, e\, \frac{K}{2} \cos \phi = 2ec.$$

$$J = c\, \frac{2\sqrt{2}}{K \cos \phi}$$

If we put $\quad \eta = \frac{2\sqrt{2}}{K \cos \phi}.$

$$J = \eta c$$

as before, only that η is now of greater importance.

It is unnecessary to repeat the process by which the following value of P_v is arrived at.

$$P_v = \frac{2wc^2}{\pi} \int_0^{\pi} \{(1 - \eta \cos \alpha)^2 (\pi - \beta)(1 + \eta\alpha \cos \alpha)^2 \beta\} d\alpha,$$

whence

$$P_v = \frac{2wc^2}{\pi} \int_0^{\pi} (\pi - 2\pi\eta \cos\alpha + \pi\eta^2 \cos^2\alpha + 4\eta\alpha \cos\alpha) d\alpha$$

$$- \frac{2wc^2}{\pi} \int_0^{\pi} 4\phi\eta \cos\alpha\, d\alpha.$$

The first integral is the same as with the current and E.M.F. in phase. The second is new. But, the value of the cosine integral between 0 and π being zero, this disappears, and this is independent of whether ϕ is positive or negative. In other words, it does not matter whether ϕ is positive or negative, except so far as it alters the value of η.

The solution of the first integral has before been given, and substituting the values we arrive at the following table:—

Output of Single-phase Transformers given in Percentages of the Output which the same Machine would give as a Continuous-Current Generator with the same Copper Heating.

cos ϕ.	1	0·9	0·8	0·7
Limiting theoretical case..	85	78	69	60
Pole width / Pole pitch $= \frac{2}{3}$	88	81	73	63
Pole width / Pole pitch $= \frac{1}{2}$	95	88	80	70

As will be noted, the machine of ordinary shape gives in every case a better effect than that in which the field strength follows a sine function. The case of multiphase rotary transformers now remains to be considered.

(*To be concluded.*)

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ON THE INFLUENCE OF THE THICKNESS OF AIR-SPACE ON TOTAL REFLECTION OF ELECTRIC RADIATION.*

BY J. CHUNDER BOSE, M.A., D.SC.

In my preliminary experiments on the determination of the index of refraction of various substances for electric radiation, I used a single semi-cylinder of the given substance; the electric ray was refracted from the denser medium into air, and at the critical angle of incidence it underwent total reflection. The experiment was repeated with two semi-cylinders separated by a parallel air-space. With light waves an extremely thin air-film is effective in producing total reflection. But a question might arise whether waves a hundred thousand times as long would be totally reflected by films of air, and, if so, it would be interesting to find out the minimum thickness of air-space which would be effective in producing this result, This point was raised by Prof. Lodge, at the discussion on my Paper "On a Complete Apparatus for the Study of the Properties of Electric Waves," read before the Liverpool meeting of the British Association last year. I have for some time past been engaged in an investigation of this subject. The factors which are likely to determine the effective thickness of air-space for total reflection are :—(1) the index of refraction of the refracting substance; (2) the angle of incidence; (3) the wave-length of the incident electric radiation. In the following investigation, I have studied the influence of the angle of incidence and of the wave-length in modifying the thickness of the effective air-space. The refracting substance used was glass.

I. *Influence of the Angle of Incidence.*—The great experimental difficulty in these investigations lies in the fact that there is at present no receiver for electric radiation which is very sensitive, and at the same time strictly metrical in its indications. This difficulty is further complicated by the fact that the intensity of the electric radiation cannot be maintained absolutely constant. For these reasons it is extremely difficult to compare the results obtained from different sets of observations. Attempts have been made in the following experiments to remove, to a certain extent, some of these difficulties. Two semi-cylinders of glass, with a radius of 12·5cm., were placed on the spectrometer circle. The plane faces were separated by a parallel air-space. The radiator was placed at the principal focus of one of the semi-cylinders; the rays emerged into the air-space as a parallel beam, and were focussed by the second semi-cylinder on the receiver placed opposite the radiator. Electric radiation was produced by oscillatory discharge between two small circular plates 1·2cm. in diameter, and an interposed platinum ball 0·97cm. in diameter. The two semi-cylinders were separated by an air-space 2cm. in thickness; this thickness was found to be more than sufficient for total reflection. The critical angle for glass I found to be 29°. I commenced my experiments with an angle of incidence of 30° (slightly greater than the critical angle). The receiver, which was placed opposite the radiator, remained unaffected as long as the rays were totally reflected. But on gradually diminishing the thickness of air-space by bringing the second semi-cylinder nearer the first (always maintaining the plane surfaces of the semi-cylinders parallel), a critical thickness was reached when a small portion of the radiation began to be transmitted, the air-space just failing to produce total reflection. The *beginning* of transmission could easily be detected and the critical thickness of air determined with tolerable accuracy. The slight discrepancy in the different determinations was due to the unavoidable variation of the sensitiveness of the receiver. When the thickness of air was reduced to 14mm., the receiver began occasionally to be affected, though rather feebly. But when the thickness was reduced to 13mm. there was no uncertainty; a measurable, though small, portion of the radiation was now found to be always transmitted.

I now increased the angle of incidence to 45deg., and observed that the minimum thickness, which at 30deg. just allowed a small portion of radiation to be transmitted, was not sufficiently small to allow transmission at the increased angle of incidence. The thickness had to be reduced to something between 10·3mm. and 9·9mm. for the beginning of transmission.

With an angle of incidence of 60deg., the minimum thickness for total reflection was found to be between 7·6mm. and 7·2mm.

Angle of incidence.	Minimum thickness of air for total reflection.
30°	Between 14 and 13 mm.
45°	,, 10·3 and 9·9 mm.
60°	,, 7·6 and 7·2 mm.

The minimum effective thickness is thus seen to undergo a diminution with the increase of the angle of incidence.

* Paper read before the Royal Society.

II. *The influence of the wave-length.*—In the following experiments I kept the angle of incidence constant, and varied the wave-length. I used three different radiators, A, B, and C; of these A emitted the longest, and C the shortest waves. The following method of experimenting was adopted as offering some special advantages. If a cube of glass be interposed between the radiator and the receiver placed opposite to each other, the radiation striking one face perpendicularly would be transmitted across the opposite face without deviation and cause a response in the receiver. If the cube be now cut across a diagonal, two right-angled isosceles prisms will be obtained. If these two prisms were now separated slightly, keeping the two hypotheneuses parallel, the incident radiation would be divided into two portions, of which one portion is transmitted, while the other portion is reflected by the air film in a direction (*see* Fig. 1) at right angles to that of the incident ray, the angle of incidence at the air-space being always 45deg. The transmitted and the reflected portions would be complimentary to each other. When the receiver is placed opposite to the radiator, in the A position, the action on the receiver will be due to the transmitted portion; but when the receiver is placed at 90deg., or in the B position, the action on the receiver will be due to the reflected portion. The advantage of this method is that the two observations for transmission and reflection can be successively taken in a very short time, during which the sensitiveness of the receiver is not likely to undergo any great change. In practice three readings are taken in succession, the first and the third being taken, say, for transmission, and the second for reflection.

I shall now give a general account of the results of the experiments. When the prisms are separated by a thickness of air-space greater than the minimum thickness for total reflection, the rays are wholly reflected, there being no response of the receiver in position A, but strong action in position B. As the thickness is gradually decreased below the critical thickness, the rays begin to be transmitted. The transmitted portion goes on increasing with the diminution of the thickness of air-space, there being a corresponding diminution of the reflected component of the radiation. When the thickness of the air-space is reduced to about 0·3mm., no reflected portion can be detected even when the receiver is made

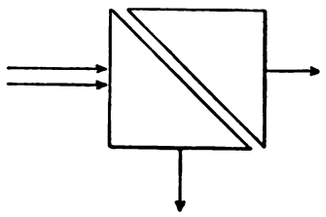

FIG. 1.—Section of the two Prisms.

extremely sensitive. The reflected component is thus practically reduced to zero, the radiation being now entirely transmitted; the two prisms, in spite of the breach due to the air-space, are electro-optically continuous. This is the case only when the two prisms are made of the same substance. If the second prism be made of sulphur, or of any other substance which has either a lower or a higher refractive index, there is always found a reflected portion even when the two prisms are in contact. Another interesting observation can be made by separating the prisms for total reflection. There would now be no transmitted portion. But if a thin piece of cardboard or any other refracting substance be now interposed in the air-space, a portion of the radiation will be found to be transmitted, and it will be found necessary to separate the prisms further to reduce the transmitted portion to zero.

Having given a general account of the experiments, I shall now describe the method of procedure. The radiator tube was provided with an ordinary lens whose focal distance for electric radiation is about 4 cm. The beam thus rendered approximately parallel fell perpendicularly on the face of the glass prism. The two prisms were made by cutting a cube of glass—an ordinary paper weight—across a diagonal. The size of the cube was 4·5cm. on each side.* One prism was fixed on the spectrometer circle; the other could be moved so as to vary the thickness of the interposed air-space between the two sections very gradually. The separation was simply effected by means of ordinary cards. The cards used were of uniform thickness, each card being 0·45mm. in thickness. A certain number of cards was taken and placed between the prisms with their surfaces in contact with the hypotheneuses. The cards were then carefully withdrawn, leaving the prisms separated by a thickness of air equal to the thickness of the given number of cards. It would, of course, be an improvement to have a micrometer screw by which the thickness may be gradually increased. Observations were now taken to determine the minimum thickness of air for

* Larger prisms would have been preferred had they been available. The prisms after cutting were found to be approximately isosceles, the angles being 90deg., 46deg., and 44deg.

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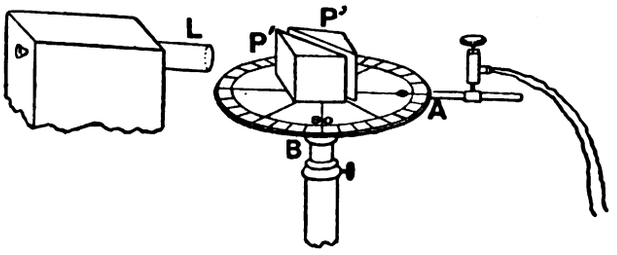
total reflection for different wave-lengths, the angle of incidence being in all cases kept at 45deg. Three radiators, R_1, R_2, R_3, were used. I have not yet made determinations of the lengths of wave emitted by these radiators, but it will be seen from the dimensions of the radiators that the waves emitted by R_1 are the longest and those emitted by R_3 the shortest. The oscillatory discharge in R_1 took place between two circular plates 1·2cm. in diameter and an interposed ball of platinum 0·97cm. in diameter. The radiators were enclosed in a tube 3·8cm. in diameter. In the radiator R_2, the discharge took place between two beads of platinum and an interposed sphere the same as in R_1. The distance between the sparking surfaces was 1·01cm. In the radiator R_3 sparking took place between two beads and an interposed sphere 0·61cm. in diameter. The distance between the sparking surfaces was 0·76cm. One prism was fixed on the spectrometer circle, and the other was at first placed somewhat apart from it; the distance was now gradually reduced till the air-space just ceased to reflect totally, when a small portion of radiation began to be transmitted. The beginning of transmission was detected by the receiver, which was placed in the A position. The detection of the beginning of tramsmission is, as has been said before, somewhat dependent on the sensitiveness of the receiver.

Radiator.	Distance between sparking surfaces in mm.	Minimum thickness for total reflection.
R_1	...	Between 10·3 and 9·9 mm. ..... (*a*)
R_2	10·1	„ 7·6 and 7·2 mm. ..... (*b*)
R_3	7·6	„ 5·9 and 5·4 mm. ..... (*c*)

From the above results it is seen that the effective thickness of the totally reflecting air-space increases with the wave-length. If the wave-lengths are proportional to the distance between the sparking surfaces which give rise to the oscillatory discharge, the wave-lengths in (*b*) and (*c*) are in the ratio of 101 : 76. This is not very different from the ratio of the corresponding minimum thicknesses of the totally reflecting air-space.



L is the lens to render the incident beam parallel; P, P', are the right-angled isosceles prisms; A and B are the two positions of the receiver. The receiver-tube is not shown in the diagram.

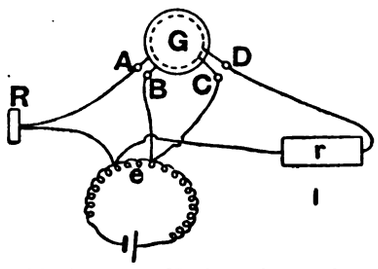
FIG. 2.

III. *On the Relation between the Reflected and the Transmitted Components of Radiation when the Thickness of Air-space undergoes Variation.*—In the general account of the experiments, I have said that as the thickness of air-space is gradually reduced the intensity of the transmitted portion of radiation is increased, while there is a corresponding diminution of the intensity of the reflected portion. This I have been able to verify qualitatively from numerous observations. But in making quantitative measurements many serious difficulties are encountered, owing to the difficulty of maintaining the intensity of radiation as well as the sensitiveness of the receiver absolutely constant.

As regards the first, the intensity of the emitted radiation depends on the efficiency of the secondary spark, and the nature of the sparking surface. Keeping the primary current that flows through the Ruhmkorff coil constant, the efficacy of the secondary spark is very much affected by the manner in which the contact is broken in the primary circuit. If a vibrating interrupter is used, the break is apt to become irregular; the torrent of the secondary sparks also spoils the sparking surface of the radiator. For merely qualitative experiments the use of a vibrating interrupter is not so very prejudicial, as along with the ineffective discharges there are present some which are oscillatory. But where successive discharges are to give rise to radiation of equal intensity, it becomes necessary to avoid all sources of uncertainty. For these reasons I prefer a single break for the production of a flash of radiation. With some practice it is possible to produce a number of breaks, each of which is effective. If the surface at the break is kept clean, and the break is properly effected, successive flashes of radiation up to a certain number are about equally intense. When the sparking has been taking place for too long a time, the surface no doubt undergoes a deterioration. But twenty or thirty successive sparks are equally efficacious when sparking takes place between platinum surfaces. The use of a single flash of radiation is preferable on another account. The receiver at each adjustment responds to the very first flash, but becomes less sensitive to the subsequent flashes. The conditions of the different experiments are maintained similar, when the action on the receiver is due to a single flash of radiation, instead of the accumulated effect of an unknown number of flashes. I give below the deflections of the galvanometer produced by four successive flashes of radiation.

(1) ..... 115 divisions.
(2) ..... 122 „
(3) ..... 113 „
(4) ..... 108 „

When very careful adjustments are made, the successive deflections are approximately equal. There are, however, occasional failures, owing either to the fault of the break, or loss of sensitiveness of the receiver. More serious is the difficulty in connection with the receiver. With the improvements adopted there is no difficulty, under any circumstances, to make the receiver very highly sensitive; but it is extremely difficult to maintain the sensitiveness absolutely uniform. I have in my previous papers explained how the sensitiveness of the receiver depended on the pressure to which the spirals were subjected, and on the E.M.F. acting on the circuit; and how the loss of sensitiveness due to fatigue was counteracted by slightly increasing the E.M.F. For each receiver there is a certain pressure, and a corresponding E.M.F., at which, for a given radiation, the receiver is sensitive. Having obtained these conditions, the sensitiveness can be increased or decreased to almost any extent by a slight variation of either the pressure or the E.M.F. An increase of pressure produced by the advance of the micrometer press screw through a fraction of a millimeter would sometimes double the sensitiveness; similarly an increase of E.M.F. of even $\frac{1}{100}$ volt increases the sensitiveness to a considerable extent. The nature of the difficulties in maintaining the sensitiveness of the receiver uniform will be understood from what has been said above. These difficulties are indeed great, and appear at first to be insuperable. But by very careful and tedious adjustments I was able on several occasions to obtain fairly satisfactory results, and was in hopes of ultimately obtaining metrical values from the galvanometer deflections. The setting of the rainy weather has unfortunately introduced other conditions unfavourable to the maintenance of uniformity of the sensitiveness of the receiver. Owing to the excessive damp and heat the spirals get rusty in a short time, and variation in the sensibility is produced by the altered condition of the surface of the sensitive layer. The results of certain experiments I have carried out lead me to hope that this difficulty will, to a certain extent, be removed by covering the sensitive surface with a less oxidisable coating.



G, the differential galvanometer; R, the receiver: *r*, the resistance box.

FIG. 3.

The deflections produced in the galvanometer can only be taken approximately proportional to the intensity of the absorbed radiation. It would be better to observe the diminution of the resistance produced by the incident radiation. This may be done with the help of a differential galvanometer and a balancing resistance. G is a high-resistance differential galvanometer, with two sets of electrodes, A, B; C, D; one pair of electrodes is in series with the receiver, and the other with a resistance box. When the receiver is adjusted to respond to the electric radiation, a weak current flows through it. The same E.M.F. acts on both the circuits. The compensating current, produced by a proper adjustment of the resistance of the box, brings the spot of light back to zero. The resistance of the box is equal or proportional to the resistance of the receiver. When radiation is absorbed by the receiver the resistance is decreased, and this diminution of the resistance is found from the new balancing resistance.

All observations agreed in showing that as the thickness of air-space was gradually decreased, the transmitted component was increased, with a corresponding decrease of the reflected portion. I give below two sets of observations, in which the receiver acted better than usual. The results are to be taken more as qualitative, as no reliance can be placed on the sensibility of the receiver being absolutely uniform.

Radiator R_1; distance between the sparking surfaces = 10·1mm.

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Thickness of air-space in terms of number of cards.	Thickness in mm.	Galvanometer deflection due to the reflected portion.	Galvanometer deflection due to the transmitted portion.
1	0·45	0 or very slight.	Against the stop.
2	0·90	Slight.	" "
4	1·8	80	160
8	3·6	145	150
10	4·5	150	120
12	5·4	160	100
16	7·2	Against the stop.	30
18	8·1	" "	0

It is seen from the above that, as the thickness of the air-space was gradually increased, the reflected component increased, while the transmitted portion decreased. The minimum thickness for total reflection was found to be about 8mm. When the thickness of air-space was reduced to about half this thickness (slightly less than half) the reflected and the transmitted portions seemed to be about equal. With the radiator R_1 the minimum thickness for total reflection was found to be about equal to the thickness of 22 cards (9·9mm.). When the thickness of air-space was reduced to the thickness of 10 cards (4·5mm.) the reflected and the transmitted portions seemed to be about equal. As two experiments immediately following each other are more likely to be comparable, the experiments were so arranged that the observation of deflection for *transmission* with a certain thickness of air followed the observation for *reflection* with a different thickness, the corresponding deflections being about equal. As stated above, the reflected and the transmitted portions were approximately equal when the thickness of air was equal to the thickness of 10 cards. Keeping 10 as the mean, pairs of readings were taken with different thicknesses. For example, the reflection reading with a thickness of air equal to the thickness of four cards was followed by taking a reading for transmission, with a thickness of air equal to the thickness of 16 cards; the deflections produced in the two cases were about equal, *i.e.*, 66 divisions of the scale.

I append below a table showing the corresponding thicknesses of air (in terms of number of cards) which gave approximately equal deflections, the deflection in one case being due to the reflected component, and in the other case to the transmitted component. The receiver was made moderately sensitive, so that the deflections lay within the scale. When the thickness of air was reduced to 0·45mm. a deflection of two divisions was obtained for the reflection reading. From this an approximate idea of the intensity of the reflected component may be obtained. Half the total radiation gave a deflection of 120 divisions. The intensity of the reflected component, with a thickness of 0·45mm., is, therefore, $\frac{1}{120}$th part of the total amount of incident radiation, on the assumption, which is only approximate, that the galvanometer deflections were metrical. When the thickness was reduced to 0·3mm., no reflected component could be detected, though the receiver was made extremely sensitive.

Thickness of air for reflection.	Thickness of air for transmission.	Deflection produced.
4	16	66
6	14	70
8	12	90
10	10	120

BOOKS RECEIVED.

"The Official Gazette of the United States Patent Office," No. 6, Vol. LXXXV. Alphabetical Lists of Patentees and Inventions, with Index, for Quarter ending June 30, 1898. (Washington: Government Printing Office.)

"Fortschritte der Elektrotechnik," 1897. No. 5. By Dr. Kahle. With Patent Register compiled by Dr. Borns. (Berlin: Julius Springer.)

The "Mechanical World" Pocket Diary and Year Book for 1899. (Manchester: Emmott and Co., Limited.) Price 6d.

ELECTRICITY WORKS ACCOUNTS.

Dewsbury Municipal Electricity Supply Works.

Our first table this week contains analyses of the Dewsbury accounts for the *fifteen months* ended March 31,1897, and for the *year* ended March 31, 1898, this latter period being the third completed year of working, electricity supply having started at Dewsbury on December 10, 1894.

Of the £25,000 of authorised capital, £24,881 has been received, borrowed at rates varying from 2½ per cent. to 3¼ per cent., £500 at 3 per cent., and £100 at 3¼ per cent. has been repaid. The expended capital at March 31st last amounted to £25,308, representing £92 per kilowatt of generating plant. During the last year under consideration the number of consumers has increased by 34, bringing the total up to 101. Corresponding with this the equivalent 8-c.p. lamp connection has increased from 6,817 to 8,056, or about 28 per cent.

The output for the year was 145,474 units sold, as compared with 150,878 for the preceding 15 months, showing a rise, estimated *pro rata*, of a little over 20 per cent. Consequent upon the introduction of the maximum demand system of charging for supply to public and private lamps, the average price obtained per unit has dropped from 5·94d to 4·65d.

A reduction of a little more than a farthing in the total cost per unit somewhat relieves the disappointing state of affairs betrayed by the slow increase in the business done, and the works costs at 1·65d. per unit are very satisfactory considering the low output. Management and property charges, as is to be expected, are high, but the figures representing these costs should, in all fairness, be discounted when we notice the electricity undertaking saddled with such items as "Town Hall Charges," £306; and "Diamond Jubilee Illuminations," £80.

A working profit of £935 has been made representing 3·78 per cent. of the mean capital. £682 has been allocated to the sinking fund, £732 paid as interest on loans and an adverse balance of £146 from the preceding period of working has resulted in a deficit of £625.

Bury Municipal Electric Supply Works.

Started on November 5, 1896, electric supply at Bury has completed but one year of existence. Our tables deal respectively with the accounts for the period from November 5, 1896, to March 31, 1897, and for the year ended March 31, 1898. The total authorised capital stands at £30,000. £28,595 has been borrowed, of which £50 has been repaid. The capital expended at March 31st last was £25,513, being at the rate of £84 per kilowatt of generating plant installed.

During the year the number of consumers has more than doubled, having increased from 41 to 84. The equivalent 8-c.p. lamp connection has risen from 2,481 to 6,155, or 150 per cent. The output for the year was 64,462 units sold, for which an average price of 4.91d. per unit was obtained.

Total costs at 2·9d., and works costs at 1·6d. per unit, are exceedingly satisfactory results at an output of only 64,000 units, especially during the first year of working, and we hope it will be found possible to maintain the satisfactory position and progress.

A working profit of £540 has been made, £548 paid in redemption of debt, and £570 as interest on loans, leaving a deficit of £579, which, like that of the preceding period, has been met by the rates.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Ayr (Municipal)	Nov. 11	Kens'gton & Knightsbr'ge (Co.)	Sept. 30
Bedford (Municipal)	Mar. 4	Kingston-upon-Hull (Municipal)	Aug. 19
Belfast (Municipal)	Sept. 23	Kingston-upon-Thames (Mun.)	Mar. 25
Blackpool (Municipal)	Oct. 7	Lancaster (Municipal)	Oct. 21
Bournemouth (Company)	June 3	Leeds (Company)	April 8
Bradford (Municipal)	May 20	Leyton (Municipal)	Sept. 23
Brighton (Municipal)	May 6	Liverpool (Municipal)	Aug. 12
Bristol (Municipal)	July 29	Manchester (Municipal)	July 29
Burnley (Municipal)	Sept. 16	Newcastle-upon-Tyne (Co.)	April 29
Burton-upon-Trent (Municipal)	April 15	Northampton (Company)	April 15
Cambridge (Company)	June 17	Notting Hill (Company)	Mar. 11
(Central) Kensington (House-to-House (Company)	Sept. 30	Nottingham (Municipal)	Oct. 28
Charing Cross (Company)	April 22	Oldham (Municipal)	Nov. 18
Chelsea (Company)	May 20	Oxford (Company)	April 1
Cheltenham (Municipal)	Oct. 7	Portsmouth (Municipal)	Nov. 4
Chester (Municipal)	Oct. 14	Preston (Company)	Oct. 28
Clerkenwell (Company)	Mar. 18	Reading (Company)	Sept. 16
Dover (Company)	Mar. 11	Richmond (Company)	Mar. 4
Dundee (Municipal)	Nov. 4	Scarborough (Company)	April 1
Eastbourne (Company)	July 22	St. James' & Pall Mall (Company)	July 1
Edinburgh (Municipal)	Oct. 14	St. Pancras (Vestry)	May 13
Exeter (Municipal)	Aug. 5	Shoreditch (Vestry)	May 27
Glasgow (Municipal)	Aug. 12	Southampton (Municipal)	June 3
Guildford (Company)	May 13	Stafford (Municipal)	Oct. 21
Halifax (Municipal)	Nov. 18	Sunderland (Municipal)	Aug. 19
Hammersmith (Vestry)	June 10	Taunton (Municipal)	Aug. 5
Hampstead (Municipal)	Sept. 9	Tunbridge Wells (Municipal)	July 22
Hanley (Municipal)	April 8	Walsall (Municipal)	Nov. 11
Harrow (Company)	Sept. 9	Wandsworth (Company)	Mar. 18
Hastings & St. Leonard's (Co.)	April 29	Westminster (Company)	April 22
Hove (Company)	May 6	Wolverhampton (Municipal)	July 15
Huddersfield (Municipal)	Mar. 25	Worcester (Municipal)	May 13
Islington (Vestry)	June 24	Yarmouth (Municipal)	June 17

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	DEWSBURY.		BURY.	
Undertaking Worked by	Dewsbury Corporation.		Bury Corporation.	
Date of Commencement of Supply	1894.		1896.	
System of Supply	3-wire continuous current.		3-wire continuous current.	
Chief Engineer	John B. Mitchell.		S. J. Watson.	
YEAR ENDED	MAR. 31, **1897.***	MAR. 31, **1898.**	MAR. 31, **1897.***	MAR. 31, **1898.**
QUANTITIES—				
Units generated	166,398	152,805	—	71,844
,, **SOLD (TOTAL)**	**150,878**	**145,474**	**11,811**	**64,462**
,, sold to consumers	148,359	141,527	11,811	59,964
,, sold for public lighting, &c.	2,519	3,947	—	4,498
,, used on works	1,744	1,109	—	3,782
UNITS SOLD PER 8 C.P. LAMP CAPACITY	19·3	16·9	1·24	6·79
Maximum supply demanded	125 kilowatts	150 kilowatts	44 kilowatts	91 kilowatts
Number of public lamps	6 arc	14 arc, 16 glow[a]	—	4 arc[a]
Number of consumers	67	101	41	84
Connections to mains in 8-c.p. lamps	6,317	8,056	2,481	6,155
CAPACITY OF PLANT IN 8-C.P. LAMPS	7,815	8,600	9,500	9,500
CAPACITY OF PLANT IN KILOWATTS	250	275	304	304
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£25,000 / £100	£25,000 / £91·0	£30,000 / £98·7	£30,000 / £98·7
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	25,000 / 100	25,000 / 91·0	30,000 / 98·7	30,000 / 98·7
RECEIVED (TOTAL)	**24,558 / 98·3**	**24,881 / 90·4**	**21,539[b] / 70·9**	**23,595 / 77·6**
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	24,506 / 98·0	24,881 / 90·4	21,539[b] / 70·9	23,595 / 77·6
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	**494 / 1·97**	**119 / 0·43**	**8,461 / 27·8**	**6,405 / 21·1**
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	494 / 1·97	119 / 0·43	8,461 / 27·8	6,405 / 21·1
REPAID (TOTAL)	**600 / 2·40**	**600 / 2·18**	— / —	**50 / 0·164**
RESERVE OR SINKING FUND	**1,024 / 4·10**	**1,723 / 6·26**	**210 / 0·691**	**714 / 2·35**
DEPRECIATION FUND	— / —	— / —	— / —	— / —
EXPENDED (TOTAL)	**24,212 / 97·0**	**25,303 / 92·0**	**19,128 / 62·9**	**25,513 / 83·9**
Lands and buildings	4,835 / 19·3	4,933 / 17·9	7,933 / 26·1	7,958 / 26·2
Plant	11,285 / 45·2	11,823 / 43·0	6,776[c] / 22·3	8,909 / 29·3
Mains	6,454 / 25·8	6,791 / 24·7	4,247 / 14·0	8,355 / 27·5
Miscellaneous	1,638 / 6·56	1,756 / 6·38	173 / 0·569	291 / 0·957
BALANCE OF CAPITAL ACCOUNT	+294 / +1·18	−422[d] / −1·53	+2,411 / +7·93	−1,918[d] / −6·31
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	**£3,733 / 5·938d.**	**£2,820 / 4·653d.**	**£288 / 5·855d.**	**£1,318 / 4·910d.**
Revenue from supply	3,632 / 5·778d.	2,702 / 4·460d.	273 / 5·550d.	1,198 / 4·460d.
,, meters, &c.	56 / 0·089d.	84 / 0·139d.	8 / 0·163d.	41 / 0·153d.
,, public lighting	—[e] / —	—[e] / —	7 / 0·142d.	80 / 0·298d.
,, sale of lamps, &c.	— / —	— / —	— / —	— / —
,, miscellaneous sources	45 / 0·072d.	34 / 0·056d.	— / —	— / —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	**£2,119 / 3·370d.**	**£1,885 / 3·110d.**	**£252 / 5·121d.**	**£779 / 2·900d.**
WORKS COSTS	**1,196 / 1·901d.**	**1,002 / 1·653d.**	**170 / 3·455d.**	**429 / 1·598d.**
Generation of electricity	*1,130 / 1·797d.*	*952 / 1·570d.*	*169 / 3·435d.*	*402 / 1·498d.*
Fuel (including cartage, &c.)	410 / 0·652d.	332 / 0·548d.	51 / 1·036d.	132 / 0·492d.
Oil, waste, water, stores	147 / 0·234d.	126 / 0·208d.	23 / 0·468d.	48 / 0·179d.
Wages at station	418 / 0·665d.	362 / 0·597d.	94 / 1·910d.	200 / 0·745d.
Repairs and maintenance at station	155 / 0·246d.	131 / 0·216d.	1 / 0·020d.	23 / 0·086d.
Distribution of electricity	*43 / 0·068d.*		— / —	*15 / 0·056d.*
Wages, &c.	7 / 0·011d.		— / —	
Repairs, renewals of mains, &c.	36 / 0·057d.	50 / 0·083d.	— / —	15 / 0·056d.
Public lighting	*23 / 0·037d.*		*1 / 0·020d.*	*12 / 0·045d.*
Attendance				7 / 0·026d.
Renewals	23 / 0·037d.		1 / 0·020d.	5 / 0·019d.
MANAGEMENT AND PROPERTY CHARGES	**923 / 1·468d.**	**883 / 1·456d.**	**82 / 1·666d.**	**350 / 1·304d.**
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*119 / 0·189d.*	*93 / 0·153d.*	*20 / 0·407d.*	*150 / 0·559d.*
Management	*804 / 1·279d.*	*790 / 1·304d.*	*62 / 1·260d.*	*200 / 0·745d.*
Salaries	323 / 0·514d.	275 / 0·454d.	55 / 1·118d.	177 / 0·660d.
Stationery, &c.	32 / 0·051d.	41 / 0·068d.	7 / 0·142d.	9 / 0·034d.
Establishment charges		52 / 0·086d.	— / —	
Law charges, &c.	449[b] / 0·714d.	422[f] / 0·696d.	— / —	14 / 0·052d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	**£1,614 / 7·22%**	**£935 / 3·78%**	**£36 / 0·188%[f]**	**£540 / 2·42%**
Sum carried to Depreciation Fund	— / —	— / —	— / —	— / —
Sum carried to Reserve or Sinking Fund	1,171[c] / 5·24%	682 / 2·75%	210 / 1·098%[f]	548 / 2·45%
Net interest on loans (incl. Debenture charges)	887 / 3·96%	732 / 2·96%	455 / 2·378%[f]	570 / 2·55%
BALANCE FROM LAST ACCOUNT	**297 / 1·33%**	**−146 / −0·59%**	— / —	— / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	— / —	— / —	— / —
Deficit	*146 / 0·653%*	*625 / 2·52%*	*629[e] / 3·286%[f]*	*579[e] / 2·59%*
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	56·8%	66·9%	87·5%	59·1%
Expenditure per kilowatt capacity	£8. 9s. 7d.	£6. 17s. 1d.	16s. 7d.	£2. 11s. 2d.
REVENUE PER KILOWATT CAPACITY	**£14. 18s. 5d.**	**£10. 5s. 2d.**	**18s. 11¼d.**	**£4. 6s. 9d.**
Expenditure per 8-c. lamp capacity	5s. 5½d.	4s. 4½d.	6½d.	1s. 7⅜d.
REVENUE PER 8-C.P. LAMP CAPACITY	**9s. 6⅜d.**	**6s. 6⅜d.**	**7¼d.**	**2s. 9¼d.**
REVENUE PER 8-C.P. LAMP CONNECTED	**11s. 10d.**	**7s. 0d.**	**2s. 4d.**	**4s. 3½d.**
Price charged for lighting, per unit	6d.	6d. to 3½d.[g]	6d.	6d. to 3d.[g]
Price charged for power, per unit	3d.	3d.	3d.	2½d.
Price charged for public lighting	6d. per unit	6d. to 3½d.[g]	—	£20 per arc per annum.

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BRITISH PATENT LAW.

Our patent law has one peculiarity which, in our opinion, gives it a great advantage over that of other countries, namely the Provisional Specification. In spite of the carping of some would-be reformers, inventors as a rule are clearly of the same opinion, since they seldom avail themselves of the privilege allowed them of filing a complete specification in the first instance. When the publication of an abandoned provisional was prohibited by the Act of 1888, the only objection to such specifications which carried weight, as compared with their countervailing advantages, was, we think, done away with. A man may now file a provisional specification in a hurry to secure priority, and if he afterwards finds he has made a mistake can abandon it, without having it afterwards brought up in judgment against him to invalidate a patent granted on his later application. An historical sketch of the origin and development of the Patent Specification, including the birth of the provisional specification under the Act of 1852, is given in a book by Mr. Robert Frost, a notice of which will be found in another column. The practice in the Patent Office as regards grants of patents, oppositions thereto and amendments of specifications is very amply dealt with in this treatise. The author expresses regret that no official searches are made before a patent is granted, and thinks it would be a real benefit to inventors and the public if the Comptroller had power to refuse a patent on the ground of lack of novelty and invention, and that much expense would be saved to persons wrongly supposing themselves to be true inventors. Here our views do not accord with those of Mr. Frost. The suggested right of patentees to be saved expense by such means does not, we must confess, greatly impress us. In the first place it seems to ignore the ground on which a patent is granted, namely, that there is a bargain between the inventor and the State quite independent of the fees paid, which are merely a matter of office administration. The inventor alleges that he has valuable information to communicate, in consideration whereof the State grants him a patent, subject to a proviso that it shall cease if the information, which the

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patentee has vouched for as valuable, proves to be valueless. Before the 1883 Act, when considerable sums were paid in advance, there may have been some hardship; but now that the fees are comparatively small and paid annually, it seems that the patentee gets strictly what he bargains for, namely, annual protection for an annual fee, with the right of renewal for 14 years, so long as the original consideration upon which the grant was made does not prove to have been illusory. Moreover, it seems unreasonable to suggest that the State should be required to maintain an army of skilled searchers sufficient to deal efficiently and expeditiously with thousands of applications on every conceivable subject, in order to tell every would-be patentee upon payment of a fee of £1, what he could learn upon payment to a patent agent of a fee more commensurate with the trouble his inquiry entails. If he is to have the right to get this information from the State, the initial fee on applying for a patent must be considerably increased, whereby the inestimable boon now enjoyed by inventors of getting provisional protection very cheaply would be taken away. But whether or not this is the right view to take, we emphatically dissent from Mr. FROST'S view that inventors would benefit by a change in the law such as he advocates. It is clearly only justice to an inventor that he should have the merits of his invention tried by the most competent tribunal. There are many cases where the question of anticipation is of such a difficult character, that it can only be justly decided after hearing the ablest scientific evidence, involving a trial which is quite unsuited to the Patent Office. If there were a right of appeal, which the author admits to be necessary, the inventor at the very inception of his undertaking, and before he has had time to prove the value of his invention, would find himself embarked in a costly patent litigation, which he might otherwise have avoided for several years, if not altogether, and in the meantime he would probably have found his invention either not worth fighting for, or else of an established value such as would enable him to provide for the cost of its defence. The alternative system of the refusal of a patent upon the *ipse dixit* of the Comptroller, acting on the report of an examiner, would undoubtedly result in many meritorious inventions being nipped in the bud, while the grant of a patent under such a system would merely imply a somewhat lesser probability than under the present practice that the patent would be afterwards upset.

A matter of historical interest, referred to in Mr. FROST'S book, is the rule of construction which has been adopted by the Courts at different times. So hateful had the monopolies granted in the reigns of Elizabeth and James I. become, that the statute passed in the twenty-first year of the last-named sovereign's reign, and which still remains the foundation of our patent law, was at first construed by judges with an eye directed chiefly towards its restrictive aspect; consequently, the tendency of the courts was to try and find out how the patentee could be defeated. Some generations passed before the recollection of the old oppressive patents of monopoly died out, when at length it came to be recognised that the statute was an enabling law, and that the patentee might be a person to be encouraged. The pendulum then for some time swung in an opposite direction, judges adopting what has been called a benevolent construction and trying to help the patentee as much as possible to maintain his patent. These oscillations have now settled down, and the judicial machine, like other good philosophical instruments, has become more dead beat. At the present time specifications are construed by our courts like other documents, simply by what they may with fairness both to the patentee and the public be taken to mean.

REVIEWS.

Law and Practice Relating to Letters Patent for Inventions. By ROBERT FROST, B.Sc. (Lond.). Second Edition. (Stevens and Haynes.)

The first thing which must strike anyone who takes up a modern treatise on patent law is its great bulk, and he will naturally inquire whether the subject might not have been dealt with equally efficiently in fewer pages. Mr. Frost tells us in his preface that his end has been to produce a work which in a reasonable compass shall reliably state the law of England in reference to letters patent. The second edition has been largely rewritten and added to, but by condensing the type in various ways the author has obviated the necessity, which might otherwise have been imperative, of putting his treatise into two volumes. When one comes to analyse the reasons for this prolixity it is found to be due in a great measure to repetition, and that of a kind which is common in legal text-books, perhaps in those of patent law more than any others, though we think that in certain matters Mr. Frost has carried it rather further than usual. For instance, in the chapter on specifications, which is, on the whole, a very good one, he treats of claims in a separate section, and there repeats a great deal which has been said before in dealing with the specification generally, sometimes in the very same words. The index of cases cited gives many which appear in more than 20 different places; though it is fair to the author to say that one case quoted 24 times in his book appears 32 times in another standard work.

Like other authors, Mr. Frost considers, under three headings, the elements required to maintain a patent, forming separate chapters on subject matter, novelty, and utility respectively. It may be convenient for the technical pleadings of a lawsuit, although we doubt whether even this is necessary, to keep these three things separate as grounds of objection to the validity of a patent; but by doing so in a treatise it is almost impossible to avoid overlapping, particularly as regards the first and second heads. In order to get a good patent it is not sufficient that the thing claimed should be merely new and useful, new, that is to say, in the sense of doing what has not been done before. You cannot claim the application of a known contrivance to a new purpose, unless there is some ingenuity in the application. There must be invention, useful invention, to provide subject matter for a patent; and saying this you cover the whole field dealt with in these chapters. The judicial decisions on subject matter mostly include the question of novelty also, and by treating both together not only would much space be saved, but we believe a clearer view of the subject would be obtained.

As to the amount of invention which is sufficient to support a patent, the law has laid down no very certain line. In the famous braided wire bustle case the patentee was held to be just inside the line, while in a more recent case a useful application of celluloid as a coating for boot eyelets was marked as just outside. Both these cases were decided by the House of Lords, where their lordships, as well as the judges below, showed considerable differences of opinion. It is interesting to notice that, of the cases quoted by the author on this part of the subject, no less than 33 were decided adversely to the patentee, while in only eight was the patent sustained. He has here, perhaps, unconsciously suggested a kind of empirical formula for the guidance of persons who hope to maintain patents for inventions of trifling merit, whereby they may learn that the odds against their succeeding is rather more than 4 to 1, probably a pretty near approximation to the truth.

A chapter is devoted to Specifications, and contains some interesting historical notes, and the all important questions as to the Patent Office procedure in granting of patents, in the event of amendments or oppositions, are treated fully. In so complete a treatise we need not look for much omission, but we are rather surprised to find no comment upon what is, perhaps, to the general public the most remarkable event since the passing of the Act of 1883. We refer to the order of the Board of Trade made during the current year directing the grant of the first compulsory licence. This weapon, which had

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for 15 years remained almost forgotten in the armoury of the State, may now be considered as placed on the efficient list for service as a defence against a patent that is used oppressively.

The inventor who, on taking up the work before us, has been appalled by the magnitude of the subject, will no doubt lay it down with a chastened conviction that he and his class have no monopoly of the inventive faculty, while, if not of a most sanguine disposition, he may despair of ever effecting his escape from the manifold pitfalls which the cruel ingenuity of the lawyers has laid for him.

Wireless Telegraphy. By RICHARD KERR, F.G.S., with a Preface by W. H. PREECE, C.B., F.R.S. (London: Seely and Co. 1898.)

This little book of some 100 small pages attempts to explain in popular language the ideas which underlie the various systems of wireless telegraphy, and to describe the apparatus employed for its practical application. An inadequate amount of space is taken up by a biographical appreciation of Lindsay; it should be remembered that—as Mr. Preece also points out in his preface—this indefatigable worker was not the first wireless telegraphist. The discussion of the relative claims of Lodge and Marconi to priority of invention might without harm have been omitted, or merely dismissed with the statement that, although the possibility of telegraphing by means of Hertzian waves had clearly been indicated theoretically and experimentally by Lodge and others, the first successful experiments over long distances were carried out by Marconi. Cutting down the letterpress in these respects would have left space for a more complete description of the actual apparatus used, and a slightly fuller elucidation of the theory upon which its design is based. As it is, not even the general principles are enunciated in such a way as to enable them to be grasped by the lay mind. The best that we can say for the production is that for a shilling it will possibly enable the large section of the public, which has not had the benefit of scientific training, to learn as much—or as little—about the new methods of telegraphy as it knows of those methods in which line wires are employed. Good portraits of Mr. Preece, Dr. Lodge and Signor Marconi are among the illustrations.

Die Entwickelung der asymptotischen Telegraphie, der sogenannten elektrischen "Telegraphie ohne Draht," in allgemein verständlicher Darstellung sachlich und historisch erläutert. By Dr. RUDOLF BLOCHMANN. (Berlin: E. S. Mittler and Son. 1898.)

In spite of the length of the title, this is merely a 30-page pamphlet containing an expanded reprint of an article which appeared in the May number of the *Marine Rundschau*. It is a general description in simple language of the methods of telegraphing without line wires, and will probably be intelligible to anyone who has been through a good school course of electricity, and possesses, in addition, a knowledge of the German language. No great historical or technical accuracy is attained. When we say simple language we must except, however, the two monstrosities "Asymptotische Telegraphie" and "Hydrotelegraphie." If German pedantry cannot permit the use of the term "wireless telegraphy," on the ground that wires are essential at the transmitting and receiving stations, let it employ some such an expression as "Telegraphie ohne *fortlaufende* Drähte." The author does not make it quite clear why he considers this form of telegraphy asymptotic. "Asymptotische Telegraphie" he divides into three varieties—Hydro-, Induktions- and Strahlentelegraphie. The two latter titles are self-explanatory. Hydrotelegraphie is applied to that form of conduction telegraphy in which earth-plates take the place of the line-wire, although Dr. Blochmann is not oblivious to the fact that his method can be used for telegraphing across land as well as across water,

Les Ondes Electro-Magnetiques et la Telegraphie sans Fils. By A. DELLA RICCIA. (Liège: Imprimerie de la Meuse. 1898.)

Although also a reprint, this book is of quite a different character to the preceding. Lieut. Della Riccia's contribution to the subject of Hertzian telegraphy was first presented as a Paper to the Association des Ingénieurs Électriciens sortis de l'Institut Électrotechnique Montefiore, and has now been reprinted from the *Bulletin* of that Society. The author confines himself to the consideration of wave telegraphy by Signor Marconi's methods, and the book is rendered the more interesting by the fact that the author, who is a lieutenant in the Italian engineers, has been in continuous correspondence with Signor Marconi during the latter's experiments, and gives particulars of them which in many cases have not been published hitherto.

After a description of the apparatus used by Marconi, an explanation is given of the mechanism of the propagation of the electromagnetic waves in the ether. The treatment of this part of the subject is not beyond criticism, but it is the second part of the book, "Critical Examination of the Apparatus," that calls more particularly for our attention. This part begins with the modest disclaimer:—

Je déclare que plusieurs des idées que j'exposerai, à défaut des recherches expérimentales directes et de recherches analytiques avisées, n'ont pas un fondement bien certain; la pratique en sanctionerra peut-être quelques-unes et en rejettera d'autres. Mais mon intention est tout simplement d'attirer sur certains sujets l'attention de personnes plus compétentes que moi, afin que la nouvelle application puisse bientôt bénéficier de leur enseignement.

But even if Lieut. Della Riccia himself has not made many experiments, he appears to have thoroughly acquainted himself with all the details of those carried out by Marconi, and his theoretical explanations of the various phenomena observed under different combinations of these details, together with the deductions he draws from his investigations, make most interesting reading. The pieces of apparatus are considered one by one. In connection with the primary generator we note that, in his experiments at Dover (unfortunately written "Dower" throughout the book, in spite of the French name for the town being Douvres), Marconi tried severally a Tesla and a Thomson oil coil in place of the usual induction coil, but he found that the latter always gave the better results. A most ingenious hypothesis is advanced to explain why vertical wires in connection with the transmitting and receiving apparatus give better results than horizontal wires. The view put forward is that in the latter case, when the ray from the radiator is polarised in the plane of incidence, a deleterious interference takes place with the ray reflected from the surface of the sea. For a similar reason the author considers it advantageous to place the radiator itself (and also the resonator) with its knobs in a vertical line. With this arrangement, however, the bubbles from the oil between the knobs have a disturbing influence; this latter effect is less marked if smaller knobs be used.

Marconi wrote from Dover:—

It was determined that there is no advantage in employing a Righi radiator, as one can obtain the same effects by using two simple knobs (of about 2cm.) separated by a layer of air, as dielectric, having determined experimentally the most advantageous explosive distance. It is also interesting to know that, when sufficiently long vertical conductors are employed, it is unnecessary to rub or clean the surface of the knobs at the place where the sparks are formed.

During his experiments in the Isle of Wight, Marconi employed five knobs of 5cm. diameter, platinised where the sparks occur, and also without oil. Lieut. Della Riccia is of opinion, however, that the substitution of air for vaseline oil, as a dielectric, is a retrograde step. Marconi appears also to have made some rough quantitative experiments to arrive at a law connecting the length of the wire with the distance over which signals can be transmitted.

In the experiments made at Salisbury . . . it was ascertained that the distance, to which it is possible to correspond, increases more rapidly than in simple proportion to the length of the two vertical wires. However, it could not be determined whether the useful distance increases with the square of the length of the vertical conductors. Using kites designed by Capt. Baden Powell, and a rubber-covered copper wire of 2mm. diameter and 70 metres long for the double purpose of aërial conductor and kite-string, it was always possible . . . to correspond to a distance of 16 kilometres across country covered with little hills. Another test with a longer vertical wire (nearly 200 metres) gave satisfactory results to a distance of 54 kilometres (Salisbury to Bath).

At Dover the law of squares was verified in the case of wires 10 and 30 metres high. In the experiments between Alum Bay and Bournemouth the vertical conductors were 40 and 80 metres long respectively. Moving vessels with 16 metres of vertical wire attached to the masts were communicated with to a distance of 20 kilometres, even where there were natural obstacles such as elevated islands between the apparatus. Messages were also successfully transmitted 8 kilometres

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through a hill whose base was 4 kilometres wide and whose height exceeded that of the longest mast by about 40 metres. In all these experiments induction coils were used capable of giving a 20cm. spark. The following notes are also interesting:—

In other experiments, also made at Salisbury, it was found advantageous . . . to employ, instead of one vertical wire, several parallel vertical wires about 30 metres apart each connected at the lower end to the same pole of the radiator. The same increase in the signalling distance can be obtained by using a wide network or metallic sheet in place of the parallel conductors. At the receiving station, an opposite effect, so to speak, was observed; that is to say, a greater distance when using a thin vertical wire, and no advantage in employing multiple wires or metallic sheets. At Dover it was found that on attaching large plates or capacities to the upper ends of the vertical, or nearly vertical, wires, the length of wire necessary for a given distance could be considerably reduced, in some cases, by using cylinders 1 metre long and 50cm. diameter. The length could be reduced to a third of what was necessary without capacity. . . .

In the Alum Bay trials:—

. . . It was found that when the length of the two wires is different, the effects can be greatly improved and brought to nearly the same value as when the two lengths are equal, by introducing in the shorter wire a coil or solenoid of thick well-insulated wire, with a certain capacity and self-induction. The number of turns of wire of this coil is determined by trial.

The author, while doubting strongly the reality of the curvature attributed to the electromagnetic rays in Mr. Preece's famous Royal Institution lecture, does not agree with the view that the rays actually traverse obstacles such as hills, &c.; he suggests instead a sort of diffraction effect. He is also sceptical about Marconi's statement that the distance over which communication can be maintained is greater in rainy weather. The only useful effect of the rain, according to Lieut. Della Riccia, might be to increase the capacity of the aërial conductors by wetting the insulation. The rain falling between the two stations would, he believes, cause a loss of electromagnetic energy, in the form of currents, induced in the drops.

Within the limits of this review we have, of course, only been able to touch on some of the various points raised by Lieut. Della Riccia. Those of our readers interested in the subject of Hertzian telegraphy should read his paper in its entirety.

RUNNING SHUNT DYNAMOS IN PARALLEL.

BY ARNOLD PHILIP, B.SC.

The recent breakdown at Brighton may give interest to the following considerations and the experiments upon which they are based. As is well known, special precautions are taken when shunt machines of different design are run in parallel. The speeds and the resistances in the shunts are adjusted so that, as nearly as possible, the electromotive forces of all the machines may fall and rise in the same ratio when the load on the bars varies. Thus, if the load increases, the consequent drop in the electromotive force developed in all the armatures must be the same. This drop in the electromotive forces is due to the increase of the back ampere-turns on the armature, the increase of the leakage coefficient and the decrease of the shunt current, and in order that the machines may share the new load in the same proportion as the old it is necessary that drop in the electromotive forces in all machines shall be the same. This means that either the machines shall be of identical design, or that if of different type the resistances in their shunts and their speeds shall be so adjusted that they shall all work at about the same magnetic induction in their field magnets. Such adjustment if carefully made may render it possible to vary the total load on the 'bus bars through a very large range without much disturbing the distribution of the total load among the machines, but in most cases some alteration of distribution is observable as the load varies, and if the adjustment has not been made very well a very large increase of load may cause the distribution of load to vary so greatly that a motoring of one or more of the machines might occur, that is, the load might be entirely removed from them and converted into a negative one. The greater the alteration of the 'bus bar voltage the greater is the danger that this accident may occur. If the machines whose loads are thus lightened are furnished with minimum current cut-outs they will not motor, but will be removed from the bars. The sudden drop in voltage on the 'bus bars may occur—

1. By decreasing the resistance between the 'bus bars, as, for instance, by a short-circuit of the bars.

2. Possibly by the breaking of a shunt circuit even when the armature had been removed from the bars.

3. By a short-circuit in the armature windings of one of the machines.

4. By suddenly switching out one of the dynamos when giving some considerable fraction of the total current,

In the case of a dead short-circuit of the 'bus bars, if all the machines are theoretically adjusted, they will first run up to the maximum currents they can give, and if they do not then burn out the short or their own armatures they will run round the lower limb of the shunt dynamo characteristic curve and cease to give any current at all, or if provided with minimum current cut-outs these will take them off the bars. If, however, one or more of the machines are working with their field-magnets excited to a flatter portion of the B H curve than the others, then when the short occurs their electromotive forces will not drop so much as is the case with the others, and they will, therefore, take most of the load, and the remaining machines, whose loads have thus decreased, will be cut out by their minimum current cut-outs; whilst, finally, the machines thus left on the bars will cut out with their excess current fuses, or if these are too large to blow with the maximum currents the machines can give, they will run round the lower limb of the characteristic curve and give zero current. The fact that at Brighton the main fuses on two of the machines are said to have remained intact whilst the machines were still on the bars appears to render the supposition that the breakdown was due to a dead short across the bars somewhat improbable.

As to whether the breaking of a circuit from 'bus bar to 'bus bar which has large self-induction and carrying a large current (such as the shunt coil of a machine) would cause any marked fall of pressure I am unable to say experimentally, as I have never had the opportunity of making the test upon a sufficiently large scale, and unless the coil so broken was very well insulated there would, of course, be a good deal of danger that its winding would be damaged. Possibly by using a transformer coil having very high inductance and carrying a considerable current, a test on this point could be made without any chance of damage, and would be of interest.

The third contingency, namely, the sudden short-circuit of the armature windings of one of the machines in parallel, will certainly cause a sudden fall in pressure across the mains owing to the large short-circuit current. An armature may have a short-circuit occur in its windings in so many ways that it is necessary for the sake of definiteness to select some particular one. Let us suppose that it is short-circuited by some accident from brush to brush, outside the brushes but inside the minimum cut-outs. The current in the armature would then suddenly increase enormously, and as the brushes have lead there would be a sudden weakening of the magnetic strength of the shunt field and consequently a sudden rise of E.M.F. across it in the same direction as would be the case if it were broken. In fact the armature would act like the primary of a step-up transformer of which the shunt windings form the secondary. The electromotive force thus set up in the shunt would act so as to lower the potential across the mains, or even possibly reverse it. It should also increase the armature currents of the machines still remaining in parallel, and weaken their shunt circuits.

In order to test the magnitude of the effect in this case, a shunt dynamo having an electromotive force of about 50 volts was coupled to the coil of a hedgehog transformer containing 2,960 turns, and having a resistance of 14·5 ohms. Ampere-meters, A_s and A_a, were placed respectively in the shunt and armature circuits of the dynamo, and a voltmeter V was connected across the shunt terminals. To the other coil of the transformer, which had a resistance of 0·1 ohms, and consisted of 192 turns; a small secondary battery was connected whose circuit could be closed or broken by means of a make-and-break key; an ampere-meter was also placed in

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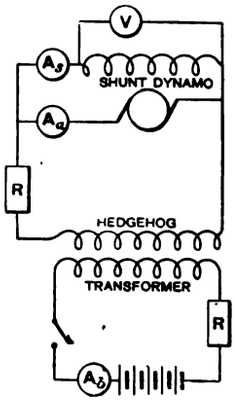
this circuit, and in both the dynamo and the battery circuit an adjustable resistance R was placed. The transformer was connected to the dynamo and the secondary battery in such a way that the field due to the current from the one was opposed to that due to the current from the other. It was then found on suddenly closing the battery circuit that :—

1. The volts on the voltmeter V fell ;
2. The current in the shunt circuit decreased ; and
3. The current through the armature increased.

These effects were reversed on opening the battery key. There is, therefore, no doubt but that the kind of action predicted takes place, but its magnitude in the experiment made was not greater than a fall of current in the shunt of about 2 per cent. of its original value. When it is remembered, however, that this experiment was made with a small hedgehog transformer about 2ft. long, and the current from the battery was only about 12 amperes at the maximum, it will, I think, be evident that very much greater effects are to be expected in the case of the short-circuited armature of a 220 kilowatt dynamo.

Lastly, the sudden removing of the armature from circuit by means of the minimum current cut-out would of itself cause a drop in the bars, and the two effects added together may account for the large similar type dynamos (if they were working on a less saturated field then the two smaller ones) cutting out and finally leaving the other two alone on the bars.



If the accident at Brighton was not due to a short on the 'bus bars, but is accounted for at all by the above facts, the fluctuation in a dynamo's field appears to follow the alteration of the exciting current more rapidly than one would expect. If the engines are governed for constant speed within small limits, such governing would, of course, assist in causing the minimum cut-outs to act, for it would prevent the weakened machines from increasing their speed as their loads diminished.

The instruments available for the above tests no doubt lagged a good deal in their indications, as their needles were heavy, and the damping was not inconsiderable, and it is possible that the alterations of current may have been really a good deal greater than was observed.

It may be added that even if all the dynamos in parallel have precisely similar armature reactions and are all working on the same portion of the magnetisation curve, yet a *sudden* fall of pressure on the bars may cause those machines whose shunt windings have the smaller time constants to drop their electromotive forces more rapidly than those machines whose shunts have larger time constants, and if this was the case at Brighton, one would expect that the shunt coils of two smaller machines had larger time constants than the larger machines whose minimum current cut-outs acted.

The Berlin Electricity Works.—After prolonged negotiations the Municipal Council of Berlin has signified its approval of a contract with the Berlin Electricity Works, permitting these firms to supply electricity to the city of Berlin until the year 1915, while the municipality is to participate in the profits to a certain extent.

ROTATORY CONVERTERS.*

BY PROF. SILVANUS P. THOMPSON.

(Continued from page 128.)

The relations between speed and field are peculiar. In the case of those grouped machines, or motor-dynamos (Fig. 3) in which each armature revolves in its own field, the conditions differ from those of the converter (Fig. 4), where there is only one field. If in either case the continuous-current side is the primary (*i.e.*, motor) side, the speed of revolution will depend on the field-magnet, the weakening of which will increase the speed. The frequency of the secondary or alternating current will in that case also vary. But the ratio of the primary and secondary voltages will be independent of speed if the fields are alike, or if only one common field is used. The secondary voltage cannot be varied, while the primary voltage is kept constant, unless separate field, and separate windings are employed, as in Fig. 3. If, on the other hand, the alternating current side is used as primary, then the machine, whether motor-dynamo or converter, runs as a synchronous motor with a fixed speed. In that case the voltage ratio remains also nearly a constant, even though the excitation of the field is increased or diminished, owing to the peculiar phase relations which take place, as is known, in the currents of synchronous motors when under-excited or over-

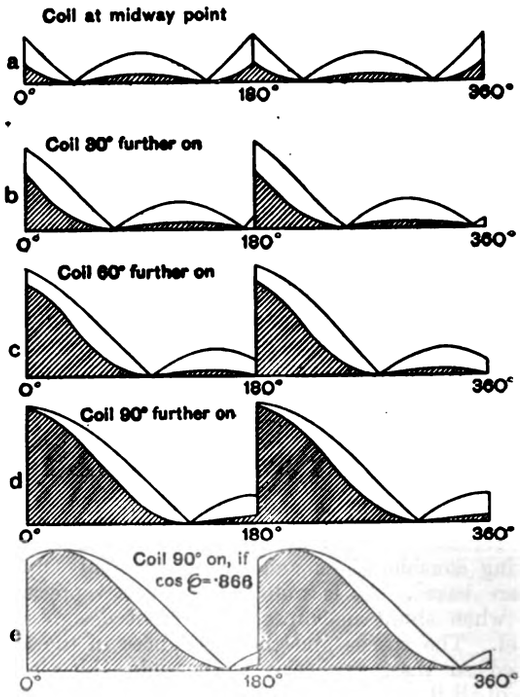


FIG. 6.

excited. This question, and the expediency of exciting in series or in shunt from the continuous-current side, or of running without excitation, has been discussed by Mr. E. J. Berg, in the *American Electrician* of February, 1897.

Returning to the question how the current in the armature of the converter gets through the windings, it will be found that a simple means of answering it is afforded by the principle of the superposition of instantaneous values of the currents. Still taking as a concrete case the 10-kilowatt converter of Fig. 3, we may calculate out the instantaneous values of the currents in its windings at different epochs in its period of rotation. If we do this for the motor currents and for the generator currents separately, and then superpose them, we shall obtain a number of instantaneous values for the combined armature as converter. This has been done in the series of drawings in Fig. 5. If the continuous current acts as motor taking 100 amperes, there will be 50 amperes flowing in each half of the winding at every instant—*qua motor*—in a direction opposing the electromotive force in the winding. This is shown in the first diagram in the upper row of Fig. 5. As single-phase generator the armature is working, as already described, with a virtual voltage of 70·7 volts, and an output (supposing the power-factor = 1) of 141·4 virtual amperes. The maximum current will be $141{\cdot}4 \times \sqrt{2} = 200$ amperes ; and this will be attained at the instant when the two conductors which lead down from the wind-

* Paper read before the Institution of Electrical Engineers, November 10, 1898.

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ing to the slip-rings are turned to the position of 90deg. to the axis joining the middles of the pole-faces. The eight diagrams which follow in the top row of Fig. 5 exhibit the successive values of the currents flowing in the armature—*qua generator*—in positions differing successively by 15deg. By supposing these eight diagrams successively superposed upon the motor diagram which precedes them, we obtain the eight diagrams of the lower row, which exhibit the currents actually flowing in the different parts at the particular times when the armature has the position shown. Exmination of these diagrams shows several interesting points. At the instant when the alternating current is reversing, and each in position 0deg. being 50 amperes. But as the armature turns these change. They increase in the two arcs that are shortening as the points where the slip-ring connectors approach toward the positions occupied by the commutating brushes. But in the two other arcs that are lengthening, the currents first decrease to zero, then increase again to 50. Further, the individual coils in different parts of the ring winding have very different currents to carry. A coil that is midway along the winding between the two connectors has to carry never more than 50 amperes. Four times in each revolution it carries 50, and four times it carries 0 amperes, with values intermediate in intermediate positions. (This will obviously

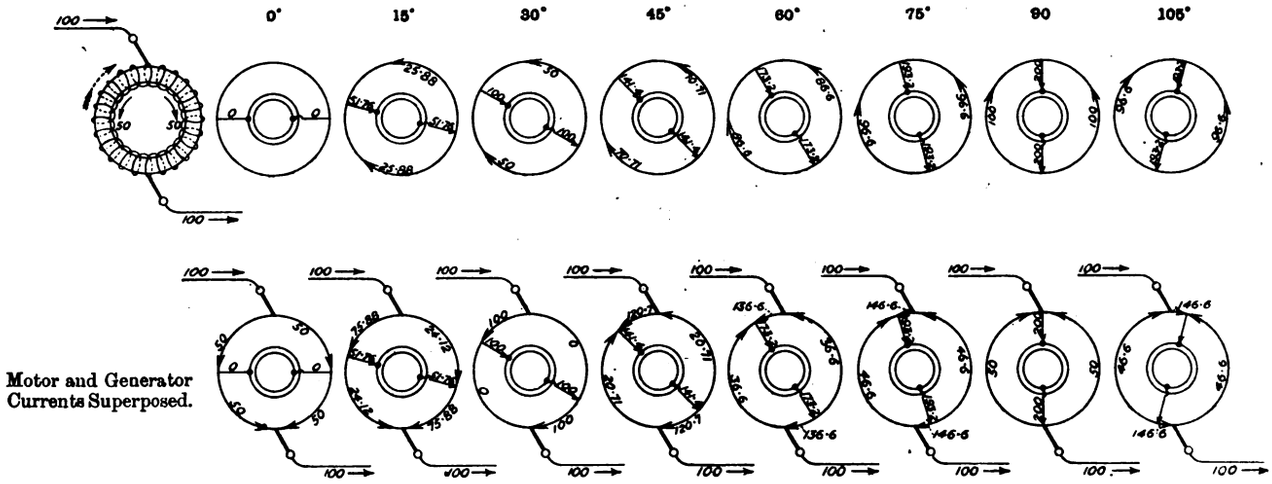

FIG. 5.—Flow of Currents in Single-Phase Converter. Continuous Current, 100 amperes at 100 volts. Single-Phase Current, 141·4 virtual amperes at 70·7 virtual volts.

has zero value (at position 0deg.), the armature is operating simply as a motor with 50 amperes in each half of the winding, and is being accelerated, At the 90deg. position, when the alternating current is at its maximum (200 amperes), the armature is operating wholly as a generator, and with an equal current of 50 amperes in each half of the winding, and the acceleration is negative. The armature is thus adding 100 amperes to the 100 amperes coming in from the primary mains. Nothing has here been allowed for the extra power needed to make up for the frictional and other losses. Suppose that an additional 4 amperes were needed for this, making set up four armature reactions in each period.) But a coil that is situated next to either of the two connectors has to carry a current which, when it is close to the brush position, rises to a maximum of 150 amperes, and changes abruptly to 50 in passing the brush; rising thus gradually twice to 150, or else rising twice abruptly from 50 to 150, and being zero twice, in one revolution. The necessary consequence of this is that the coils which are close to the slip-ring connectors are much more heated than those which lie midway along the periphery between the connectors. The distribution of the heating is here quite different* from that which

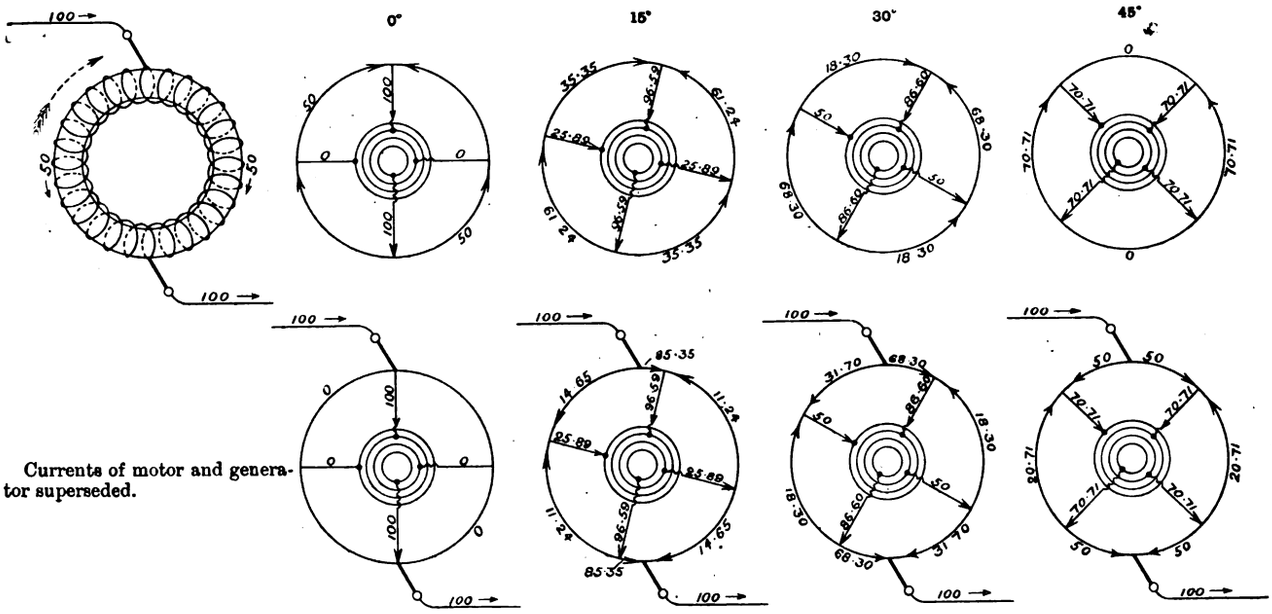

FIG. 7.—Flow of Currents in Two-phase Converter. Continuous Current, 100 amperes at 100 volts. Two-Phase Currents, 4 lines each carrying 70·7 virtual amperes. Line voltage, 50 virtual volts.

104 amperes as the motor current: in position 0deg. the two downward currents would be 52 each instead of 50, increasing the positive acceleration; in position 90deg. the upward currents would be 48 instead of 50, decreasing the negative acceleration. The output current at that instant would still be 200, being made up of 104 incoming plus 96 generated in the windings.

On further examining these diagrams it will be seen that the currents in the armature windings consist of a set of four currents, would obtain in either armature of the motor-dynamo machine (Fig. 3). This unequally distributed heating effect is in total somewhat greater than that in the same armature if used purely as a continuous-current motor or generator, but is less than the total heating effect (for equal power) if used purely as single-phase generator or motor; the ratios of the heating being as 1 : 1·366 : 2 in the three cases. Or, if we consider the output of an armature to

* *Vide* Steinmetz, *loc. cit.*, p. 154.

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be limited by equal heating effects, the several outputs which would give equal total heating in the same armature would be:—As continuous-current generator or motor only, 100 kilowatts; as single-phase generator or motor only, 50; as single-phase converter, 85 kilowatts. Fig. 6 exhibits this unequal heating effect in the case of a single-phase converter. The first line represents graphically by the outline diagram the varying current (irrespective of direction) which a coil midway between the connectors will carry in one revolution; and the outline curve of the darkened area within it is drawn with ordinates squared so as to be proportional to the heating effect at different instants. The total area blackened represents the total heating effect in that coil. The second line represents similarly the current and heating for a coil 30deg. further towards the connector. The third line represents current and heating for a coil 60deg. further, whilst the fourth line represents similarly the current and heating in a coil that is next to the connector. The relative heatings in these four coils are about in the proportions 10, 21, 50, 86. The curves in the fifth line depict the case of one of the coils next to a connector when there is, in consequence of self-induction in the circuit, a lag of 30deg. in the phase of the current. The result of such phase-difference is an increase of heating for the whole armature, but an extra increase for those coils which are near the connectors.

We may now pause to consider what differences will be made in the preceding considerations if the distribution of the magnetic flux around the periphery of the armature does not follow a sine law. It will be noticed that when any arc of the winding (and this applies to two-phase and three-phase cases) lying between two slip-ring connectors is acting as generator, it produces its greatest electromotive force when its mid-point is passing the mid-point of any pole. Hence, if the poles are narrowed so as to concentrate the field, even though the average electromotive force for continuous-current purposes remains unchanged, the root mean square value of the electromotive force will be increased, and the curve of induced electromotive forces will be more peaked than a sine curve. If the machine is being used to convert continuous current into alternating, the effect will be to raise the relative alternating voltage and lower the relative alternating current, and, on a non-inductive circuit, the current also will have a more peaked curve. If the machine is being used to convert alternating into continuous currents, the converse result takes place, the relative value of the alternating voltage being lowered. An eight-pole converter at the Technical College, Finsbury, constructed in 1891 by the Allgemeine Elektricitäts Gesellschaft, of Berlin, has a curve of induction which is remarkably close to a sine curve, and its relative voltage for continuous and three-phase currents is practically identical with the theoretical value. Herr Friese, in the article already referred to, gives the following comparison in Table V. for three machines with ring armatures constructed by Messrs. Schuckert:—

Table V.

Nature of service.	Voltages as measured.			Voltage calculated.
	Machine No. 1.	Machine No. 2.	Machine No. 3.	
Continuous-current ...	100	100	100	(100)
Single-phase	71·0	71·8	..	70·7
Three-phase.....	61·3	62·0	61·8	61·2
Two-phase	71·0	71·8	...	70·7
Four-phase	49·8	50·7	...	50·0
Six-phase.....	35·0	35·8	...	35·4

M. Hanappe* has published a careful analysis of a Schuckert converter, capable of yielding alternating currents in one, two, three, four or six phases, and suitable for laboratory experiments.

If the machine is being used to convert a single-phase current into a continous one, the form of the impressed voltage curve, and the distribution of the flux around the periphery, are of even greater importance. The current delivered, though certainly continuous, will not be uniform, but will have a periodic fluctuation superimposed upon it by departures from the sine law. Armature reactions will, as we have seen above, impose fluctuations of a frequency double that of the primary current. Indeed, in any case the single-phase converter is a less satisfactory apparatus, from several points of view, than the two-phase or the three-phase converter. It has more considerable variations of armature reaction, a greater and more unequable heating, and requires a more accurate setting of the commutator brushes than the polyphase converters. Moreover, it is not self-starting from the alternate-current side. Notwithstanding these disadvantages, single-phase converters are in satisfactory use; for example: several constructed by the Elektrizitäts-Aktiengesellschaft (Schuckert and Co.) are in operation on the city circuit at Cologne. A single-phase converter when standing still can act partly as a mere stationary transformer. When running at a certain speed in a field with a given number of poles it will act as converter, converting into continuous current those currents only which come to it with a frequency corresponding to the frequency of the movement of revolving conductors past the poles. Any alternating currents or components of alternating current of any other frequency that may be superposed, can affect the continuous-current output at the other side by producing superposed fluctuations.

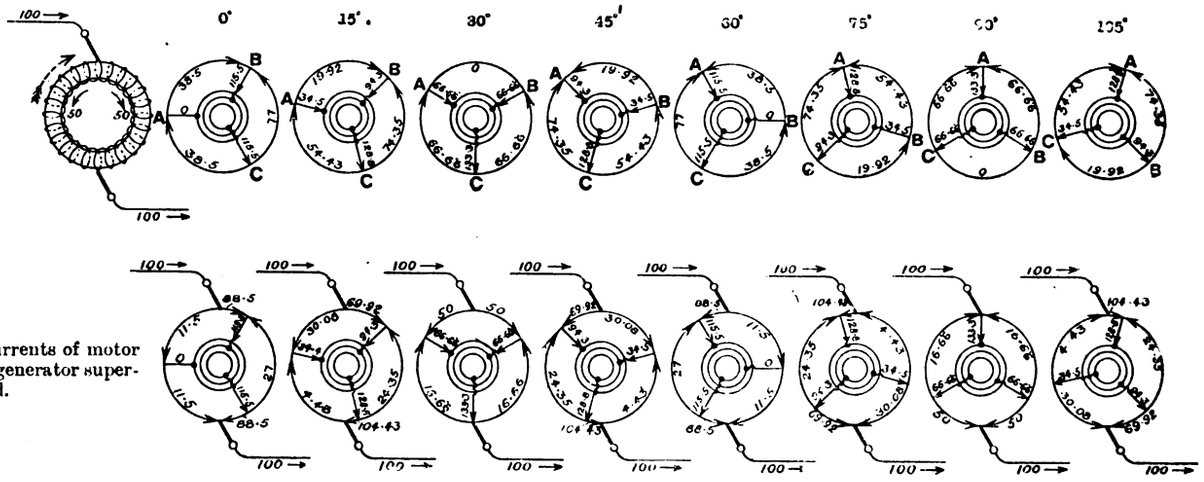

FIG. 8.—Flow of Currents in Three-Phase Converter. Continuous Current, 100 amperes at 100 volts. Three-Phase Current, 3 lines, each 94·3 virtual amperes; line voltage, 61·2 virtual volts.

Passing on, then, to the case of the two-phase converter, we may at once apply the same principle of superposition of instantaneous currents to study the flow of current through the windings. Fig. 7, which gives the corresponding series of diagrams, requires no further explanation. The generator action during one-eighth of a revolution is illustrated by the four figures on the right of the upper line. The superposed action is exhibited in the lower line. Inductive reactions and energy losss are, as before, supposed to be absent. In position 0deg. the converter is acting neither as motor nor as generator, the current at that instant simply running through from the commutator to the slip-rings. In the position 15deg. it is observed that the currents in the armature windings consist of six sets. Two short portions are carrying a motor current of 85·35 amperes each; two others of somewhat longer arc are carrying a motor current of 14·65 amperes; whilst two quadrantal parts are delivering generator currents of 11·24 amperes. On the whole, in this position the armature is acting as motor, increasing the acceleration. In the next position, at 30deg., the motor action has decreased. In the position at 45deg. the action is chiefly generator, the current in that part of the field which is strongest being at its maximum and flowing with the electromotive force. It will again be noted that the currents in those coils of the armature which lie close to any of the four connectors will be more heated than those midway along the intervening quadrants; the maximum current for the former being 100, for the latter 50. The inequality of the heating is much less, however, than in the single-phase armature. Also armature reactions are more nearly balanced throughout, and there is much less tendency to impart a periodic fluctuation to the continuous current. Such machines will

* *L'Eclairage Électrique*, VIII., 151, July 25, 1896.

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be self-starting, and will give little trouble from sparking at the commutator.

Fig. 8 exhibits the flow of currents in the armature of a three-phase converter. Comparison of the successive positions will bring out several points. The current in any one of the three lines is at its maximum (on a non-inductive circuit, when generator; or when, as motor, the field has normal excitation) when the connector for that line is just passing a commutator brush; and its maximum is $1\frac{1}{2}$ times the continuous current. In certain positions of symmetry—for example, in position 30deg.—the motor and generator actions resulting from the flow are bilaterally similar. In other position—for example, in position 0deg.—one side (the left here) is acting wholly as motor, the other side partly as generator and partly as motor. A coil which lies midway between two connector ends will carry a current that has a maximum of 27 in one part of its revolution, and another maximum of 50 in another part of its revolution; there being two of each of these maxima in one revolution. A coil situated close to a connector has 133·3 as its maximum twice in each revolution, with an abrupt change to or from 16·66 just as it passes the brush. The inequality of heating of coils is less in a three-phase converter than in a single-phase, but it is greater than in a two-phase converter. The inequality of heating in the case of two-phase converters has recently been examined analytically by Messrs. Woodbridge and Child in recent numbers of the *Electrical World* (January 1 and February 12, 1898). Their Paper, which is one of great skill, concludes with the interesting deduction that, assuming a power factor of unity, if such a converter is driven mechanically so as to be generating *both* a continous and a two-phase current at the same time, the heating of the armature will be less than would be the case if, with same output, it were used as either a continuous-current generator alone or a two-phase generator alone.

(To be concluded.)

THE RAPID DEVELOPMENT OF ELECTRICAL ENGINEERING DURING THE PRESENT YEAR.

The following is an abstract of the Presidential Address, recently delivered by Mr. G. S. Raworth to the Northern Society of Electrical Engineers:—

The Northern Society of Electrical Engineers, measured by its numbers was small and insignificant, but measured by its activity, by the energy and enterprise of its members, it was, he believed, the first electrical society in the Kingdom. It was because the members had been so very full of work during the present year that the Council had found it extremely difficult to get the members to prepare and to promise papers for this session: in fact, so great was the difficulty that, although they were able by the assistance of Members of Council to fill up succeeding dates, it was found quite impossible to carry out the intention of the Council that the first Paper of the Society should be read in October.

He first of all proposed to run lightly over the departments in which the development had been more or less strongly marked. The first thing that naturally arose in the mind was the department of electric lighting. He was not going to trouble them with many figures, but must give them a few, because they were so interesting that he did not think they would like to go away without knowing them. In the year 1896 the subscribed capital for companies was £5,800,000, and for municipalities just under two millions. In 1897 the companies went to £6,600,000, and municipalities to £3,500,000. In 1898 companies jumped up by nearly two millions, and municipalities by a rather larger amount, *i.e.*, to £5,735,000, so that at the present moment the total amount of capital involved in electric lighting was £14,142,000. A most important point was that in the years 1882-3, which were known as the years of the electrical boom, the total amount of capital subscribed was £14,743,000. If they had only taken care of the money which the public subscribed in those two years, we should never have had to ask for a single penny more in the whole of the 15 years which had since elapsed. Coming to the present year, they found that the activity in electric lighting was very pronounced. There were in 1896, 38 applications for Provisional Orders; in 1897, 55; in 1898, 84, the total Orders in force being 343—100 held by companies and 243 by municipalities. There were works in operation owned by 57 companies and 75 local authorities, and 66 works were in course of preparation. He wished to draw attention to the important fact that 145 Provisional Orders had been granted, concerning which nothing whatever had been done. There was no doubt but that in most of those cases the ground was ready for the ploughshare. There was a point of interest which he had noticed in analysing the figures; he found that out of every £100 applied for the purposes of electric lighting, £37 went to the manufacturer of plant and £34 per cent. to the manufacturer of mains. Manufacturers of plant made all the noise and held all the meetings, and, as far as he could see, the manufacturers of cable made the profit. In 1897 the total number of units sold was 60,125,000, and a curious point about that was that the whole of that current could have been produced by no more than 20 1,000 kilowatt sets working during factory hours, but the actual amount employed was not less than 72,000 kilowatts. The human mind always found a difficulty in dealing with small or large figures. The moment they got into millions it seemed as though the mind could not quite grasp what was talked about. They might think that, because we had got 14 millions in the electrical industry, that we had pretty well absorbed all the capacity of the English shareholder. But compare electricity with gas; the total capital employed in gas was 76 millions, and they spent as much every year upon making their gas as the total subscribed capital of the electrical industry—*i.e.*, $14\frac{1}{2}$ millions.

The next point to consider was that of electric propulsion. As he had told them last Christmas, they had in all about 133 miles of tramway working. Owing to Parliamentary preliminaries to be gone through, plans to be got out, and capital to be subscribed, there had been very slow progress. They had only added a matter of about 40 miles to the total of last Christmas. There were under consideration at the present moment 39 miles by municipalities and 45 miles by companies. In the session of 1898 five electric railway bills were passed, 17 tramway bills for local authorities and 10 for companies, and 11 Provisional Orders, in addition to which light railway Bills had been granted for 140 miles of line. When they came to actual figures, they found that the amount of subscribed capital was £14,400,000, being about £270,000 more than the subscribed capital for electric lighting. He thought this high figure was partly owing to the initiatory expenditure on schemes, and partly owing to the large and expensive undertakings which were being carried out in London to connect the suburbs with the City by means of underground tunnels. Every mile absorbed nearly half a million pounds, so that the amount of capital subscribed for that alone had gone very far to produce the figure of £14,400,000. The unfortunate part about it was that the money did not go into their pockets, or, at least, only a very small percentage of the money subscribed for underground railways ever reached the pockets of electrical engineers. It went to the engineers of Westminster, or to the contractors for underground work. There were one or two other developments in propulsion which he had to speak about, but which were not quite so hopeful from their point of view as those which he had already mentioned. The first was the propulsion of boats, and as far as he knew the only active company was the Immisch Company on the Thames, which owned a large number of launches, having a capital of £10,500, and which paid a small dividend. He himself was one of the Directors. He was looking forward to that class of propulsion developing somewhat in the future. Electric launches were tried on Lake Windermere, and they were probably aware of the fact that the undertaking was a comparative failure. He wanted to disabuse their minds that that failure was due to the shortcomings of the electrical portion. It was entirely due to the human element. The undertaking had been badly planned, so that the boats had to go several miles to be charged, and several miles back again to their work. The consequence was that the actual available net charge was below the paying limit. The next point which he would bring before their notice was the electric cab. He wished he could tell them that the electric cabs were going to be a great success. Their number had been very greatly increased, and he understood they worked very well, and as far as passengers were concerned he believed they gave every satisfaction. How the accumulators were working he could not tell.

The present year had been a very important year to them from the point of view that a Lords and Commons Committee had been appointed to sit upon the general question of electrical distribution of power. First of all, they passed two Bills, the Chelsea Company's Bill to enable them to purchase compulsorily a site within their own area; that was an enormous step in advance of anything that had been previously done. The next one was the Metropolitan Company's Bill to enable them to lay mains outside their area, and to bring current in. That was a still further and a more drastic change. It enabled a company supplying a given area to put its generating station right outside that area, and to get wayleaves across the territory of adjoining authorities for its mains to enter its own area. Then the joint committee passed its opinion as follows upon the general principle of the distribution of power. First they expressed the opinion that powers should be granted for the supply of electrical energy over an area including districts of numerous local authorities on conditions differing from those imposed by the existing Acts. Differing meant better. Secondly, they expressed the view that the provisions of the Electric Lighting Acts for the purchase by local authorities were inapplicable in the case of an undertaking

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supplying energy in bulk at a high voltage. Those expressions would prove most valuable in the coming session of Parliament The Bills now before the House were the General Power Distributing Co., which they knew was going to take a large area in the neighbourhood between Nottingham and Sheffield, an area of about 2,000 square miles; the Midland Electric Co. for power distribution, whose area was in the black country, and who had a capital of £200,000 on paper. Those two were magnificent schemes. Whether they were well thought out and going to pay he was not prepared to say, but they owed a debt of gratitude to them because they squeezed out of the Lords Committee those two very important concessions. They had in their midst, as it were, a scheme which he thought would commend itself not only to them but to all electricians and engineers throughout the country, as being, perhaps, the most practical development of this idea that had yet come out. He referred now to the Trafford Park Estate scheme. That was an undertaking that had been favoured by Messrs. W. T. Glover and Co., who were promoting it, and, so far, finding the money for it. The object was to supply power in bulk for driving all the factories, lighting the factories, and for supplying producer gas to the houses on the Trafford Park Estate. That was a perfectly feasible scheme. It was one of which every engineer could form an opinion from the commencement, and it would be the nucleus of a much larger development. The engineers to the scheme had told him that they originally looked upon his figures of the price at which electrical energy could be manufactured and sold with considerable doubt. They set to work and worked out those figures upon their own lines, and for their own satisfaction, and they found that the results of his calculations and theirs came out sufficiently close for all practical purposes. There was at the same time that scheme called the Highland Power Scheme of Scotland, of which he could give them no further information. As to the general distribution of power in factories, that was making very satisfactory progress.

The electrical chemical industry, that was one of those things which he did not understand, but he believed it was making very good progress. It must be patent to every one of them that the Castner-Kellner process of making alkali by electrical energy had proved so far a success. There was one other point came to his notice, and that was the new process of reducing ores by powdering aluminium, making it up with ore, and igniting the mass electrically, when chemical energy would be immediately let loose and propagated through the whole mass, and heat generated being nearly equivalent to that of the electric arc. The immediate effect was the reduction of the metal operated upon. If that invention proved a commercial success, it would open an enormous field for the use of aluminium, and consequently for the use of electric current.

He ought now to consider what were the causes which were working towards the extension of the use of the electric current. They knew perfectly well whenever an electric lighting station was put down, and worked well or badly, its customers increased, the revenue increased, and the profit increased, and the most natural thing which he could do was to give them a few figures to show what that development amounted to. He had taken as illustrations four stations which had suffered very little from alterations in price, viz., City of London, Newcastle, Kensington and Chelsea, and he found that with those, with the exception of the year 1894-5, when the increase in the City of London was 48 per cent., the increase from year to year had been about 25 per cent. The year 1895-6 was a phenomenal year. The City of London increased 43 per cent. and Chelsea 41 per cent., but both these places were subject to peculiar circumstances. The extension of Chelsea had been almost entirely depending upon the rate at which the builders spend their money. However, they might take it, he thought, that the natural increase, was somewhere about 52 per cent. The next point was one of much more importance to them. That was a question of how far the cost of plant and the cost of working affected their business. A few years ago (about five or six), the cost of a 100 kilowatt plant, rope driven, was £1,600 to the public. Now the price for a direct-driven plant was from £1,300 to £1,400, but in the meantime either our faith or ideas had grown so much that no longer did we talk about 100 kilowatt sets. Last year the inquiries were for 300 kilowatts, this year they were for 600 kilowatts, and he understood Manchester had gone to 2,500 H.P. A 600-kilowatt plant was worth about £6,000, and six plants of 100 kilowatts each would cost £9,600, so that there was a saving of £3,600. If they put on to the top of that the saving in switchboards, land, foundations and buildings, they came to the fact that at the present day the cost of plant should not be more than about 60 per cent. of what it was five or six years ago. He thought to a very large extent their efforts had been stimulated to take those big leaps by the clear understanding that those enormous wastes which were supposed to accrue from running engines at half load could be obviated by a good vacuum and automatic expansion. With reference to the working of stations it was worth while putting upon record the fact that, whereas four or five years ago they did not think it at all an extravagant thing to spend 5d. a unit, now they had 14 stations whose total costs (not meaning the absolute cost of the unit) was under 2d. In Edinburgh the cost had just come under 1¼d., and in Manchester it was about 1½d. As the cost came down the demand increased. The moment they got the prime cost to such a point that they could sell to the ordinary consumer at a price which was obviously to him less than the price of gas, they would sweep in the whole number of possible consumers which they could supply.

The next point was "Parliamentary Procedure," which at present was both tedious and costly. There was not a great prospect of their getting much amelioration in that line, but they might get some, the recommendations of the Lords and Commons Committee and the provisions of the Light Railways Acts being distinctly favourable to the progress of the electrical industry.

He had down on his list of principal influences, which affect the rate of progress, an item under the heading of "Avarice of Municipalities," and he had limited it to this narrow word "avarice," because he did not want to go into the discussion of the question as to whether from political reasons it was an advantageous thing for municipalities to take over and manage their business. Electric lighting was too young to provide a good basis of comparison; the results were contradictory, and at present too much under the influence of the personality of the engineer to permit of accurate conclusions being drawn from them; but municipal gas lighting was quite old enough for the purpose, and the results could be compared by reference to two large volumes, which were the Board of Trade returns of the gas undertakings in the United Kingdom, one representing companies and the other municipalities. There were 208 municipalities and 433 companies owning gasworks.

First, consider Manchester, a city which manages its gas works nearly as well as they can be managed by a Corporation. The price is 2s. 3d. per thousand, and the profit is £33,153 interest and £40,000 in aid of the rates—total £73,153. On the other hand, the South Metropolitan Gas Co. charges its consumers the same price and makes four times the profit, or double the output—that is, twice the profit *pro rata*, notwithstanding that it has to pay heavy carriage on coal. Again, compare Manchester with the Sheffield United Gas Light Co., the two cities being nearly on a par as to cost of coal. The price of gas at Sheffield is from 1s. 8d. to 2s.; the consumption is about one-half of Manchester, and the profit is £78,829—that is, more than double *pro rata*. If the Sheffield Corporation were to authorise the Company to charge the Manchester price of 2s. 3d. they could afford to pay over £42,000 in aid of the rates at the expense of the consumer; or, if their output were as large as that of Manchester, they could pay over £80,000 a year in aid of the rates and still pay to their shareholders £140,000 per annum, as against the £33,153 paid for interest in Manchester. But assuming for the moment that the results in Manchester were as perfect as in Sheffield, the amount handed over in aid of rates would be not £40,000 but £80,000 + (140,000 − 33,153) = £186,847. In Birmingham, with equally cheap coal, their price is from 2s. 3d. to 2s. 7d. with 5 per cent. discount, and yet they desire to manage their electric lighting. Take two towns as dissimilarly placed as possible—Wigan and Plymouth. Wigan is built on gas coal; Plymouth is hundreds of miles from it. Wigan Corporation charges 3s. 1d.; Plymouth charges 1s. 9d.; but in this instance Wigan pays in aid of rates £9,697, but the difference between their price and that of Plymouth on their output amounts to £6,600, so it is clear that, considering the relative prices of coal, they are taking the whole of their apparent profit out of the pockets of their gas consumers, that is to say, of their ratepayers. Again, compare two gas undertakings placed side by side and subject as nearly as possible to identical conditions—Stoke-on-Trent Corporation and the British Gas Light Co. (Potteries). The Corporation price varies from 3s. 6d. to 2s. 9d., but the Company's price is only 2s. 3d.

Electric traction and electric distribution of power were being pushed on by private enterprise, and he hoped that this active private energy of theirs would not be entirely killed by municipal obstruction. There was one point which was always before them, and that was foreign competition. He was not afraid of it; in fact, it appeared to him that, at the present moment, it was a good thing that it was possible to get plant from America, because, had it not been for that fact, electrical enterprise in the year 1898 would have been suffering from great strangulation. Speaking from his own knowledge alone, the Central London Railway Co. had ordered, he believed, seven sets of 1,400 H.P., the Metropolitan three of 2,500, and the County of London two sets of 1,000, all manufactured in the States and sent over here; but he knew that, with regard to some of them, if they could have been made in this country in the time the order would not have been given to the States. It came down to this fact, that the Americans were not competing with us at our prices; they were only supplying those orders which could not be done in this country.

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PHYSICAL SOCIETY.

At an ordinary meeting, held on November 11, 1898, Mr Shelford Bidwell, F.R.S., President, in the chair, the discussion was resumed on Mr. ALBERT CAMPBELL'S Paper on

"The Magnetic Fluxes in Meters and Other Electrical Instruments."

Prof. AYRTON said he wished to offer some remarks on behalf of Mr. Mather and himself. The Paper would perhaps have received more adequate discussion at the Institution of Electrical Engineers, for it was of a technical character. The importance of neutralising the effect of leads when using instruments with very weak fields, such as a Siemens electro-dynamometer, should be emphasised. In instruments of the Kelvin-balance type, where two opposed coils carry two opposed currents, the field spreads at the edges; the true "working" flux is not that directly between the coils. Mr. Campbell would have done better if he had used a long search coil wound round one of the swinging coils, forming part of a vertical cylinder. It would have been well also to have supplied some experimental proof that the astatic arrangement of the swinging coils of the Kelvin balance makes the instrument independent of the earth's field. The effect of the earth's field is of the order 0·2, so that with instruments of the Weston type, with a field of the order 1,000, it was sometimes assumed, erroneously, that the readings were practically independent of the earth's H. Prof. Ayrton's own tests showed that by turning a Weston voltmeter towards different points of the compass, the errors in a particular case were far greater than might be predicted from the above ratio; the induction in the voltmeter pole-space, due to the earth's field, was much higher than 0·2; the earth's field was exaggerated by the iron pole-pieces; it was not necessary to suppose that the magnetism of the permanent magnet caused the variation. The error observed was about 0·2 per cent. in a horizontal field, and 0·8 per cent. when the field of the voltmeter was parallel to the earth's induction. Here the induction in the gap was 1,200, and H = 0·2. In tests relating to the Ayrton and Perry magnifying-spring voltmeter, it was more important to know the B in the air-space *near* the iron than the B *within* the iron. Eddy currents might account for the extraordinary results obtained with the Shallenberger meter.

Mr. J. H. REEVES described a method he had adopted for measuring the effect of stray fields upon ammeters and voltmeters. The instrument to be tested is first mounted on a stand, and is brought under the influence of a large coil carrying a current. In this way, fields of known magnitude can be superimposed on the working field, throughout the range of the instrument, and the change of deflection due to them can be observed. From these known values, the working field can be deduced. For let the current in the solenoid of the instrument at any moment be A amperes, producing a corresponding unknown working field of magnetic force X. Then X is proportional to the solenoid current, as measured by the indications of the instrument. If a magnetic force, x, is superimposed on X, then x is measured by x/X of A. If x is known, the working field X can be calculated from the change of deflection produced by the superposition. With Evershed ammeters, the field measured in this way was in one instrument 200, and in another 226; or about one-third of Mr. Campbell's figure (700) for the Evershed ammeter. Mr. Campbell's value of B did not represent the working field, but the field at the end of one of the fixed pieces of iron.

Mr. CAMPBELL, in reply, said he thought the theory of electrical instruments to be well within the limits of Physics, and he had for that reason presented the Paper to the Physical Society. The position chosen for the search coil in the Kelvin-balance tests may not have corresponded to the working flux, but it was near to the right position, and he had carefully specified the position chosen. His results as regards the Weston instrument differed from those of Prof. Ayrton; the errors he had observed for the particular ammeter used were under 0·1 per cent. The earth's field probably produced an effect different for different Weston instruments, according to the degree of saturation of the permanent magnet. In Mr. Campbell's tests, the Weston instrument did not have an iron case.

Prof. J. D. Everett then read a Paper by Prof. W. B. MORTON on—

'The Propagation of Damped Electrical Oscillations along Parallel Wires."

In a Paper published in the *Phil. Mag.* for September, 1898, Dr. E. H. Barton compared the attentuation of electrical waves in their passage along parallel wires, as experimentally determined by him, with the formula given by Mr. Heaviside in his theory of long waves. He finds close agreement as regards the effect of a terminal resistance, but large discrepancy in the case of the attenuation-constant. Prof. Morton now investigates how far the results should be modified when it is supposed, as under actual conditions, that the oscillations propagated from the origin are damped, and that the circuit is not balanced, as in the ideal case of distortionless transmission. He finds (1) that the velocity of propagation is increased, while (2) the attenuation is increased, and (3) with infinite resistance between the ends of the wires, the waves are, as before, reflected completely with phase unchanged. As the resistance is diminished the amplitude of the reflected waves is decreased, and a phase-difference is introduced. For a certain value of the resistance the reflected amplitude is a minimum, and the phase-difference is $\pi/2$. When the resistance is zero there is again complete reflection, with phase difference π; *i.e.*, the waves are reversed. The result is that the reflection factor for amplitude *seems* to pass continuously from $(+1)$ to (-1) *without* passing through zero. Using the numbers given by Dr. Barton it is found that the corrections to the simple theory are extremely small, so that in actual cases the damping may be ignored, and the circuit may be regarded as distortionless.

Mr. OLIVER HEAVISIDE (abstract of communication), using his own notation, exhibited mathematically the connection between the case investigated by Mr. Morton, of a wave-train arising from a damped source, and the standard case of an undamped source. The cause of the attenuating coefficient coming out twice as great in Dr. Barton's experimental conditions, as when the resistance is calculated by Lord Rayleigh's formula, he attributed to lack of correspondence between the experimental conditions and those of the ideal theory. For: (1) The external resistance, of unknown amount, is ignored. (2) It is not certainly to be expected that the formula in question is true for millions of vibrations per second. It may, however, be concluded from the experiments that the theory furnishes an approximation to the real resistance. (3) The magnetic vibrations to which the wires are subjected are not long continued and undamped, as assumed by the formula. When a wave train passes any point on a wire its surface is subjected to an impulsion vibration lasting only a very minute fraction of a second; a vibration, moreover, which is very rapidly damped. So there is no definite resistance, and the resistance is greater than according to Lord Rayleigh's formula. (4) Perhaps, also, the terminal reflections involved in Dr. Barton's calculations may introduce error.

The PRESIDENT proposed votes of thanks to the authors, and the meeting was adjourned until Nov. 25.

REPORT OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE COMMITTEE ON STANDARDS OF MEASUREMENTS.*

The determination of the mechanical equivalent of heat by the electrical method, as reported by Griffiths,† and by Schuster and Gannon,‡ gave a larger value than Rowland's corrected result. This fact has created a demand for the redetermination of the ampere in terms of the electro-chemical equivalent of silver. At the Toronto meeting of the British Association last year a grant was made to the British Association Committee on Electrical Measurements for the purpose of carrying out this investigation.

At the Detroit meeting of this Association the grant of 50dols. previously made for the use of this committee was made available for the past year. Though this appropriation was clearly insufficient for the purpose, it was decided that the redetermination of the ampere should be undertaken for the committee of this Association in the physical laboratory at Ann Arbor. The work has been ably carried to completion by Prof. Patterson and Dr. Guthe.

The discrepancy between Griffiths' results and those of Rowland is about one part in 400 at all temperatures between 15deg. and 25deg. on the nitrogen scale. Those of Schuster and Gannon exceed Rowland's at 19·1deg. on the same scale by about one part in 500.§ These differences exist after the final elaborate comparison of thermometers and the reductions to the same absolute scale of temperature.

Since the electrical methods employed to determine the mechanical equivalent of heat involve either the current and the E.M.F. of the Clark cell, or the square of this E.M.F., and since the E.M.F. of the Clark cell is determined by means of the silver voltameter, it is evident that the current enters the final result as the square. If the discrepancy is due entirely to an error in the value of the ampere, assuming the ohm to be correct, then the ampere should be one part in 1,000 to one part in 800 larger than the present accepted value. That is, the electro-chemical equivalent of silver should be increased from Lord Rayleigh's value of 0·001118 to 0·0011191 or 0·0011194. Lord Rayleigh does not claim for his result an accuracy greater than one part in 1,000.

The method used by Patterson and Guthe was that of a specially constructed electrodynamometer of large dimensions, and the employment of the torque of a phosphor-bronze wire to equilibrate the counter-torque due to the effort between the magnetic fields of the stationary and movable coils. This method eliminates entirely the value of gravity g. The torque of the wire was measured by observing the period of vibration of a cylindrical brass weight of known mass and dimensions when suspended by the phosphor-bronze wire. The entire success of this part of the investigation was due to the fact that the observations were made with the whole apparatus enclosed in a fairly good vacuum. Under these conditions the vibrations could be followed for hours at various inter-

* Presented by Prof. Henry S. Carhart, secretary of the committee.
† *Phil. Trans.*, "A," 1893.
‡ *Proc.*, Roy. Soc., November, 1894.
§ John Hopkins University Circulars, June, 1898.

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vals ; the logarithmic decrement was almost entirely constant, and it was easy to obtain a curve connecting temperatures and periods of vibration as a torsional pendulum. The wire was so connected to the support and to the brass cylinder that it could be transferred from the vacuum apparatus to the electrodynamometer and back again without disconnecting it from the terminal pins. From personal inspection at the several stages of the investigation assurance can be given that the work has been most carefully executed at every point, and all known sources of error have been as completely eliminated as possible. The result of the investigation is that the electro-chemical equivalent of a used solution of neutral silver nitrate, 15 parts by weight of the silver salt to 85 parts of distilled water, is 0·0011192 grammes per ampere per second. This exceeds Lord Rayleigh's value by about one-ninth of one per cent. and causes the discrepancy in the mechanical equivalent of heat to disappear.

The corresponding change in the E.M.F. of the Clark cell will be from 1·4342 to 1·4372 at 15°C. A direct termination has not yet been made and this redetermination is reserved for the coming year. Dr. Kahle has obtained for the electro-chemical equivalent of silver the value 0·0011182* by the use of an electrodynamometer designed by Von Helmholtz and a fresh solution of the salt. Pellat and Potier found the same value as that of Patterson and Guthe.†

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *November 4, 1898.*

Peace Jubilees.—The week before last a peace jubilee was celebrated in Chicago, and last week a similar celebration took place in Philadelphia. The chief features of the celebrations were the night illuminations, in which, of course, the electric light was predominant. In Chicago 50,000 extra incandescent lamps, at the lowest estimate, were burned in the streets. The plan adopted of decorating the downtown districts consisted of making a roof of flags by day and of light by night. The flags and lights were strung in rows at regular intervals across the streets, the lights swinging in graceful festoons above the centre of the roadways to the buildings on either side. Over three miles of streets were decorated in this manner, and upwards of 10,000 16 c.p. incandescent lamps were employed. The work was done by the Chicago Edison Co., and was completed in two weeks after the signing of the contract, over 100 men being employed on the task. The lights were turned on every evening at 6:30 o'clock, and extinguished at 11:30. The system of decorative lighting took about 2,500 amperes at 220 volts, supplied by the Edison central station. Next to the festoon lighting the principal feature of the jubilee was the municipal arch donated to the city by the Western Electric Co., the General Electric Co., and the Chicago Edison Co. The structure was 45ft. high and 50ft. wide, and was lighted by 1,200 lights set in porcelain wall sockets arranged 15in. apart on strips of wood fastened to the arch in 8ft., 10ft. and 12ft. lengths. The entire 1,200 lights were put in place, wired up and connected in 24 hours. The arch was connected with the City Hall plant, which furnished the current by a 300ft. overhead line consisting of three No. 0000 B. & S. cables. The cost of the lighting for the peace jubilee is estimated to have been between £6,000 and £8,000. At the Philadelphia jubilee the principal feature was a similar arch and a colonnade of 28 columns illuminated by 5,000 incandescent lights. The arch was 80ft. long and 45ft. high and was constructed of wood and finally covered with plaster previously made in sections from the design. Feeders were carried from the underground mains of the Edison Electric Light Co. in iron pipes laid along the gutters on each side of Broad-street, and branch circuits for the columns were carried by the shafts on the outside. Current for the illumination was supplied by the Edison Electric Light Co. from its Sansom-street station for five hours on each of the three nights of the celebration. As the extra load upon the station came after the peak of the load, no extraordinary arrangements were necessary for power, the regular equipment supplying all that was needed for the occasion.

* *Wied. Ann.*, Vol. LIX., p. 532.
† *Journ. de Phys.*, 9, p. 381, 1890.

Electric Tanning Processes.—At the meeting of the Electric Potential Club in Boston, on the evening of October 26, Mr. George D. E. Burton illustrated and described by the aid of lantern slides the various apparatus and processes employed in tanning by electricity. The process of unhairing hides is effected by means of a vat or tank containing a suitable solution in which the hides are suspended and through which the current is passed by means of electrodes partially immersed therein. Screens are provided to protect the hides from actual contact with the electrodes, and there are also means for agitating the liquid. The effect of the current is to raise the hair from the skin and thus render the hair porous as well as more accessible to the action of the solution than was the case with the existing methods. Mr. Burton explained that the comparative rapidity of the electric treatment did not injure the leather. The tanning process was substantially similar as to apparatus and procedure, a suitable solution for the purpose, of course, being employed. The operation of the current, Mr. Burton considered, was mainly to open the pores of the material, thus affording the tanning solution better access thereto. Among the principal advantages claimed for the process are saving of time involved and consequent tying up of capital ; some improvement in product and a considerable reduction in space occupied, as the tanner using the electrical process may dispense with at least one-third of his vats. As to the actual saving in dollars and cents, information was meagre at present, but in one instance it has been found that there was a saving of 8d. on every 60lb. hide, as compared with the ordinary methods of tanning.

The Third Avenue Railroad Co.—Last Monday this company commenced the preliminary work of introducing electric power on its various lines in this city. The principal lines of the company are now operated by cable and the minor roads by horse. The underground conduit system will be installed on all lines and the work will be carried on as rapidly as possible. The company some time ago built a large power station at the upper end of the city, which has ever since been lying idle. It is proposed to equip this station with the most modern generating machinery of the alternating type and distribute high tension currents to various sub-stations throughout the city, where the current will be transformed to lower potential for the operation of the cars.

The John Stephenson Co.—This well known street car builder of this city has applied to the Court for permission to dissolve the corporation and for the appointment of receivers. Messrs. Albert A. Wilson and Louis Stern were appointed receivers. The petition states that the company cannot meet its maturing obligations. The company is carrying out a number of important and valuable contracts from which, if they can be completed, considerable profit can be realised which will be of benefit to its creditors.

Calcium Carbide Furnaces in Canada.—A new industry has been established in Ottawa, Canada. It is the manufacture of calcium carbide for the production of acetylene gas by means of a new—yet simple and effective—method. The inventors are Messrs. H. Lamoth and J. W. McRae, of Ottawa. The novelty lies in the furnace itself, which consists of two electrodes, one suspended above, and the other placed on the ground. The two are connected by means of carbon pencils which form an arc, producing sufficient heat to melt the coke and limestone which are piled around the electrodes, and form it into calcium carbide. It is the intention of the promoters of this new industry to erect a plant of forty furnaces which will be kept running 16 hours a day. Carbide is produced for £12 a ton wholesale, and the factories now manufacturing this product throughout Canada are unable to keep up with the orders.

The American Asiatic Association.—Many of the largest producing concerns in various lines of trade have organised an associatien under the above-named title, for the purpose of disseminating among its members all the information touching matters pertaining to trade with Asiatic countries, including China and the Philippines. Among its members are such concerns as the General Electric Co., the Okonite Co., the Westinghouse Electric and Manufacturing Co. and many others of equal standing in different branches of industry.

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LEGAL INTELLIGENCE.

Holophane (Limited) v. O. Berend and Co. (Limited).

Mr. Justice Kekewich heard this action on Tuesday.

Mr. JESSEL (for plaintiffs) said the action was for infringement of patent, and at the last moment defendants had agreed to submit to an injunction and pay costs, plaintiffs waiving their claim for damages. He asked his lordship to issue an injunction and for two things besides: first, a certificate that the plaintiffs' particulars of breaches were reasonable and proper; and, secondly, a certificate that the validity of the patent had come into question.

Mr. Justice KEKEWICH: I am bound by the authorities.

Mr. JESSEL submitted that the authorities were in favour of granting the certificates. Defendants admitted that they did threaten, and did intend to put on the market, a globe which they now admitted was a breach of the Holophane patent. In the present case defendants, by appearing by counsel and admitting the plaintiffs' rights to an injunction, admitted that there were breaches. When the defendants not only did not run away, but fought you and only gave in at the very last minute—the case was settled only an hour or two before—in order to save expense, the Court had jurisdiction to certify. This case did not stop there. One of the principal grounds of defence was anticipation of patent by Mr. A. P. Trotter, an electrician of great eminence, who was now electrical adviser at the Cape. His evidence had been taken on commission, and did not support the defendants' contention, now abandoned, that his own patent anticipated the Holophane; he said it was outside the Holophane patent altogether. Considerable expense had been entailed in going out to the Cape, and they might take it that the defendants had come to the conclusion that they could not resist the action. So that really there was no reason for withholding the certificate which his lordship would have given if he had put one witness in the box, and counsel for the other side had said that he could not carry the case further. There was only one case he could find, a judgment by Mr. Justice Kay, which went against his contention that the plaintiffs were entitled to a certificate that the validity of the patent had come into question, and that was on the ground that there was no appearance. There was a mass of evidence taken on commission on the file which supported the plaintiffs' case. Sometimes a certificate had been refused where there was a possibility of collusion, but there was no suspicion of the kind in that case. It had been fought out to the very last moment, and was defended both on the action and on the original motion.

Mr. CANN, for defendants, said he submitted to the order. They had come to an arrangement with plaintiffs, and there was an honourable understanding that defendants abide by his lordship's decision upon this point of certifying.

Mr. Justice KEKEWICH said an injunction would issue on the terms agreed upon. As to the certificates which he was asked to grant, he said without hesitation that the tendency of the Courts had been to refuse a certificate unless the Court was first satisfied, as it could only be by hearing witnesses and examining documents, that the certificate ought to be granted. He was asked to certify that the plaintiffs' certificates of breaches were reasonable and proper without understanding them, without knowing how far they could be proved or might fail. That was not a proper exercise of judicial functions. As regards the second certificate for which he was asked, that the validity of the plaintiffs' patents had come into question, he asked himself why that certificate was wanted. It would not increase the costs payable to the plaintiffs now, but it would enable them on another action if they won—as they might win—without doing more than filing a statement of claim against a defendant who did not appear, to tax costs as between solicitor and client. That was a very great advantage to a patentee, and plaintiffs sought to obtain it in a case in which, so far as his lordship knew, if it were fought out the letters patent might prove to be invalid. His lordship did not think that in a case where invalidity had been pleaded and at the last moment the defendants submitted, he ought to grant a certificate. While agreeing with the statement that there was no collusion here, such a course might open a door to possible oppression of other defendants. On those grounds the certificates must be refused.

Judgment accordingly.

Earl of Galloway v. Elieson Lamina Accumulator Co. (Limited).

This action came before Mr. Justice Kekewich, on Saturday, on a motion for judgment on default of appearance in a debenture-holder's action, and Mr. Justice KEKEWICH (addressing counsel for plaintiffs) said, although counsel did not ask to continue the manager after Jan. 31, 1899, he should extend the time if possible.

Mr. WARRINGTON, Q.C. (for plaintiffs) said that they hoped to sell the undertaking as rapidly as possible, and if his lordship would continue the manager until some time after the sale he should be glad.

His LORDSHIP: I think you had better say till April 30.

Mr. WARRINGTON said that there ought to be an inquiry as to the debentures.

Mr. Justice KEKEWICH: Not only that, but I think there ought to be an inquiry as to the other charges. I have generally found it necessary, and it does not add to the expense.

Mr. WARRINGTON: It is proposed to sell at the present moment the business, stock-in-trade, book debts and other assets, with liberty to apply in chambers as to the other property. Sale was the only way to protect the assets.

Mr. Justice KEKEWICH said he did not care to order a sale, as a rule. The plaintiffs were entitled to a charge, but it was a charge which could not be effective.

Mr. WARRINGTON: No; your Lordship sees that at the time the money comes into Court the debentures will become due. They will become due on non-payment of interest. Interest is payable half-yearly on June 30th and December 30th, so that it will become due on December 30th, and the principal money will become due three months after default. It will become only a question of the plaintiffs receiving their debentures out of the proceeds of the sale. If something is not done the assets will all disappear. It is desirable to sell the business at once as a going concern, and to sell the stock-in-trade at once as it is likely to injure if kept for any length of time. Your lordship can order the stock-in-trade to be sold at once, but it would be a serious loss to everybody to sell the stock-in-trade by itself. That would be breaking up everything. I submit there being a charge your lordship has the means of protecting the property. The debenture holders are entitled to a charge in virtue of the debentures, and your lordship is entitled to make an order for sale although it may be that they cannot be paid immediately out of the proceeds of the sale.

Mr. Justice KEKEWICH: I think I may go that far. This is goodwill and stock-in-trade. You only ask me to sell the business. The minutes must, therefore, be altered.

Pearson v. Hartnell.

At the Leeds County Court, on Wednesday, this adjourned action, which was for the recovery of £280. 12s. compensation for injuries received while in the employment of Mr. Wilson Hartnell, of Leeds, was heard. Full particulars in this action were given in our issue of the 28th ult. After hearing further evidence, judgment was given for the defendant, but without costs.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury court, Fleet-street, London:—

NOW READY.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. The Author hopes that, besides Telegraph and Telephone Engineers, it may, perhaps, also prove of service to those in charge of cables for the transmission of light and power. The localisation of faults has been very fully investigated, including the different degrees in which the various methods are affected by the presence of a second fault or of general leakage.—*Extract from Preface.* Demy 8vo, fully illustrated. 10s. 6d., post free; abroad 11s.

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d.

"The Students' Guide to Submarine Cable Testing."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition now ready.*

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"Laboratory Notes and Forms."—With the above title we have ready the New Edition of a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves."—By Dr. O. J. Lodge, with many original illustrations. *Enlarged Edition*, 2s. 6d. net, 2s. 9d. post free.

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"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated. price 1s. 6d.; post free, 1s. 9d.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. Prospectus on application.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. A fine large paper edition with wide margins for notes can also be supplied. Price 12s. 6d.; post free, 13s.; abroad, 13s. 6d. *New Edition in the press.*

"THE ALTERNATE CURRENT TRANSFORMER," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *New Edition.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth 2s. 9d. Single Primers, 8d. each, post free.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s.

IN THE PRESS.

"THE ELECTRIC ABC."—By Mrs. Ayrton.

"THE MANUFACTURE OF CARBONS FOR ALL ELECTRICAL PURPOSES."—By Francis Jehl.

"ELECTROMAGNETIC THEORY." By Oliver Heaviside. Vol. II.

"SECONDARY BATTERIES, THEIR DESIGN AND MANUFACTURE."—By E. J. Wade.

"PRIMARY BATTERIES: THEIR CONSTRUCTION AND USE."—By W. R. Cooper.

"PRACTICAL TELEPHONY."—By Dane Sinclair and F. C. Raphael.

"'THE ELECTRICIAN' WIREMAN'S POCKET-BOOK."

"The Electrician" Electrical Trades' Directory and Handbook.—An important announcement in connection with the 1899 issue of the "Big Blue Book" will be found in an advertisement on another page of the present issue, to which our readers will please refer.

TENDERS INVITED.

Extension of Time.—The *Salford* Electric Lighting committee invite tenders for the supply and erection of the following: (1) boilers, (2) engines, (3) dynamos, (4) boiler feed-pumps, (5) mechanical stokers, (6) superheaters, (7) economisers, (8) condensers, &c., (9) steam and water pipes, (10) cranes and weighing machines, (11) tanks, &c., (12) switchboards, and (13) booster. Further particulars are given in an advertisement in another column, and specifications, forms of tender, &c., may be obtained from the borough electrical engineer (Mr. C. L. Turner), Walness-road, Broughton. Tenders, addressed to the chairman of the Electricity committee, must be delivered at the offices of the town clerk (Mr. Samuel Brown), Town Hall, Salford, *by Dec. 15, not Dec. 1, as originally advertised.*

The *Beckenham* District Council invite tenders for the supply of the following electric lighting plant:—(*a*) Water-tube boilers and economiser; (*b*) steam alternators, transformers and switchboard; (*c*) pipework, feed pumps, overhead tank, feed-water heater, &c.; (*d*) arc lamps, lamp posts, &c.; (*e*) cables and street work; and (*f*) travelling crane. Specifications, &c., can be obtained after the 21st inst. from the consulting engineers (Messrs. Wilson and Story), 66, Victoria-street, London, S.W. Further particulars are set out in an advertisement elsewhere, and tenders must be sent to the clerk to the council (Mr. F. Stevens) by noon of Saturday, Dec. 17.

The *Shoreditch* (London) Vestry invite tenders for the supply of six direct-current rotary transformers, with switch gear complete, three of 66 kilowatt and three of 33 kilowatt capacity. Further particulars are given in an advertisement elsewhere. Tenders must be sent in not later than noon of Tuesday, Dec. 13, to the chief electrical engineer (Mr. C. Newton Russell), Electricity Supply Department, Coronet-street, Shoreditch.

The Corporation of *Barnsley* invite tenders for the supply and erection of: (1) Lancashire boilers and Green's economiser; (2) engines, dynamos, switchboard, condensers, feed-water pumps, balancing transformers, boosters, piping, tanks, crane, wiring of works, and engine, &c., foundations; (3) secondary batteries and accessories; (4) feeder and distributing mains (solid system); (5) potential leads, network and service boxes and service connections. Further particulars in our advertisement columns, and specifications, &c., can be obtained on application to the consulting engineer (Mr. Thos. L. Miller), 7, Tower-buildings, N., Water-street, Liverpool. The Corporation also invite tenders for the erection of a chimney and engine, dynamo and boiler house, storage rooms and offices. Specification, &c., from Mr. J. Henry Taylor, borough surveyor, to whom tenders should be sent by noon of Monday, Dec. 12th.

The *North-Eastern Railway Co.* invite tenders for the supply of telegraph apparatus, wire and line stores during the six months ending June 30, 1899. Some further particulars are set out in an advertisement elsewhere. Forms of tender from Mr. Graves, telegraph department, York, and tenders must be sent to the secretary (Mr. C. N. Wilkinson), at York, by noon of Monday, Dec. 5.

The *Shanghai* Council also invite tenders for a concession, for a period of 30 years, for the exclusive right of establishing and working a telephone system in Shanghai. Further particulars are set out in an advertisement on another page, and plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary Axe, London, E.C. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, whose telegraphic address is "Dynamo Shanghai." Tenders must be sent to the secretary (Mr. J. O. P. Bland), Shanghai, by noon of Friday, March 31.

The *Shanghai* Council also invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system. Particulars from Messrs. John Pook and Co., 8, Jeffrey's-square, London, E.C. Tenders to Mr. J. O. P. Bland, secretary, by noon of Wednesday, March 15, 1899.

Tenders are invited by the *Board of Control, Dublin*, for the supply of the necessary plant, wiring, &c., for the electric lighting of Richmond District Lunatic Asylum. Tenders to Mr. H. Williams, Custom House, Dublin, by 10 a.m. Dec. 5.

The *Great Northern Railway Co.* invite tenders for the supply of new, and the purchase of old, stores for 12 months from Jan. 1. Patterns will be exhibited at the Stores Department, Doncaster, where they may be inspected up to 5th prox. Tenders, addressed to the Stores Committee, must be sent to the Company's offices at King's Cross, London, N., by 10 a.m. on Tuesday, Dec. 6.

The *Glasgow* Corporation invite tenders for supplying switchboards and instruments at the new electricity works, Port Dundas. Tenders to town clerk (Sir J. D. Marwick) by Dec. 5.

The *Dublin* United Tramways Co. invite tenders for the supply of general stores, including electrical supplies, car fittings, ironmongery, &c., for the year 1899. Tenders to the chairman of the Company, 9, Upper Sackville-street, Dublin, by 5th prox.

The Electric Lighting committee of the borough of *Middlesbro'* require tenders for the supply and erection of electric generating plant, &c. Tenders to Mr. Geo. Bainbridge, Municipal Buildings, Middlesbro', by Nov. 29.

The *Halifax* Corporation require tenders for meters, house and sub-station transformers, arc lamp transformers and alternating current arc lamps. Particulars from borough electrical engineer.

The *Shoreditch* (London) Vestry invite tenders for boring an artesian well at the electricity works. Tenders to Vestry Clerk, Town Hall, Old-street, E.C., by Dec. 12.

The *Coventry* Electric Light committee require tenders for the erection of five electric sub-stations. Tenders to the town clerk by Dec. 13.

The *Tanfield* District Council invite tenders for electric lighting plant. Particulars from Mr. R. Heslop, Burnopfield, R.S.O., to whom tenders by 29th inst.

The *French* Post and Telegraph Authorities require tenders for supplying 80 kilometres of submarine cable core, 30 tons of galvanised iron wire (5mm. dia.), and 100 tons of galvanised iron wire (8mm. dia.). Tenders to Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris, by Dec. 6.

TENDERS RECEIVED AND ACCEPTED.

The *Watford* District Council have accepted the tender of the Reason Manufacturing Co. for supply of cut-outs, and that of Messrs. Venner and Co. for the supply of Hookham electricity meters to their electricity department.

The *Wimbledon* District Council have accepted the tender of the British Electric Transformer Manufacturing Co. for the supply of transformers and boxes at £1,960. 13s. 6d.

The *Barnsley* Town Council have accepted the tender of Mr. J. Taylor to provide electrical communication between the central fire station and the houses of firemen, for £102. 10s.

The Electric Lighting committee of the *Edinburgh* Town Council recommend the acceptance of the tender of Messrs. Mather and Platt for the supply of steam engines and dynamos for the new electricity supply station in M'Donald-road. The amount of the contract is about £40,000. Two of the new machines must be delivered by Aug. 15, two by Sept. 15 of next year, and the remaining two on a later date. In all there will be 17 boilers to contract for, amounting to about £20,000; Mr. Sinclair has

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obtained the contract for seven, and Messrs. D. Stewart and Co. for six, to be delivered on Aug. 15 and Sept. 15. The remaining four boilers, two from each contractor, are to be delivered at a later date. Altogether there will be installed next year at M'Donald-road station more machinery than there is at Dewar Place at the present time, and the committee will be able to supply current to more than double the present number of lamps.

The *Hornsey* District Council have accepted the tender of Messrs. Jukes, Coulson, Stokes and Co. for the supply of cast-iron telephone pipes. The following tenders were received :—

	Pipes.	Covers.
Jukes, Coulson, Stokes & Co. (*accepted*)	£6 5 0	£1 3 9
Gibb and Co.	6 3 4	1 7 0
Newton, Chambers and Co.	6 5 0	1 17 6
Bird and Co.	6 5 0	1 6 4
Hollom and Co.	6 10 0	1 7 0
Stanton Iron Co.	6 18 6	1 17 6
Pontifex and Co.	7 0 0	1 10 0
H. and G. Measures	12 0 0	1 3 0

The Tramways committee of the *Liverpool* City Council have accepted the tender of the Leeds Steel Works, for the supply of steel rails, for the new Aigburth-road extension, at £7 per ton.

APPOINTMENTS VACANT AND FILLED.

A technical instructor is required for the Thomason Engineering College, Roorkee, India. Further particulars are given in our advertisement columns, and applications must be sent in, on forms to be obtained from the Director-General of Stores, India Office, Whitehall, London, S.W., not later than 28th inst.

The Electricity committee of the borough of Ashton-under-Lyne require an assistant engineer. Salary £130 per annum. The committee also require a switchboard attendant for a three-wire and traction switchboard. Particulars in our advertisement columns. Applications, addressed to chairman of committee, must be in by Dec. 7.

The Wimbledon District Council require a resident electrical engineer. Salary £250 per annum. An advertisement elsewhere contains further particulars. Applications must be sent to the clerk (Mr. W. H. Whitfield), Council Offices, Broadway, Wimbledon, by 10 a.m. of Tuesday, Dec. 6.

The Vestry of St. Mary, Newington, London, require a resident electrical engineer to take charge (under the superintendence of the consulting engineers) of the erection of the machinery at their electricity generating station. Salary £250 per annum. Applications to Mr. L. J. Dunham, Vestry Hall, Walworth-road, S.E., by Dec. 2.

As announced in our advertisement columns the Leyton District Council require a book-keeper, who understands electric lighting accounts. Commencing salary £100, rising to £150 per annum. Applications to the chief electrical engineer (Mr. H. Collings Bishop), Cathall-road, Leytonstone, by Dec. 3.

The Leith Town Council require for their electric lighting department two assistant engineers, jointer, arc lamp trimmers, mains superintendent, switchboard hands, clerks, &c. Applications to convener of Electric Lighting committee by Nov. 26.

Mr. John Young, the tramway manager at Glasgow, has been chosen by the General Purposes committee of the London County Council as superintendent of the London tramways. The salary attached to the office is £1,500 per annum.

Mr. Theodore Parsons, of Bath, has been appointed assistant electrical engineer at the Halifax Corporation electricity works.

Mr. S. L. Smith, London, has been appointed third assistant engineer at Southampton.

At the meeting of the Worcester City Council, on Tuesday, Mr. C. J. Sutherland, of Hanley, was appointed city electrical engineer at a salary of £350 per annum. Mr. Sutherland has for some years occupied the post of joint electrical engineer and manager (with Mr. C. A. Cowell) of the Hanley electricity works.

BUSINESS NOTICES.

The Notting Hill Electric Lighting Co. (Limited) have removed to new offices at 140, High-street, Notting Hill Gate, London, W., adjoining the works.

Attention is called to a legal notice which appears in our advertisement columns relating to the action decided on Tuesday by Mr. Justice Kekewich in the Chancery Division, dealing with the manufacture and sale of Holophane globes and shades.

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting will be held at Swan House, Great Swan-lane, London, E.C., on Dec. 21, to receive an account of the winding up of the Times Electric Lamp Co. (Limited).

At a meeting of the United Ordnance and Engineering Co., on 14th inst., it was decided to wind up the company *voluntarily*, and Mr. W. E. Davies, of Broad Sanctuary-chambers, Westminster, was appointed liquidator.

Creditors of J. Goodman and Co. (Limited) must send particulars of their claims to the liquidator, Mr. J. F. Lovering, 3, Church-passage, Guildhall, London, E.C., by Dec. 29.

Creditors of Rose and Bird (Limited) must send particulars of their claims to the liquidator, Mr. A. H. Rose, 24, Stamford-street, by Dec. 9. It will be remembered that this company recently went into voluntary liquidation for the purpose of amalgamating with the Crystal Electric Lamp Co.

Plant for Sale.—The Glasgow Corporation invite offers for the purchase of two 200 H.P. boilers, two 200 H.P. engines and four 50-light Brush arc light dynamos. Further particulars from the city electrical engineer (Mr. W. A. Chamen), 75, Waterloo-street, and tenders to the town clerk (Sir J. D. Marwick), City-chambers, Glasgow, by Dec. 6. See also advertisement.

Storage Batteries.—The following letter has appeared from Mr. Marshal Halstead, United States Consul, 16A, Corporation-street, Birmingham :—

Perhaps in your desire to be useful to Birmingham manufacturers you may wish to give circulation to the following inquiry, which I have received from a firm of merchants in the United States :—"We are looking for a chloride storage battery, to run about 150 hours without being recharged. If you know of any one in your territory who makes such a battery please put us in commuication with them. We want a price on 1,000 to 5,000 of these, delivered in London. Any information you can give us in relation to this matter, or the whereabouts of storage battery people, will be appreciated." If British manufacturers of storage batteries wish to get into correspondence with the American merchants making the inquiry they may address their communications to me (open), and I will forward them with due promptness.

Collision.—On Thursday the new cable steamer "Anglia," of the Telegraph Construction and Maintenance Co's. fleet, while at anchor in the Thames taking in cable and stores, was run into by another vessel and received damage which will necessitate her being put into dock for repairs.

Trades Unionism and the Wages Question.—We have received from Mr. F. E. Sims, general secretary of the Electrical Trades Union, copies of correspondence that has passed between the Union and Her Majesty's Office of Works with reference to the discharge of a member of the Union from his employment as an electrical wireman. The correspondence extends from June 9 to Nov. 11, and commences with a request, from the workman, for an increase of wages on the ground "that the rate of pay was below the minimum rate paid by contractors." In this letter it is stated that a large number of electrical contracting firms pay 9½d. and 10d. per hour to wiremen, and 11d. and 1s. per hour to charge hands. This application was met by a refusal, on the ground that the wages paid were fair for the class of work being done by the applicant. This was shortly afterwards followed by the dismissal of the aggrieved workman, on the ground that his services were no longer required. Subsequent letters between the parties concerned and the First Commissioner of Works complete the correspondence. We have only room for the following, which expresses the views of the Union and the reply of the Department :—

"To the Right. Hon. A. Akers-Douglas, M.P. "September 16, 1898.

"SIR: I am requested by my committee to bring before your notice the action of your engineer at the Houses of Parliament Electrical Department in dismissing one of our members, who was employed as an electrical wireman at St. Stephen's House, S.W. He was discharged on July 2 last on the ground that the Department had no further need for his services. We contend that he has been discharged because he ventured to ask for a higher rate of pay than the Department are at present paying, and for no other reason. At the time he was discharged, other men were taken on and kept on for weeks, so that slackness cannot be urged as the reason, and we are in a position to prove that Mr. Fennimore, foreman of the Department, told other men in the Department's employ, that the reason he was discharging Mr. Calipe was because he was dissatisfied, as he had asked for 9½d. per hour and they were only paying 9d. No fault was found or could be found with his work, and we contend that the Department treated this man very unfairly in discharging him because he ventured to ask for ½d. an hour rise. The reason that this man wrote in for a higher rate of wages than the Department was paying was because, to begin with, the men in the employ of the Department are allowed only to work 50 hours a week, which, at 9d. per hour, amounts to £1. 17s. 6d. When we are working for electrical firms we work at least 53 or 54 hours, so that the men lose at least 2s. 3d. per week, as compared with that they get in outside firms. As there are several firms who pay 9½d. per hour, the discharged man thought that there would be no harm in calling the Department's attention to it, and suggesting that considering the loss involved the Department might see their way to increase his wages by ½d. per hour. There was no suggestion that he would leave or was dissatisfied; the advance was simply asked as a matter of justice, with the result that he was discharged for so doing.—F. E. SIMS, Gen. Sec."

[REPLY.] "October 14, 1898.

"SIR: With reference to your letter of the 16th ultimo relative to the discharge of an electrical wireman in the employment of this Department, I am directed by the First Commissioner of Her Majesty's Works, &c., to

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acquaint you, for the information of the Electrical Trades Union, that the man in question was dismissed because he was an unsatisfactory workman, and his discharge was in no way connected with his request for an advance of wages.—REGINALD BRETT."

Telephones and Telephone Accessories.—We have received from Messrs. W. F. Dennis and Co., 23, Billiter-street, London, E.C., a general price list of telephones, switchboards, and telephone instruments and accessories, manufactured by the Antwerp Telephone and Electrical Works, for which firm Messrs. Dennis and Co. are sole agents in this country.

Wires Price List.—Messrs. Ward and Goldstone, of Manchester, forward a price list of insulated high-conductivity wires.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Nov. 16 to Nov. 22, with the ports of destination :—

Aden—£895 (telegraph material). *Argentina*—Buenos Ayres, £804. *Australasia*—Adelaide, £73 ; Launceston, £90 ; Melbourne, £476 ; Rockhampton, £313 ; Sydney, £1,023 ; Wellington, £32. *Belgium*—Brussels, £30 ; Ostend, £10. *Brazil*—Bahia, £217 ; Rio Janeiro, £32. *Canada*—Halifax, £18 ; Quebec, £100. *Ceylon*—Colombo, £81. *China*—Shanghai, £1,180 (incl. £1,087 telegraph material) ; Tientsin, £79 (telegraph material). *Denmark*—Copenhagen, £84. *Germany*—Hamburg, £110. *Holland*—Amsterdam, £61; Rotterdam, £107 (telegraph material). *Hong Kong*—£122. *India*—Bombay, £140 ; Calcutta, £829 (including £329 telegraph wires ; Madras, £38. *Japan*—Yokohama, £644. *Malta*—£157. *Mexico*—Vera Cruz, £33 (telegraph material). *Norway*—Christiana, £460. *Russia*—Helsingfors, £43. *South Africa*—Cape Town, £54 ; Durban, £2,246 ; East London, £151 ; Port Elizabeth, £73. *Spain*—Malaga, £40 telegraph cable). *Straits Settlements*—Penang, £118 (telegraph material) ; Singapore, £58. *Sweden*—Gothenburg, £103 ; Stockholm, £189 (telegraph material). *United States*—Boston, £45. *West Africa*—Senegal, &c., 55 knots telegraph cable. Total, £11,358 against £22,140 in the corresponding week last year (Nov. 17 to 23).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Aberdeen.—A bill is being promoted by the Corporation for the extension of the tramways and for the introduction of electric traction. A deputation has been appointed for the purpose of visiting the Glasgow electric tramways in order to obtain information for the guidance of the Council. The visit of the deputation, which will be accompanied by the burgh surveyor and the electrical engineer (Mr. J. A. Bell), will take place on Dec. 6.

Aberystwith.—The District Council have entered into a new agreement with the Aberystwith Electric Lighting Co. for the public lighting. The annual charge for current to, and maintenance of, each arc lamp is now £17. 17s. against £20 previously.

Alleged Perjury.—John Limbrey Higgs, Delahay-street, again appeared before Mr. Lushington, at Bow-street Police Court, to an adjourned summons charging him with having committed perjury in the course of his examination in connection with the winding up of the I.E.S. Accumulator Co. (Limited). Over two hours were occupied in the cross-examination of the mortgagor, Mr. John Walton, but eventually the case was again adjourned till 29th inst.

Argentine.—A law passed on Sept. 22 by the Argentine Congress (which remains in force until Dec. 31) increases certain of the Customs duties. *Ad valorem* duties of 5 per cent. and under are doubled, above 5 per cent. are subject to 10 per cent. additional, and 10 per cent. on Customs law. Among the goods which come under the 5 per cent. *ad val.* classification are electric light and power plant and apparatus (except meters and fittings) and steam motors.

Ayr.—The Town Council, which has had under consideration a lengthy report from Mr. I. E. Winslow, on the construction of electric tramways, have decided to obtain a provisional order for an electric tramway from Burns's monument to Prestwick Cross. A scheme for the construction of a light (electric) railway in the district is to be opposed.

The salary of the burgh electrical engineer (Mr. A. J. Fuller) has been increased from £250 to £300 per annum. The Lighting committee recommend the Police Commissioners to obtain parliamentary powers for wiring buildings in that town on the easy payment system.

Battersea (London).—The Vestry have appointed Mr. H. Riley, 28, Victoria-street, S.W., to get out quantities in connection with the projected electric lighting station.

Birmingham.—At a meeting of the City Council, on Wednesday, proposals regarding the purchase of the undertaking of the Birmingham Electric Supply Co. at £420,000 were approved, and the draft bill of the Council was passed. Powers to borrow £500,000 are being sought

Brighton.—The Town Council have decided to create a special Tramways committee to deal with the proposal to construct electric tramways in the town.

British Columbia.—One of the most important improvements in Victoria, B.C., during 1898 has been the extension of the lines of the Western Union Telegraph Co. to the city. This line has been in operation since June 9. The Western Union Co., being incorporated under the laws of the United States, has no right to operate in Canada, and consequently the line connecting with Port Angeles, Washington, is operated by the Great North-Western Telegraph Co., connecting with the Western Union Co.'s service. The new line has a cable across Puget Sound, from Seattle to Port Townsend, thence by land to Port Angeles, thence a cable across the straits of Juan de Fuca to Albert Head, and thence by land to Victoria. Since this line was built the Canadian Pacific Railway Co. has laid a cable from Victoria to Port Angeles direct, so that now Victoria has two telegraph lines direct to the States. Each company works duplex. During August the work of conducting power from the Sooke Mountains, 18 miles distant from the city, for the electric tramroad and the illumination of Victoria by electricity, has been completed. The water from the mountains starts 2,300ft. above the level of the sea, and is the highest fall in Canada. About 700ft. above sea level and 16 miles from Victoria, these waters form a lake covering 150 acres, into which empties Goldstream River, which is tapped 3 miles from its source by an artificial lake or reservoir covering 7½ acres, 1,122ft. above sea level. From this reservoir the water passes through a steel pipe 33in. in diameter, 6,700ft. to the power house, which is 460ft. above sea level, thus giving a fall of 1,000ft. from the main lake, and through this pipe 15,000,000ft. of water pass every 24 hours, giving 1,500 H.P. In the power house, located at the foot of a mountain, is an electric plant which is said to be without a rival for size and completeness on the North Pacific coast. This plant was supplied by Messrs. Hasson and Hunt, of San Francisco. From the power house current is carried 12 miles to the city, and furnishes power sufficient to operate the street-car and electric light systems and private supply to a number of offices and factories.

Burnley.—A Local Government Board inquiry was held here last week into the application of the Town Council to borrow £10,000 for further extensions of the electric lighting system. £25,000 is already being spent on extensions, and the additional loan is required for new mains to meet the rapidly increasing demand for current.

Camberwell (London).—The Vestry has decided to wire the Vestry Hall and offices for the electric light.

City of London.—At the meeting of the Common Council last week the Streets committee presented a report on the application of the Metropolitan Electric Supply Co. for the Corporation's consent to an application for a provisional order for the supply of electricity within the City. The committee recommended that the company should be informed that the Corporation regretted it was unable to give its consent to the application. The report was adopted.

Cork.—The first experiment in electric street lighting was made on the 15th inst., when current was switched on to the arc lamps erected in Patrick and Bridge-streets.

Croydon.—A Local Government Board inquiry was held here last week into the application of the Town Council to borrow £2,250 for the purchase of that portion of the undertaking of the Crystal Palace District Electric Supply Co. within the borough of Croydon, and £850 for erecting a sub-station at Upper Norwood.

Darwen.—A town's meeting on Wednesday approved the proposals of the Town Council to acquire the local tramways, to construct additional lines, to introduce electric traction, and to carry out other improvements at an estimated cost of £150,000.

Dublin.—The report of the Electric Lighting committee presented at the meeting of the Corporation on Monday stated that the gross income for the year 1897 had been £13,089, expenditure £8,036. After allowing for interest and sinking fund there was a credit balance of £953. Ald. Meade stated that application would be made for sanction to borrow a further £8,000 for the renewal of the mains. Pending this loan the committee had confined their efforts to putting the existing mains into fair order. The report was adopted.

Edinburgh.—Since Oct. 17 applications for an equivalent of 7,252 8 c.p. lamps have been received. In another column some particulars are given of the tenders accepted for the supply of plant for the new station at M'Donald-road.

Electric Lamps in Japan.—Writing on Sept. 1 last, on the subject of the outlook for the electric lamp trade in Japan, the United States Consul at Yokohama says :—"Almost every prominent American and European manufacturer of these goods is represented here either by specially-appointed agents or by correspondents. The Edison-Swan Company (British), Siemens and Halske, Severin Senator, and the General Electric Co. (Berlin) may be mentioned as leading European concerns here, who, by their agents, are making strong efforts to secure a large

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share of the trade. German 16-c.p. lamps, guaranteed for 1,000 hours, have been offered here for 6d. each. American and other lamps of the same quality are now selling here for 8d. each. This unusually low price is the result of over competition, and will probably be of short duration."

Electric Lighting Notices.—Notice of intention to apply for provisional electric lighting orders has been given by the following:

Corporations of Durham, Heywood, Kilmarnock, Mansfield and Rawtenstall.

District Councils of Ashford, Audenshaw, Bognor, Cheriton, East Barnet, Failsworth, Fenton, Halesowen, Pemberton, Stourbridge, Swinton, Wath-upon-Dearne, and Worksop, and the Township Commissioners of Clontarf (Dublin).

County of London and Brush Provincial Co. for Bermondsey, Rotherhithe, Deptford, Lambeth, Lewisham, and Lee (London); Charing Cross and Strand Electricity Supply Corporation and Metropolitan Electric Supply Co. for City of London; Smithfield Markets Electric Supply Co. for City of London, St. Luke's and Holborn; West Kent Electricity Supply Co. for Bexley, Crayford and Erith; Camborne Electricity Supply Co. for Camborne; Blackheath and Greenwich District Electric Light Co. for Lee; Drake and Gorham Electric Light (Pioneer) Syndicate for Musselburgh; Ventnor Electric Light and Power Co. for Newport (Isle of Wight); Kelvinside Electricity Supply Co. for Partick; Ryde Electric Light and Power Co. for Ryde; Laing, Wharton and Down for Slough and Datchet; Weston-super-Mare and District Electric Light and Power Syndicate for Weston-super-Mare; and Mardy Electric Lighting Co. for Ystradyfodwg (Glam.).

In the following cases notice to proceed by private Bill has been given:—

Corporations: Birmingham, for powers to purchase the undertaking of the Birmingham Electric Supply Co., and to extend the company's area of supply; Loughborough, to supply electric current, to sell and let on hire electric motors, &c.; Manchester, for lighting culs de sac, to purchase and let on hire electric motors and other electrical apparatus, to establish an insurance fund, for borrowing powers, &c.; Whitehaven, to extend electric lighting area.

Companies: Kensington and Knightsbridge Electric Lighting Company, and the Notting Hill Electric Lighting Company, to acquire lands and erect a generating station in the parish of Hammersmith (London), and to lay mains therefrom into the areas of supply of both companies; St. James's and Pall Mall Electric Lighting Co. to purchase compulsorily land in the parish of St. James's, Westminster, and to erect generating station thereon and for other powers; Central Electric Supply Co. to generate and supply electric energy "in bulk," and to erect generating station in the parish of St. Marylebone; County of London and Brush Provincial Electric Lighting Co. to compulsorily acquire certain lands and buildings in the parishes of St. James (Camberwell), Wandsworth, St. Luke's (Middlesex) and St. James (Southwark), and other parishes; Walker and Wallsend Union Gas Co. to generate and supply electric current.

Bills will also be presented:

To incorporate a company to be called the South Lancashire and Cheshire Electricity Co., to generate and supply electric current within parts of the counties of Lancaster and Chester (including St. Helens, Widnes, Warrington, Wigan, Liverpool, Runcorn, Eccles, and Bolton), to enter into agreements with local authorities and others; to incorporate a company to be entitled the Leicestershire and Warwickshire Electric Supply Co., to generate and supply electrical energy within parts of the counties of Leicester, Warwick, and Derby (including Birmingham, Leicester, Coventry, Sutton Coldfield, Rugby, Leamington, Warwick, Ashby, Market Bosworth, Tamworth, Atherstone, Hinckley, Coleshill, Lutterworth, Nuneaton, Burton, Lichfield, and Derby), and to enter into agreements with local authorities and others; to incorporate a company to be entitled the Lancashire Electric Power Co., to generate and supply electricity within parts of the counties of Lancaster and Chester (including Liverpool, Manchester, Preston, Burnley, Bolton, Blackburn, Oldham, Widnes, St. Helen's, Stockport, Macclesfield, Birkenhead, Salford, Accrington and Darwen); to incorporate a company to acquire undertakings of Crowborough District Gas and Mayfield District Gas Light Companies, and to enable the company to generate and supply electric current for lighting and other purposes.

Electric Power Schemes for Lancashire.—As will be seen from the list of official notices given above, bills are being promoted to incorporate companies to generate and sell electric current for public and private lighting, motive power, heating, chemical reduction, trade manufacturing, and all public and private purposes in Lancashire and Cheshire. The proposed area of supply includes St. Helens, Widnes, Warrington, Wigan, Prescot, Leigh, Hindley, Ormskirk, Liverpool, Birkenhead, Runcorn, Eccles, Manchester, Bolton, Horwich, Chorley, &c., besides all other boroughs, towns, &c., within the district. Powers are also sought to acquire, construct, maintain and use, and to sell, let and otherwise dispose of machinery, plant and apparatus connected with electric supply, &c. One of these companies is to have an authorised capital of £1,000,000.

Electric Traction Notices.—Official notice of intention to apply for provisional tramway orders, to be worked electrically, has been given by the following:—

The Corporations of Belfast, Blackpool, Hastings, Reading and Southport, and the District Councils of Audenshaw, Barking, Matlock and Moss Side; the Gravesend, Rosherville and Northfleet Tramways Co., to construct additional tramways, introduce electric traction, and to sell the undertaking to the Drake and Gorham Electric Power and Traction Co.; and the Ipswich Tramways Co. to construct additional tramways, to use electric traction, and to sell undertaking to the Drake and Gorham Electric Power and Traction Co.

In the following cases procedure, by private bill, has been decided upon:—

Corporations: Blackpool, Bradford, Halifax, Leeds, Sunderland, Bury, Darwen, Derby, Gt. Yarmouth, Oldham, Wolverhampton, Manchester, Stockport, Newcastle-on-Tyne and Nottingham.

Companies: Baker-street and Waterloo Railway Co., British Electric Traction Co. (for Bexhill and St. Leonards, Hastings), Brompton and Piccadilly Circus Railway Co. (to enter into agreement with Metropolitan Railway Co. to guarantee interest, &c.), Charing Cross, Euston and Hampstead Railway Co., Central London Railway Co., City and Brixton Railway Co., London United Tramways, and the South Staffordshire Tramways Co.

Bills will also be introduced:—

To incorporate a company to construct an underground (electric) railway from Wood Green to the Fleet-street end of the Strand (London), and to incorporate a company, to be entitled the North West London Railway Co. to construct an underground (electric) railway from the Marble Arch to Cricklewood.

Exhibition Lighting.—One of the features of the Jubilee Cattle Show, which was opened on Saturday, at Bingley Hall, Birmingham, is the installation of a permanent electric lighting plant by the Walsall Electrical Co. Hitherto the electric lighting has been of a temporary character.

Fire.—A serious fire occurred on Friday at the works of Messrs. Hick, Hargreaves and Co., engineers, of Bolton. The damage was very great, and 300 employés are affected.

Gainsborough.—The District Council are promoting a bill for the acquisition of the gas company's undertaking and for power to generate and supply electric current.

Glasgow.—At a recent meeting of the Electricity committee it was reported that the Kelvinside Electricity Co. were willing to dispose of their undertaking to the Corporation for £50,000. The committee are willing to pay £30,000, being the amount of the company's outlay in establishing the business, and what they consider is the value of the goodwill. The Corporation and the Partick Commissioners will oppose the company's application to extend their powers to Partick.

The question of equipping the Govanhill tramway route on the overhead trolley system has been postponed pending the presentation of an analysis by the general manager (Mr. Young) of the report recently received from the Metropolitan Street Railway Co., of New York, in which three months' experience of the working of the conduit system on that line was dealt with. Reference to this report will be found in our last issue.

Great Grimsby.—The Public Lighting committee have approved the plans of the proposed electricity supply works.

Greenock.—The burgh electrical engineer (Mr. S. E. Fedden, late of Edinburgh) has taken up his duties.

Hants.—The County Offices at Winchester are to be wired for electric light. Current will be taken from the mains of the Winchester Electric Light and Power Co.

Heckmondwike.—Mr. W. C. C. Hawtayne has been appointed consulting engineer to the District Council, in connection with their proposed electric lighting scheme.

Imperial Penny Post.—Ceylon has arranged to join the Imperial Penny Postage movement, and letters between the United Kingdom and Ceylon can be sent after Christmas day at the cost of a penny each.

Institution of Engineers of the River Plate.—There has recently been established at Buenos Ayres an institution which embraces members of all branches of the engineering profession. It was originally intended to establish an electrical engineering institute, but, upon discussion amongst probable members, the larger scheme was adopted, and on Sept. 29 the following gentlemen were elected members of the governing council:—

President: J. W. McCrosky.
First Vice-President and Secretary: Ernesto Danvers.
Second Vice-President: T. L. Chubb.
Third Vice-President: Malcolm Graham.
Treasurer: L. B. Trant.
Committee: J. Abella, W. B. Basset-Smith, C. Cicogna, E. W. Dean, Percy Grant, G. H. Green, J. Marjoribanks, H. Randolph, J. R. Sutton and E. Wilson Woods.

The movement to establish the institution has been very successful, over 60 members having joined up to the 10th ult. The memorandum and articles of association have been approved, and the new society, which owes its initiation mainly to its first vice-president and secretary (Mr. Ernesto Danvers), has started upon what promises to prove a successful career. The new institution will doubtless form a rallying point for the large number of engineers of all nations whose work lies in the Plate region.

Islington (London).—In moving the adoption of a report of the Electric Lighting committee recommending the execution of certain

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building work at the electricity station, Mr. Gordon announced that, if the work were not completed within six months, they would have to disappoint a large number of customers who had applied for current. Eventually the recommendation was referred back in order that the work may be put up for public tender.

Japan Customs Tariff.—The rates of import duties established by the recent general tariff law of Japan places a duty of 10 per cent. *ad valorem* upon electric light machinery and parts thereof, telephones and telephone parts, telegraph wire (galvanised, tramway cars and carriages and parts thereof, submarine cables and subterranean telegraph wires; and 20 per cent. *ad valorem* on lamps, lanterns and parts thereof. Articles which enter Japan duty free include printed books and pamphlets, and scientific diagrams.

Klondyke.—The Dominion Government have granted a charter to the Northern Commercial Telegraph Co. for the construction of a telegraph line from the head of the Lynn Canal, or Skagway, to Dawson City, *vid* Lake Bennett and Selkirk. The company also has the sole right to lay a cable from Vancouver to Skagway. It will probably be some time before the cable is laid, but the overland wire is to be in operation by April or May at latest.

Lewisham (London).—The Crystal Palace District Electric Supply Co. recently obtained sanction of the London County Council to lay mains in a portion of the district controlled by the Lewisham District Board of Works. As this permission had been given without prior sanction of the local Board of Works this body, except upon onerous conditions, refused its consent. The company appealed to the Board of Trade, but the appeal was disallowed. Several similar cases to the above have recently occurred, notably at Bermondsey, where the Vestry has strongly protested against the action of the L.C.C. in granting certain facilities to the London Electric Supply Corporation without first taking the opinion of the Vestry on the subject.

Limerick.—The Board of Trade have notified the Town Council that the revocation of the Limerick provisional order will shortly be considered. The order was obtained in 1892.

Liverpool.—The Tramways committee have had before them a report from Mr. A. Bromley Holmes, the electrical engineer, as to the re-construction of certain old and the construction of new tramway lines, at an estimated cost of £143,060. It recommended that 8½ miles of lines be constructed, and that the present routes of West Derby-road, Stanley-road, Kensington and Walton-road, having a mileage of 18½, be reconstructed. The report was adopted and it was resolved that the Smithdown-road route be proceeded with as soon as possible, so that it might be completed before the end of July next. It has been decided to construct loop (electric) lines between Lord-street and Paradise-street, and at the Dingle terminus, at a cost of £4,770.

London County Council.—At Tuesday's meeting, the adjourned report of the Highways committee, on the question of the overhead wires of the National Telephone Co. at Islington, was again discussed, the committee recommending that the company be permitted to retain these wires for a certain period. Mr. Radford moved that the report be referred back. The company (he said) had not been carrying out the bye-laws for years, and was not entitled to any consideration. They knew that the company had the most costly system in the world and one of the worst. Mr. Benn (Chairman of the committee) said he would take the report back, and hoped the Vestry of Islington would communicate with the Council. Mr. Beachcroft, at a later stage, asked if it was a fact that 900 persons in London were unable to get telephones owing to the Council refusing consent to the National Telephone Co. to lay underground wires. Mr. Benn said it was perfectly true that certain consents had been withheld by the Council because the company would not consent to concede to the Council terms which they had conceded to other cities. They regretted the inconvenience caused to people who were prepared to pay the high rates, and they had arranged to meet the representatives of the Company in order to see what could be done. The delay was, however, caused by the company refusing to concede the concessions they should.

Long Distance Telephony.—Rapid progress is being made with the telephone line between Berlin, Brussels and Paris, which, when completed, will be 621 miles long, and the most important in Europe.

Manila.—There will probably shortly be an immense development of the Philippines, and in Manila especially, there already exists opportunities for trading in electric plant and apparatus. One electrical plant of Spanish manufacture is already installed, and there is a telephone exchange service available. There are a large number of cigarette and rope factories, some employing as many as 4,000 hands. A tramway worked partly by steam and partly by horses is also running. A large part of the trade of Manila is in English hands, and the change over from horse traction to electric and of the primitive methods of driving in many of the factories in Manila (especially the rope factories) for electric methods afford a good opening for electrical enterprise. There are 7,000,000 people in the Philippine group.

Marylebone (London).—The Metropolitan Electric Supply Co. have replied to the Vestry on the subject of the purchase by that body of the portion of the company's undertaking situate in the parish of Marylebone, and asking (as the Vestry give notice of their intention to apply for compulsory powers to purchase and also powers to enter into competition with the company) for further information with regard to the proposed basis of negotiations. The Electric Lighting committee are considering this communication. At last night's meeting of the Vestry Mr. G. B. Crook had a motion on the paper asking for information regarding the actual powers possessed by the Metropolitan Co. so far as the parish of St. Marylebone was concerned. He, however, asked leave to withdraw this resolution.

Morecambe.—The electrical engineer (Mr. C. F. Parkinson) has been instructed to report upon the proposal to extend the electric light mains to Bare. Messrs. Stoddart and Co., who have submitted a scheme for wiring premises in the district on the easy payment system, have been requested to supply additional details.

Musselburgh.—The Town Council have decided to consult Mr. W. A. Bryson, the Leith burgh electrical engineer, as to establishing electricity supply works.

National Telephone Co.—Particulars are published of bills to be presented to Parliament by the National Telephone Co. Bill No. 1 seeks powers to dissolve the present company and to cancel its memorandum and articles of association, to re-incorporate the shareholders into a new company, and to vest in the new company all works, plant, rights, powers, privileges, licences, wayleaves, &c., &c., belonging to the present company; to re-arrange the capital, provide additional capital, and to give various powers to the new company in connection with the opening of streets, acquisition of licences from the Postmaster-General, &c. Bill No. 2 seeks powers to confer upon the new company such rights and privileges as may be necessary for the purpose of effectively providing telephonic communication throughout the United Kingdom, the Channel Islands, and the Isle of Man.

Northallerton (Yorks).—Mr. J. E. Hutton appeared before the District Council last week to present his proposal for the electric lighting of the district. A company has been formed to establish electricity works, and Mr. Hutton now formally asked for permission to carry out this scheme, which was granted.

Portsmouth.—The Town Council have decided to give the Provincial Tramways Co. 12 months' notice of their intention to purchase the local tramways.

Perugia (Italy).—The municipal authorities of this town have entered into arrangements with the Siemens and Halske Aktien Gesellschaft, of Berlin, for the erection of electricity supply works.

Presentation.—A presentation has been made to Mr. J. H. Lee, late borough electrical engineer at Southampton, by the members of the Electric Lighting committee and staff. Ald. Bone, who made the presentation, spoke very highly of Mr. Lee's connection with the committee of which he was Chairman, and regretted that Mr. Lee was leaving the town.

Rawmarsh.—The District Council have appointed a special committee to consider and report upon putting the provisional order into force.

Sleaford.—The Tradesmen's Association urge the District Council to call in an electrical expert to report on the advisability of putting down electricity supply works.

Southport-Lytham Electric Tramway.—The Southport Town Council have expressed their approval of Mr. Wood's scheme for the construction of this tramway. The proposed line, which would be constructed on the Brighton and Rottingdean system, is estimated to cost £300,000, and a provisional order will shortly be applied for.

Speed of Electric Trams.—Sir F. Marindin opened an inquiry at Dublin, on Wednesday, into the application of the Dublin United (Southern District) Tramway Co., for permission to increase the speed of the tram cars on the Dublin-Dalkey route. A mass of evidence was given in support of the application, and most of the witnesses favoured an increase to 12 miles an hour. The inquiry was adjourned for further evidence.

Stretford.—A meeting of ratepayers has condemned the proposal of the District Council to establish municipal electricity supply works as it is thought that current could be obtained at a cheaper rate from the Manchester Corporation. The council's consulting engineer (Mr. R. P. Wilson) has advised the erection of independent generating plant.

Stockport.—The Stockport and Hazelgrove Tramways Co. (Limited) has been approached by a London syndicate with a view to the purchase of their undertaking. The syndicate offer a sum of £40,000, the amount recently tendered by the Corporation.

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It is probable, however, that the Corporation, who are anxious to introduce electric traction, will be able to come to terms with the company. A bill dealing with electric traction is being promoted by the Corporation.

Tamworth, (N.S.W.).—An electric lighting scheme has been prepared for the Municipal Council of this district by Mr. J. O. Callender, of Sydney. The scheme, which involves the utilisation of the power available in the service reservoir of the waterworks, is estimated to cost £5,560.

Telegraphic Communication in Egypt.—The Berber-Suakin telegraph line having been completed, telegraphic communication is now available between Cairo and Suakin and Kassala, over the Egyptian and Suakin lines.

Telephone Municipalisation.—The National Telephone Co. are endeavouring to arrive at an understanding with the Glasgow Corporation as to improvements of the local telephone service, and at the same time to meet the views and objects expressed by the Corporation in the course of the recent inquiry. The company propose to make the minimum charge £6 per annum for each instrument with a maximum of 500 conversations, any excess to be charged on a fixed scale. In return for these concessions the Corporation are asked to withdraw their objections to the granting of wayleaves, &c.

A special meeting of the Parliamentary Bills committee of the Glasgow Corporation was held last week for the purpose of adjusting the clauses of the bill for power to establish and work a telephone exchange system in Glasgow. In the course of the discussion the town clerk (Sir J. D. Marwick) questioned the legality of the common good being included in the bill as a guarantee for the scheme, maintaining that only the rates could be used for that purpose. It was pointed out that the common good had been similarly pledged in connection with the tramway scheme, but Sir James was obdurate. The committee were equally emphatic, and the result was that Sir James absolutely refused to have anything to do with the bill or to allow his name to be appended to the notice in the usual way. The committee, in the circumstances, decided to ask their London agents, Messrs. Beveridge, to attach their names to the notice in terms of the Act of Parliament, and to promote the bill.

Mr. William Thomson, of the Mutual Telephone Co., Manchester, dealing with the question of the probability of the company obtaining a licence from the Postmaster-General, writes:—

"At the present moment the question of granting a licence to the Mutual Telephone Co. is under the consideration of the Treasury, and I feel sure that if Manchester will fairly represent the position of the telephone question here a licence will be granted. The Mutual Telephone Co. was formed by reason of, and in accordance with, the terms of the Treasury minute which stipulates for competition only by private companies, and as a large amount of time and money has been spent by the few on behalf of the many in the town and district it is to be hoped that Manchester will not be satisfied with any attempt to repudiate the telephone Treasury minute and to ruthlessly sweep away all that has been done by those who formed the Mutual Telephone Co. The recent Select Parliamentary Committee expressed the opinion that competition should be commenced immediately, and the only objection which Mr. Hanbury had to private companies was that they might be bought up by the present licensees. This can be prevented by an undertaking which this company is willing to give. The Corporation cannot commence a telephone exchange for a year or two from now, whilst the Mutual Company can commence operations immediately, and as it is willing to transfer its plant and business at any time to the Corporation or to the Post Office under conditions which can be arranged before the licence is granted, it is difficult to see any reason for withholding the licence from it, especially as it would save Manchester people at least £20,000 per annum and give an increased and more efficient telephone service to the city and district."

The Bedford Town Council have decided to repeat their application to the Postmaster-General for a telephone licence.

Wednesbury.—The Town Council have retained Mr. F. J. Warden-Stevens as consulting electrical engineer.

West Australian Tariffs.—Under a new Customs tariff, to be levied on certain goods imported into Western Australia, machinery of all kinds will bear a 3 per cent. *ad valorem* duty, and parts of machinery 10 per cent.

Whitchurch (Salop).—A meeting of ratepayers has rejected a proposal to purchase the gas works at £37,000, as it is considered that electricity supply works could be erected at less cost.

Wigan.—At a recent meeting of the Electric Lighting committee the deputation recently appointed to inspect the electricity works at Leeds, Bradford and Wakefield presented a preliminary report in which they recommended the erection of electricity supply works. The Committee were, however, instructed to prepare and present a complete report on their visit for the instruction of the Council

Willesden.—The electrical engineer (Mr. E. T. Ruthven-Murray) has selected a site for the proposed electricity station at Lower-place, between the London and North-Western Railway and the Grand Junction Canal. The Local Government Board are to be asked for sanction to a loan for the wiring houses.

Woking.—The purchase of the undertaking of the Woking Electric Supply Co. is under the consideration of the District Council.

Workhouse Lighting.—The Shoreditch (London) Guardians have decided to borrow £2,000 for the electric lighting of the workhouse.

Electro-Harmonic Society.—Members are reminded that a "ladies' night" entertainment will be given at the St. James's Hall Restaurant this (Friday) evening, at 8 o'clock.

COMPANIES' MEETINGS AND REPORTS.

Cuba Submarine Telegraph Co. (Limited).

The fifty-fourth ordinary general meeting of this Company was held on Wednesday, under the presidency of Mr. CHARLES W. PARISH.

The SECRETARY (Mr. James Scott) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, the Board are glad to be able to present to you such a satisfactory report, notwithstanding the anxious period through which we have passed since our last meeting. You will recollect that the insurrection which broke out in the island of Cuba in February, 1895, was in full force at the commencement of this year, and its continuance led to the outbreak of the Spanish-American war in April last. On the outbreak of hostilities, the American Government practically took control of the cables of the Western Union Co. at Key West (an island between Havana and Florida), and instituted a strict censorship over all messages, none being allowed to pass in cypher. This compelled the Spanish authorities at Havana to send their government messages *via* Santiago and Jamaica to Spain, instead of by the usual route through America, and this also applied to the messages which business firms in Havana preferred to send *via* Santiago instead of through America. This unexpected diversion of traffic caused a considerable increase in the receipts of our Company; in fact, many messages from Havana were carried over the whole length of our system which, under normal circumstances, would not have touched our lines at all. The American authorities then set to work to isolate Cuba as far as possible from the outside world, and also the chief towns one from the other where cable communication existed, and with the unfortunate result that many of our cables were cut, while our cable hut at Cienfuegos was entirely destroyed by the bombardment of the American fleet. It is with a feeling of pride and satisfaction, in which I am sure you will sympathise—that I can tell you that our staff kept to their posts under most trying circumstances, and that, as a matter of fact, they were able to maintain communication from Havana to Jamaica right through the war. When the Americans entered Santiago, after the capitulation on July 17th, they were greatly surprised to find our cables still working, but on hearing that they belonged to an English company they contented themselves with sealing them up, which stopped all our through traffic for about three weeks. At Santiago and Manzanillo our representatives were able to do real service in the cause of peace by keeping to their posts during all the dangers of bombardment by the American fleet; in fact, all our staff passed through a most trying experience with a high sense of duty, which I am glad to say has been recognised both by the Spanish and American generals. We arranged that they should have an increase of pay to meet the special circumstances in which they were unfortunately placed, as the price of living rose to an abnormal level. Since the termination of hostilities we have been able to repair the damaged cables with the exception of the Cienfuegos-Casilda section and the 1891 Cienfuegos-Batabano cable. The breaks in these two cables appear to be in deep water, and will need a regular cable steamer to put them in order, and we are now arranging to send one out. Directly we learnt of the damage to our property we put ourselves in communication with the Foreign Office, and asked for their assistance to claim suitable compensation from the American Government, and we propose to give in a regular claim as soon as we know the total cost of the repairs. I am sure our Foreign Office will do what they can to assist us consistent with international law, but I cannot yet tell you that our claim will be admitted. I rather like to make a point of that, because I know that some of the shareholders think that we have only to appeal to the Foreign Office to ask the Americans to pay us when we shall be paid at once, but I rather doubt that. It will take some time before we are paid even if our claim is recognised. Since the cessation of hostilities, and in view of the change of government in the island, the position of our Company in regard to its concessions and subsidy has received the best attention of your Board, and we have taken steps to bring before the United States Government the rights of the Company in order that they may receive formal recognition. We have every hope that this recognition will be duly secured. I may remind you that the subsidy which we have for the cable to the towns south of the island is in the form of a charge on the Havana treasury. Before turning to the accounts I wish to explain that, owing to the complicated way in which our rates are now calculated on what is called a mileage basis, instead of on a fixed tariff, we cannot satisfactorily continue the system of estimating the receipts for the two last months of each half-year (which has been our custom for many years), and before presenting to you the accounts in future we shall have to wait for the detailed returns from Cuba. We shall aim, therefore, at issuing the half-yearly accounts in April and October, and the meetings will be held as soon after as possible. The accounts for the half-year show a gross income of £33,504; expenditure, £8,091. We commenced the half-year with a reserve fund of £106,000, and have drawn from this £11,553, as the balance of cost of the Manzanillo-Santiago cable, and repairs to the

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Cienfuegos-Santiago cable of 1881. We are now able to place to reserve £15,553, bringing it up to £110,000 to June 30th last, against £118,000 to June 30, 1897. We propose to pay the Ordinary shareholders 3 per cent. for the half-year and a bonus of 2s. per share. We have adopted this method because our increased receipts have come altogether from a special source not likely to ever occur again. I now propose—

"*That the report and accounts for the half-year ended June 30 last, now submitted, be received and adopted.*"

Mr. GEORGE KEITH seconded.

Mr. WILLIAM HANNAY: May I ask about your remark as to the subsidy to the cable of the Company falling on the Havana Government, whether that means that it will be continued to be paid or that the Company will have no claim on it in future?

The CHAIRMAN: We shall be exceedingly disappointed if we lose our subsidy. At present we see no chance of that.

In answer to further questions as to the arrangements with the United States for the payment of damages to the Company's cables, and as to whether the United States or the Spanish authorities would be the parties to grant an extension of the concession,

The CHAIRMAN said he could not answer the question as to what was going to happen in Cuba, or who was to be the ruling power there. As to the future prosperity of their Company, he must remind the shareholders that whereas they used to receive 5s. 2d. for every word telegraphed to Jamaica, it is now only 3s.

The report was then adopted unanimously. Dividends at the rate of 10 per cent. per annum, less tax, on the Preference shares, and 6 per cent. per annum and a bonus of 2s. per share, tax free, on the Ordinary shares, were approved. Mr. Alexander Graham Low was re-elected a Director, and Messrs. Gane, Jackson, Jefferys and Wells were appointed auditors.

A vote of thanks to the Chairman, Directors and staff terminated the proceedings.

Yorkshire House-to-House Electricity Co. (Limited).

An extraordinary general meeting of this company was held on Monday to ratify the provisional agreement for the sale of the undertaking to the Leeds Corporation. The Chairman (Mr. Grosvenor Talbot) said they had met to take one of the final steps towards handing over their undertaking to the Corporation, under the inexorable terms of the act and provisional order which called the company into existence. He gave a sketch of the steps taken by the Corporation for the acquisition of their undertaking, particulars of which have been given from time to time in *The Electrician*. By Clause 1 of the final agreement the Corporation accepted the accounts as passed by the Board of Trade auditor up to 1897. This, he thought, was a wise step on the part of the Corporation. Clause 2 was the clause for the appointment of the capital account. This account had been taken in this way:—All goods and machinery which had been delivered, if not paid for, went into the capital expenditure. In addition with goods that had been manufactured under contract or order of the company, but not completed, such part as had been finished, and was in the works of the contractors on August 31st, would also be included in the amount properly expended on capital account. He thought this was a reasonable and liberal arrangement for the adjusting of the capital expenditure. It did away with a great deal of difficulty, and would make it much more easy to come to the final division. Clause 3 dealt with the depreciation which they had been in the habit of allowing every year under the direction of the Board of Trade and under necessity. This would still continue for the few months of this year that they were working on their own account. Clause 6 provided that the company should have no claim in respect to back dividends in order to make up the aggregate 5 per cent. They had a divided opinion as to whether that would be allowed or not. They were advised that they had no claim because they had already put £8,000 by for equalisation of dividend, which might have been used to pay dividends. Moreover, this was a point upon which the Corporation would have gone to law. The whole arrangements would have been broken off; everything would have had to be begun again *de novo*, and the affair arranged under the Court of the Board of Trade. This being so the Directors decided that the point was not worth standing out for. The Directors thought the agreement was one they could recommend to the shareholders as a desirable arrangement, and the best possible way they could bring this matter to a conclusion. The negotiations had been carried on throughout, with a desire that an amicable and fair result should be arrived at. The arrangement to wind up the company under a provisional order, rather than the bargain first suggested, they believed to be a wise one. He believed the ratepayers could have no cause of complaint against the company, and the shareholders could have no cause for a moment to feel that their interests have been sacrificed. It was a satisfaction to know that in handing over their business to the Corporation, Leeds would receive the concern in a high state of efficiency, a full career of prosperity, and capable of almost indefinite expansion. The agreement was unanimously approved.

Hampstead Electric Supply Co. (Limited).

We understand that the first (statutory) meeting of the shareholders of this Company was held on Monday last at the Westminster Palace Hotel, Victoria-street, Westminster, S.W., under the presidency of Mr. J. SOARES. As the report of the proceedings appears as an advertisement in several of the London daily papers, it is to be presumed that the particulars have been supplied by the Company. We publish the following abstract without accepting any responsibility for its accuracy. The customary invitation for the representative of *The Electrician* to be present to take a note of the proceedings was not received:—

The CHAIRMAN said: This meeting is only a formal one, at which it is not possible, as a rule, for the Directors, who have practically only just got into harness, to give much information as to the past working of the Company; but we nevertheless have much pleasure in putting before you as much information as possible at this early stage of the Company's existence. You will remember that in the prospectus we gave prominence to the very important fact that our Company is in the strong position that it cannot be interfered with by the local authorities in the way of compulsory purchase. This is so, and this fact alone should considerably add to the value of the shares from the point of view of the investor. There is less speculation in the holding of shares of an established undertaking, the goodwill of which has not to lapse at the end of a certain number of years, as is the case with most other electric lighting companies. The great advantage which shareholders in electric lighting companies have over shareholders in other industrial concerns is that their profits not only do not fluctuate but necessarily increase each year of the Company's existence. You will also remember that at the date of the prospectus we had in operation the respectable figure of 33 miles of mains. This, of course, has now been considerably added to. To go further into figures, and taking the latest information available, the increase in the number of houses supplied since March 31 is no less than 168, and there are contracts in hand for connecting with 400 more. These figures speak volumes for the increased and increasing prosperity of your Company. I think it also well to state that since the issue of the prospectus we have materially added to the electric lighting plant, and it is now even in a higher state of efficiency than when Prof. Silvanus Thompson testified to its excellent condition. We shall shortly have in operation two additional boilers, these being necessary to cope with the rapidly-increasing output. We anticipate that we shall soon require to make still further extensions, and without in any way interfering with our existing premises I may state that the land beyond the boilerhouse is available, without further cost, for the erection of a range of five more boilers; in fact, the unoccupied land will suffice for at least 1,000 kilowatts more, and then, as you know, in addition to this we have the very valuable premises of Messrs. Taylor and Lowns, whose business is a most profitable and progressive one. Those of you who reside in the large area covered by our Company in Hampstead must have observed that in the main road, almost adjoining the Finchley-road Railway Station, and in close proximity to this Company's central supply station, a large store (to be conducted, I believe, on similar lines to John Barker and Co. and Harrod's Stores) is in course of construction and is shortly to be opened. We are in treaty for the supply of electric current not only for the lifts, but for the electric lighting throughout. There is also another and larger undertaking of a different character in the neighbourhood, for which we hope to obtain a contract. We have, of course, adequate working capital for the extensions and for undertaking these large contracts. Perhaps I have gone more fully into the affairs of the Company than is usual at a statutory meeting, but I consider that shareholders should always be taken into the confidence of the Directors when possible, and I have now only to assure you that the Board will always be unremitting in their endeavours to promote your interests and to justify the prospects referred to in the prospectus. I may add, in conclusion, that the brokers to the Company will be instructed to apply for a special settlement and quotation of the Company's shares.

Mr. E. T. READ proposed a vote of thanks to the Chairman for the satisfactory statement he had given to the shareholders. He said he had lived in Hampstead all his life, and he knew very well what an immense prospect there was of expansion, and he had no hesitation in saying, from his knowledge of the neighbourhood, that this Company, if properly managed, would be one of the most prosperous electric lighting companies in the country. The outlook for the supply of motor-cars for the tradesmen in the neighbourhood was also very bright, and by being able to get rid of their day current in that way they would be enabled to supply the electric light at far cheaper rates than other companies could do at present.

The motion was carried unanimously.

NEW COMPANIES, STATUTORY RETURNS, &c.

CRYSTAL PALACE LIGHT RAILWAYS AND TRAMWAYS CO. (LIMITED). This company has been registered, with a capital of £5,000, in £1 shares, to carry on the business of railway, tramway, omnibus, carriage and van proprietors, electrical engineers, carriers of passengers, goods, &c.

HIMALAYA ELECTRIC RAILWAY (LIMITED).—This company was registered on Nov. 15, with a capital of £2,000, in £1 shares, to acquire and develop an invention known as the Himalaya Electric Railway, and a railway and accessories erected under the said invention at the New Brighton Tower Grounds. The first subscribers (each with one share) are:—P. Violi, Mrs. A. Violi and G. Spagnuoli, engineer; W. Turner, H. Hodson, H. A. Sewards, and R. H. Davey.

TOURTEL MANUFACTURING CO. (LIMITED).—This company was registered on Nov. 9 with a capital of £18,000, in £1 shares, to acquire the English business of engineers and meter apparatus manufacturers, now carried on by the Tourtel Gas and General Engineering Co. (Limited), and to carry on the business of electricians, electrical engineers, suppliers of electricity, electrical apparatus manufacturers, mechanical engineers, &c. The first subscribers (each with one share) are: Arthur F. Davies, F. S. Springell, J. M. Tourtel (engineer), D. H. Davies, C. E. Smith, M. Sharpe and G. T. Stebbing. The first Directors are: Arthur F. Davies, J. B. Rombach and J. M. Tourtel.

CECIL WRAY AND CO. (LIMITED).—This company was registered on Nov. 17, with a capital of £3,000, in £1 shares, to acquire the business carried on by Cecil W. Baxter and Cecil May, as manufacturing opticians, electricians, electrical engineers, &c. The first subscribers (each with one

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share) are :—T. Middlebrook, J. H. Oulton, J. Oulton, G. B. Russell, Mrs. E. Wray, W. T. Sykes and W. Wray.

CAMBORNE ELECTRICITY SUPPLY CO. (LIMITED).—The statutory return to Oct. 9 gives the capital as £10,000, in £1 shares, of which seven have been taken up and paid for in full.

ELECTRICAL POWER DISTRIBUTION CO. (LIMITED).—The statutory return to Nov. 1 has been filed. The capital is £20,200 divided into 2,000 shares of £10 each and 200 shares of £1 each; 154 of the former and all the latter have been taken up. £3 per share has been called on the £10 shares, and the full amount on the others.

MACKEY'S ELECTRIC LAMP CO. (LIMITED).—According to the statutory return to Oct. 13, the capital is £2,000, in £1 shares, of which seven have been taken up and paid for in full.

SANDGATE AND HYTHE ELECTRIC CO. (LIMITED).—The statutory return to Oct. 24 has just been filed. The capital is £1,000, in £10 shares, of which seven have been taken up, but no calls have been made.

WERNER CADMIUM ELECTRIC ACCUMULATOR SYNDICATE (LTD).—The statutory return to Oct. 2 gives the nominal capital as £6,000, in £1 shares, of which 4,515 have been taken up. The full amount has been called and paid on 415 shares, and 4,100 shares are considered as paid.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Oct. 13, 1898). Price of silver 27$\frac{13}{16}$d. per oz. (Nov. 24). Consols (2¾ per cent.) 110½—110¾ for money, 110⅝—110¾ for account; 2½ per cent. 104¾—105¼ (Nov. 24), Stock Exchange Settling Days: Consols, Dec. 1; Stocks and Shares Continuation Days, Nov. 28 and Dec. 13; Ticket Days, Nov. 29 and Dec. 14; Pay Days, Nov. 30 and Dec. 15; Mining Share Carry-over Days, Nov. 26 and Dec. 12.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LIMITED).—During the week this company invited subscriptions for 12,000 non-Cumulative Five Per Cent. Preference shares of £10 each at £11. The company has an authorised capital of £370,000, of which the Ordinary shares (£200,000) have been issued. There are in addition £250,000 Four and a-half Per Cent. First Mortgage Debentures and £60,000 non-Cumulative Six Per Cent. Income Bonds. Some further reference is made to this company's undertaking on another page.

CRYSTAL ELECTRIC LAMP AND ROSE AND BIRD (LIMITED).—We are informed that at the statutory meeting of this Company on 10th inst., the Chairman congratulated the shareholders on the satisfactory increase in the orders received since the amalgamation. The factory at Bedford was working at full pressure, and in order to cope with old customers' increasing demands and the new connection the Directors had been compelled to increase the apparatus and machinery. The Company had one of the best, if not the best, lamp factories in the kingdom, replete with every modern improvement, and they had 500 customers, including the Admiralty, War Office, Post Office, several railway companies, the London County Council, and numerous corporations, and most of the electricity supply companies and large contractors.

DORMAN, LONG AND CO. (LIMITED)—A profit of £74,623 is reported on last year's working, which, with balance brought forward, makes £90,101. A dividend of 8 per cent. is declared, against 6 per cent. in 1896-97, 4 per cent. in 1895-96, and *nil* in each of the two preceding years. £26,601 is carried forward.

ELMORE AMALGAMATION.—There is shortly to be an amalgamation between Elmore's Patent Copper Depositing Co. (Limited), Elmore's Wire Manufacturing Co. (Limited), and two other companies in the Elmore group. We are informed that a large working capital is to be provided.

RICHARD HORNSBY AND SONS (LIMITED).—The Directors' report states that there was a profit of £37,827 on the year's working. There is a disposable balance of £29,637, and the Directors recommend a dividend on Preference stock at 6 per cent. (including arrears) and a dividend at 6s. per share on Ordinary shares.

MIDDLESBROUGH TOWN AND LANDS CO. (LIMITED).—At the annual meeting of this company the Chairman (Major W. T. E. Fosbery) said that the subsidiary Electric Lighting Company was making fair progress and paying its way. They offered to the shareholders of that company 10 per cent. of the face value of their shares in debenture stock, and this was accepted to the amount of £7,150 worth of shares, so that they had issued £715 of debentures in that way, and the Town and Lands Company hold in that company something more than half of the issued capital.

PERTH (WESTERN AUSTRALIA).—The work of constructing and equiping of the Perth Electric Tramways (Limited) is being pushed forward; rails, sleepers, blocks, &c., have been ordered; the permanent way is being prepared, and the fencing round the power-house commenced. The engineers, Messrs. J. G. White and Co., New York, expect to open the first section for working by May 31 next.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange committee to appoint a special settling day in and to grant a quotation to 100,000 £1 fully paid Ordinary shares of the Blackheath and Greenwich District Electric Light Co. (Limited), and £100,000 Five per Cent. Perpetual Debenture stock of the British Electric Traction Co. (Limited).

WESTERN AND BRAZILIAN TELEGRAPH CO. (LIMITED).—This company's traffic receipts for the week ended Nov. 18 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Co., Limited) were £2,870.

WEST INDIA AND PANAMA TELEGRAPH CO. (LIMITED).—The estimated amount of the traffic receipts of this company for the half-month ended Nov. 15 is £2,966, against £2,093 in the corresponding period of 1897.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
*Birmingham Tramways.	Nov. 19	3,883	+ 274	...	...	—
Blackpool Corporation...	" 17	148	+ 31	33	15,564	+ 2,260
Blackpool and Fleetwood Co.	" 19	201	...	19	13,566	...
*Bristol Trams & Carriage	" 18	2,668	+ 114	20	61,717	+ 7,524
City & South London Ry.	" 20	1,044	− 19	21	20,405	+ 680
Dover Corporation	" 19	150	+ 51	33	6,301	—
Dublin United (Southern)	" 18	672	+ 294	20	19,935	+ 6,432
Liverpool Overhead Rly.	" 20	1,358	+ 32	21	33,038	+ 2,999
*Sheffield Tramways......	" 20	1,155	+ 178	46	46,721	+ 1,606
*South Staffs. Trams......	" 18	632	+ 43	46	29,179	− 139

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Nov. 16.		Price Wednesday, Nov. 23.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Week Ending Nov. 23. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.					£ s. d.		Highest	Lowest
6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	10½	10¾	10½	10¾	—	—	..	..
6,000	10	1/3$\frac{1}{10}$	Do. 4½ per Cent. Cumulative Pref.	10¾	11½	10¾	11½	4 0 0	—	..	
[illegible]	5	3/0	Charing Cross & Strand Electricity Supply Corp.	11½	12½	11½	12½	2 16 0	February & August	12	11¾
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6½	6	6½	3 9 3	" "	—	—
£34,000	5	2/6	Chelsea Electricity Supply Ordinary	8	9	8	9	3 6 8	March	8⅞	8⅞
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	113	115	114	116	3 18 11	June and December	—	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red)	103	105	103	105	4 15 3	..	..	..
50,0[illegible]	10	5/0	City of London Elec. Lighting Ord. 40,001 to 90,000	24	25	24	25	5 0 0	February & August	24½	24½
10,000	10	1/9	Do. Ordinary 90,001 to 100,000	23½	21½	23½	24½	..	..	..	..
40,000	10	6%	Do. 6% Cumulative Pref.	16½	16½	15½	16½	3 11 9	January and July	16	[illegible]
£4[illegible],000	Stock	5%	* Do. 5% Debenture Stock (red.)	127	132	127	131	3 16 1	June and December	—	..
30,000	10	—	County of London & Brush Prov. Ord. (fully paid)	12½	13½	12½	13½	—	—	—	—
10,000	10	..	Do. (£8 paid)	10	11	10	11	..	—	10$\frac{7}{16}$	—
20,000	10	6/0	Do. 6% Cumulative Preference	14½	15½	14½	15½	4 0 0	March & September	14⅞	[illegible]
15,660	5	2/6	House-to-House Electric Lighting Supply Ord.	9	10	9	10	2 0 0	..	9$\frac{7}{16}$	—
1[illegible],000	5	3/6	Do. 7 per Cent. Preference	9½	10½	9½	10½	3 6 8	March & September	—	—
15,000	5	10%	Kensington and Knightsbridge Ord.	13	14	13	14	3 18 7	..	..	—
10,000	5	6%	Do. 6% 1st Pref.	7¾	8¼	7¾	8¼	3 12 9	January and July ..	..	—
110,000	3	—	London Electric Supply Ordinary	3½	4	3½	4	—	—		
48,050	5	..	Do. Preference	6¼	6¾	6	6½	—	—	6⅞	6½
62,400	10	5/0	Metropolitan Electric Supply Ordinary	16	17	16½	17½	3 8 7	April and October	17	16¾
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	121	117	121	3 14 9	June and December		—
6,452	10	6/0	Notting Hill Electric Ordinary	15	16	15½	16½	3 12 9	March	15⅞	..
275,000	1	—	Rand Electric	⅞	1⅛	⅞	1⅛	—	—	—	..
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb	83	93	88	93	5 8 1	—	—	—
150,000	$100	$2	Royal Electric Company of Montreal Shares	155	160	155	160	5 0 0	—	..	—
130,900	100	4½%	* Do. 4½% 1st Mort. Debs.	104	106	104	106	4 5 0	April and October	..	..
31,980	5	5/0	St. James and Pall Mall Electric Ordinary	16½	17½	16½	17½	4 11 5	February & August	17	16½
20,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	" "	9	—
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.)	105	108	105	108	3 15 6	June and December	..	—
65,000	5	..	South London Electric Supply Ordinary (£3 paid)	7⅞	8½	7⅞	8½	..	..	..	..
79,900	5	5/0	Westminster Electric Supply Ordinary	16	17	16	17	3 16 6	March & September	16⅞	16
18,848	5	5%	Yorkshire House-to-House	7¾	8	7¾	8	3 2 6	February and July	—	—
18,626	5	5%	Do. (£4 paid)	5¾	6¼	5¾	6¼	3 18 5	February and July	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Nov. 16.		Price Wednesday, Nov. 23.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 22.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS								
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	100	104	104	105	3 17 0	January and July	..	..
25,000	10	..	Amazon Telegraph	3½	4½	3	4	—	—	4½	—
£125,000	100	5%	Do. 5 per Cent. Debentures	92	95	92	95	5 5 3	—	..	..
£905,560	Stock	15/0	Anglo-American	63	66	63	66	4 11 3	Feb., May, Aug., Nov.	65	63
£3,047,220	Stock	30/0	Do. Preferred	114	115	114	115	5 4 10	" "	114⅞	114
£3,047,220	Stock	..	Do. Deferred	15½	15⅝	15½	15⅞	—	—	15 5/16	15⅝
180,000	10	5/0	Brazilian Submarine	15½	15⅝	15½	15⅝	4 15 3	Mar., June, Oct., Dec.	15⅝	15½
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	111	115	111	115	4 8 0	June and December	..	..
10,000,000	$100	$1¾	Commercial Cable Capital Stock	180	190	180	190	4 4 3	Jan., Apr., July, Oct.	..	..
£918,297	Stock	4%	* Do. 4 per Cent. Debenture Stock	104	106	104	106	3 15 6	" "	10 7/16	105
16,000	10	—	Cuba Submarine Ordinary (Deferred)	10	11	10½	11½	—	February and August	10¼	..
6,000	10	..	Do. Preference 10 per Cent.	16½	17½	17	18	—	—	..	..
12,951	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October	—	—
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	..	—
£80,000	50	4½%	Do. 4½ per Cent. Debentures	104⅞	107⅞	104⅞	107⅞	4 4 8	January and July	..	—
60,710	20	3/0	Direct United States Cable	11½	12	11½	12	5 8 4	Jan., Apr., July, Oct.	11⅞	11⅝
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	101	104	102	105	4 7 8	..	..	—
4,000,000	Stock	..	Eastern Ordinary	172	177	172	176	3 19 9	Jan., Apr., July, Oct.	176	173½
£1,295,000	Stock	17/6	Do. 3½ per Cent. Pref. Stock	104	107	104	107	3 5 5	" "	104¼	104½
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	124	128	124	128	3 2 6	May and November	127½	125½
£89,900	100	5%	* Do. 5 per Cent. Debentures, 1899	101	104	101	104	4 17 0	February & August	..	..
£500,000	Stock	8/9	Do. Provisional Certificates 50% paid	53	56	53	56	..	..	—	..
250,000	10	2/6	Eastern Extension	17½	17¾	17½	17¾	3 18 11	Jan., Apr., July, Oct.	17¾	17½
£820,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	129	125	129	3 2 4	February & August	129	..
£16,200	100	5%	* Do. 5 p. c. (Austin.Gov. Sub.) Debs.1900 (reg.)	100	104	100	104	4 16 10	January and July	..	..
£64,400	100	5%	Do. (Bearer)	101	104	101	104	4 16 10	" "	—	—
£35,100	100	5%	*Eastern and S. African 5 p. c. Mor. Deb.,1900 (reg.)	100	104	100	104	4 16 10	" "	—	—
£46,500	100	5%	Do, (Bearer)	101	104	101	104	4 16 10	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures,1909	102	105	102	105	3 16 4	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	102⅞	105⅞	102⅞	105⅞	3 16 2	May and Novembsr	..	—
180,227	10	1/9	Globe Telegraph and Trust	12	12½	12¼	12¾	4 0 9	Jan., Apr., July, Oct.	12½	12½
180,042	10	6%	Do. 6 per Cent. Preference	16½	17	16¼	17	3 10 7	" "	17	16½
150,000	10	5/0	Great Northern of Copenhagen	28½	29½	28½	29½	3 7 10	January, April, July	28½	—
£150,000	100	5%	* Do 5 per Cent. Debs., 1888 Issue Series "B"	100	103	100	103	4 17 10	March & September	—	—
£97,800	100	4½%	Halifax and Bermuda Cable 4½% 1st Mort. Deb.(red)	101	104	101	104	4 7 0	June and December	..	—
17,000	25	12/6	Indo-European	54	57	54	57	4 7 9	May and November	..	—
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	109	112	109	112	5 7 7	March & September	..	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs.(red)	105	108	105	108	3 14 3	June and December	—	—
11,839	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October	—	—
3,381	£100 Cert.	6%	Submarine Cables Trust	133	138	133	138	4 6 11	" "	..	—
15,609	10	—	West African Telegraph	..	—	—	..	..	—	—	—
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	4 18 0	March & September	..	—
30,008	2½	—	West Coast of America	¼	¾	¼	¾	..	—	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	104	107	103	106	3 16 6	June and December	..	..
88,321	10	0/6	West India and Panama	1½	1⅝	1½	1⅝	..	May and November	1 5/16	..
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½	10	9½	10	6 0 0	" "	..	—
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7	9	7	9	6 13 4	" "	..	—
£80,000	100	5%	* Do. 5 per Cent. Debentures	106	109	106	109	4 12 10	January and July	..	—
64,269	15	6/9	Western and Brazilian Ordinary	12½	12¾	12½	12¾	3 16 6	May and November	12¾	—
33,129	7½	6/0	Do. 5 per Cent. Preferred Ordinary	8	8½	8	8½	4 8 2	" "	..	—
33,129	7½	0/9	Do. Deferred Ordinary	4	4½	4	4½	—	" "	..	—
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	107	110	107	110	3 13 1	June and December	..	..
1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	—	—	—	—	6 7 10	Feb., May, Aug., Nov.	—	—
£158,100	100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	98	103	98	103	5 16 6	March & September	—	—
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	2¾	3¼	2¾	3¼	6 8 1	August	—	—
224,850	10/0	1¼d.	Consolidated Telephone Const. & Manufacturing	1 1/16	1 3/16	1 1/16	1 3/16	6 7 0	July	—	—
28,000	5	4/0	Monte Video Telephone 6 per Cent. Preference	—	—	..	..	7 5 6	October	—	—
£84,597	5	3/0	National	5½	5½	5⅝	5⅝	5 6 8	February & August	5 7/16	5⅝
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	12	14	12	14	4 5 9	" "	13½	13
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	12	14	12	14	4 5 9	" "	..	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	5½	5⅝	5½	5½	4 10 11	" "	5⅝	5 7/16
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	100	103	100	103	3 6 8	June and December	102½	101½
171,504	1	0/4	Oriental	⅜	⅝	⅜	⅝	6 13 4	April and October	—	—
58,000	5	6/0	United River Plate	4½	4¾	4½	4¾	6 6 5	July	4 7/16	—
£151,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	106	103	106	4 14 4	June and December	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	2	1/2½	Brush Electrical Engineering	1¾	2	1¾	2	3 0 0	—	1⅞	—
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	—	2 3/16	—
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	109	113	111	115	3 19 0	February & August	112	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102	105	102	105	4 7 0	June and December	—	—
£20,000	5	5/0	Callender's Cable Construction	9½	10½	9½	10½	6 8 7	" "	..	—
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	110	113	110	113	4 0 6	November and May	..	—
300,000	1	9⅜	Castner-Kellner Alkali Co. (fully paid)	1½	1⅝	1½	1⅝	5 16 5	—	1½	—
50,000	1	..	Chadburn's Ship Telegraph Ordinary	1½	1⅝	1½	1⅝	—	—	..	—
50,000	1	7½	Do. 6 per Cent. Cumulative Pref.	1	1½	1	1½	4 16 0	—	1 5/16	—
32,098	3	—	Crompton and Co. (Nos. 1 to 32,098)	1½	2	1½	2	..	—	—	—
£32,850	100	5%	* Do. 5% First Mort. Deb. (red.)	91	96	91	96	5 5 10	January and July	—	—
99,261	5	2/1½	Edison and Swan United ("A" Shares) (£3 paid)	2	2½	2	2½	7 4 0	February & August	2⅜	2½
17,139	5	3/1½	Do. (£5 paid)	4	5	4	5	6 0 0	" "	..	—
£194,023	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	99	101	99	101	4 0 5	June and December	99⅜	—
17,400	5	5%	Edmundson's Electric. Corporation Ord (fully paid)	5	5½	5	5½	4 10 11	Half-yearly	..	—
110,000	2	1/2⅞	Electric Construction Co. (Limited)	2½	2⅝	2½	2⅝	4 12 0	February & August	..	—
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Pref.	2⅜	3⅛	2⅜	3⅛	4 6 2	August	3	—
£111,100	Stock	4%	Do. 4% First Mortgage Deb. (red.)	105	107	105	107	3 16 2	—	106½	—
91,196	1	—	Elmore's Patent Copper Depositing	½	¾	½	¾	..	—	—	—
12,500	10	8/0	Henley's Telegraph Works Ordinary	20	21	20	21	6 3 10	February & August	20⅞	20½
3,000	10	7/0	Do. 7 per Cent. Preference	18	19	18	19	3 13 8	" "	..	—
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 3	" "	114½	—
60,000	10	5/0	India Rubber, Gutta Percha, &c., Works	22	23	22	23	4 7 0	" "	22 1/16	22½
£30,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	102	106	102	106	3 15 6	March & September	—	—
£7,350	12	12/0	Telegraph Construction and Maintenance	37	41	37	41	4 6 2	March and July	38½	38
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	104	107	104	107	4 14 9	January and July	—	—
£30,000	5	4/0	Willans and Robinson Ordinary	7⅜	8½	7⅜	8½	4 17 0	April and October	8 1/16	—
£30,000	5	3/0	Do. 6% Cumulative Preference	6⅜	7½	6⅜	7½	4 2 9	" "	7⅝	7 1/16
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	108	110	108	110	3 18 8	May and November	—	—
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	..	Blackpool and Fleetwood Tramways	15½	16½	16½	17½	..	—	—	—
25,000	10	6%	Bristol Tramways and Carriage	21½	22	21½	22	2 14 7	—	—	—
25,000	10	6%	Do. (£7. 10s. paid)	18⅜	18⅞	18⅜	18⅞	1 14 1	—	—	—
£90,410	Stock	4%	Do. 4% Debenture	121	123	121	123	3 5 1	—	—	—
80,000	10	..	British Electric Traction Ordinary	16½	17½	15½	16½	..	—	—	—
10,000	10	2/4 7/10	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm.pd.)	13	14	12½	13½	4 8 11	—	13⅜	—
£35,250	10	3/0	Central London Ordinary	10	10½	10	10½	2 17 2	June and December	10½	—
178,303	10	1/9⅜	Do. (£6 paid)	5⅜	6½	5⅜	6½	2 16 6	" "	..	—
£680,000	Stock	2½%	City and South London Railway Con. Ordy.	69	71	68	70	2 17 9	January and July	70	68
22,500	10	..	Do. Ordinary (£4 paid)	3½	4	3½	4	..	..	—	—
9,251	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	3 4 6	January and July	15⅝	14 13/16
£137,701	Stock	4%	Do. 4% Perpetual Debenture	134	133	134	138	2 18 10	May and November	..	—
20,000	10	6%	Imperial Tramways Ordinary (old £6 shares)	16⅛	16⅜	16⅛	16⅜	2 3 9	March & September	—	—
10,000	10	6%	Do. 6% Preference	15	15½	15	15½	3 18 8	" "	—	—
37,500	10	3%	Liverpool Overhead Railway Ordinary	10 7/16	10 9/16	10⅛	10½	3 3 5	February & August	—	—
10,000	10	5%	Do. 5% Preference	15½	16	15½	16	3 2 6	" "	—	—
125 000	Stock	4%	Do 4% Debentures	108	110	108	110	3 13 1	January and July	—	—
20,000	5	3/3½	New General Traction 6% Cumulative Pref	4⅜	5½	4⅜	5½	—	—	—	—
£540,000	Stock	3%	Waterloo and City Ordinary	107	112	107	112	2 14 11	June and December	111½	110½

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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CONTENTS OF THE CURRENT NUMBER.

NOTES	179	Institution of Electrical Engineers Revised Articles of Association	195
Meetings of Scientific Societies.	181	Electricity Works Accounts	196
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe. Illustrated	182	THE INSTITUTION OF ELECTRICAL ENGINEERS	198
Electromagnetic Theory. By O. Heaviside. Continued	183	Electric Lighting and Traction Notices	199
The Langdon-Davies Motor Works. Illustrated	187	Correspondence	201
Rotatory Converters. By Prof. Silvanus P. Thompson. Illustrated. Concluded	190	Legal Intelligence	202
A Three Thousand Kilowatt Dynamo. Illustrated	194	Trade Notes and Notices	203
		Companies' Meetings & Reports	210
		City Notes	211
		Companies' Share List	212

NOTES.

THE official inquiry has placed beyond a doubt that the lamentable disaster to the "Mohegan" was not due to any aberration or inaccuracy of the compass. Now that the full facts are known, it is no longer necessary to point out that the ship was wired on the two-wire system, that the dynamos were 100ft. distant from the compasses, and that there could be no local deviation of the compasses of sufficient magnitude to produce so serious an error in the course; for the evidence before the Court of Inquiry has clearly established that the course, W. by N., was intentionally steered by the man at the helm, the following of which course after passing the Eddystone would undoubtedly lead in the direction of the Manacles.

THE judgment of the Court conveys one useful lesson, however. There was a serious error in having all the lights of the ship controlled directly from the dynamo. The use of oil lamps, kept trimmed and ready for use in case of accident, proved an insufficient reserve, and, had the lamps been ready lighted, as the Court now recommends, there might have been time to put them in position. It would be an improvement to light the masthead light and a few other lamps of almost equal importance by means of secondary batteries, so that they would continue to burn whatever happened to the machinery. The batteries for these few lamps would be of such small size that their weight would be of no consequence. In a disaster of this kind it is inevitable that the dynamo should stop running, and it is undeniable that the unfortunate loss of life would have been less had it not been for the extinction of the lights.

WHEN the model form of Electric Lighting Provisional Order was recast in 1889, in consequence of the passing of the Act of the previous year, the London County Council obtained certain special privileges not accorded to County Councils in the provinces, and consequently in the London form of order its name appears in several clauses where, in the opinion of many people, it might with advantage have been left out. One of these provisions peculiar to London requires notice to be given to the County Council, as well as to the Local Authority, before laying mains or carrying out other works in any street, and gives powers of objection to both bodies. As the streets of London are, except in a few cases, under the control of District Boards as Local Authorities, and not of the County Council, it is difficult to understand why the latter should have anything to do with the matter; but since the Orders framed by the Board of Trade and confirmed by the Legislature have accorded this privilege, presumably it must be on the ground that the Council has some interest distinct from that of the Local Authority. The manner in which the privilege has been exercised by the Council in giving consent to works in streets not under its control seems to have given some umbrage, which has been noticed in our columns in the cases of the districts of Lewisham and Bermondsey, where the Local Authorities appear to object to works in their streets being approved by the County Council without previous consultation with them. On the assumption that the Council has a separate interest in such streets, it is, of course, entitled to act on its own initiative without consulting the Local Authority, who still have their say in the matter; but at the same time it is not unnatural that the legal guardians of the streets should be unable to appreciate, any more than we do, what interest the County Council in fact has, and should take every opportunity of expressing this feeling.

WHATEVER fault may be found with the managers of the National Telephone Co., they cannot be accused of not knowing their own mind, or of lacking courage to back it up. The three Parliamentary Bills which they have given notice of their intention to introduce in the ensuing session embody not only a distinct policy, but a direct challenge to Postal and Municipal authorities. The policy of the Company is evidently to make a big fight for its existence by strengthening its hands in all directions, of which perhaps the financial changes are the least important. Nothing short of powers

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equal, if not exceeding, those exercised by the POSTMASTER-GENERAL will satisfy the Company; and the creation of a Court of Appeal to deal with the obstructive tactics of local authorities is intended to rid the Company of its most troublesome opponents. If these Bills, or even any considerable portion of their far-reaching provisions, should by any chance pass the ordeal of Parliamentary inquisition, truly the Company will have gained a position that will be practically unassailable.

OF the financial part of the scheme, we need say nothing, its object being perfectly plain, and, in the circumstances, quite legitimate from the Company's point of view. The Government will probably regard it from their point of view, as being part and parcel of the general scheme, and will oppose it or accept it according as they may, by that time, have made up their minds what their own future policy is to be. Not unlikely the Company's immediate aim is to force the pace, and compel the Treasury to come to some working understanding with the Post Office that will let the Company know exactly how it stands. But on its merits alone the application for additional powers is both reasonable and expedient. Virtual monopoly though it is, the National Telephone Co. is a monopoly without any powers whatever, the result being that the public is badly served because the public itself, either individually or by its representatives, hinders the Company from serving it well. The situation is intolerable, and the best way of escape would be for the Post Office either to assume the business itself, or to exercise the powers it possesses on behalf of the Company. The Post Office can obtain fresh and enlarged powers if it wants them; it is very doubtful whether the Company can.

A Correction.—We are concerned to find that Messrs. Macartney, McElroy and Co., of Glasgow and London, were incorrectly stated (in our description of the Glasgow tramways in *The Electrician* of November 18th) to have carried out the overhead construction of these tramways as sub-contractors to Messrs. R. W. Blackwell and Co. We are now informed that Messrs. Macartney, McElroy and Co. were the actual contractors for the whole of this work, and erected and supplied all the overhead material with the exception of one or two minor details.

Cable Interruptions.—

	Date of Interruption.
St. Louis and Noronha	Oct. 17, 1898
Para—Maranham.....	Nov. 15, 1898

Distribution of Prizes.—We are informed that Mr. W. H. Preece, F.R.S., has consented to distribute the prizes at the Merchant Venturers' Technical College, Bristol, on Wednesday, December 21st.

The Electrical Engineers R.E. (Volunteers).—The following promotions are announced:—E. Rorke (sapper) to be quartermaster sergeant, 13 sappers to be promoted to the rank of sergeant, and 14 to the rank of corporal.

Long-Distance Telephony.—A correspondent telegraphs to *The Times* from Little Rock, Arkansas, U.S.A., that successful telephone communication has been established between Little Rock and Boston, a distance of 1,900 miles.

The Institution Annual Dinner.—The Secretary has reminded us that members who wish to attend the annual dinner of the Institution of Electrical Engineers, on December 7th, should apply for tickets to-day or to-morrow.

Institution of Electrical Engineers.—We are informed that candidates for election to the Institution who wish to be admitted under the existing rules should send in their applications before Monday next, December 5th, if they seek election as members, or, if as foreign members, associates or students, before Thursday next, December 8th.

Underground Railways for Berlin.—An extensive system of underground electric railways is to be built in Berlin. It is intended to place them only a few feet below the surface of the roadway, and they will resemble in that and several other respects the subway railway in Budapest, described in *The Electrician*, Vol. XXXVIII., p. 55.

The Late Dr. John Hopkinson.—At the meeting of the Institution of Electrical Engineers, on November 24th, letters were read from the American Institution of Electrical Engineers and the South African Society of Electrical Engineers, expressing sympathy with the loss the Institution had sustained in the death of Dr. John Hopkinson.

Obituary.—We regret to announce the sudden death of Mr. Charles H. Summers, chief electrician of the western division of the Western Union Telegraph Co., at the age of 61. Mr. Summers had been connected with the American telegraph service since 1854, when he was engaged as an operator on the old Pittsburg, Cincinnati and Louisville line.

Municipal Telephony.—The Secretary to the Post Office has sent the following letter to the Town Clerk of Bedford:—

I am directed by the Postmaster-General to acknowledge the receipt of your letter of 21st inst., enclosing a copy of a resolution passed by the Corporation of Bedford, applying for a license to transact telephone exchange business, and to state, in reply, that he is unable to accede to your request, as he is advised that municipalities are not empowered to work such business.

This time there is no promise of a licence if Parliamentary powers be obtained, a simple refusal being apparently deemed all that is necessary.

Electric Light in Gasworks.—The town of Longton (Staffs.) has no public electricity supply, but it can boast at least of one private electric lighting plant—viz., at the gasworks. Current is generated for lighting the purifier house, the governor house, engine room, manager's room and offices. The plant consists of a 110-volt continuous current dynamo, and is capable of supplying sixty 16-c.p. incandescent lamps. It has already proved itself eminently useful in enabling the purifiers to be attended to at night on the occasion of a breakdown. We may add that Longton's name figures in the list of Corporations applying for electric supply power next session.

The Telegraph in South Africa.—The following particulars of the condition of the telegraph system in Rhodesia and South Africa generally have been sent by a correspondent to the *Telegraph Age*:—The alphabet and system of working are exactly the same as those used in England, while the majority of the operators are also English. All the lines are worked on the open circuit principle with tape instruments, relays not being used. In some districts iron poles have been substituted for wooden ones, on account of the white ants, who have a way of eating the bottom parts of the poles, and causing their collapse. Some samples of makeshift methods of insulating are to be seen. One consists of iron spikes driven into the pole, the neck of a glass bottle being fitted on them, and the wire fastened to the glass.

The Long-Schattner Meter.—Messrs. Schattner and Co. write us that the prepayment meters they now supply work with a fall in voltage slightly lower than that given in our article last week. The maximum drop for the 100-volt 5-ampere meters is 0·6 volt, and for 200-volt meters 1·2 volts. Attempts were made to produce reliable instruments to work with a drop of 0·1 and 0·2 volts respectively, but it was found that these did not register small currents correctly. The reason is obvious. A drop of 0·6 volt across the resistance shunting the copper voltameter, when 5 amperes is passing through it, means a drop of only 0·04 volt when the third of an ampere required for a single 8-c.p. lamp is passing, and this fraction of a volt does not greatly exceed the minimum required to produce deposition in a copper voltameter. Even these meters could be cheated with a 5 c.p. lamp of fair efficiency.

Unipolar Dynamo.—The *American Electrician* suggests that by coupling a unipolar dynamo to a steam turbine, a cheap and effective machine for generating currents at low voltage could be evolved. The current-carrying capacity of a dynamo

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of this type is very great, but, as is well known, when run at normal speeds its voltage is extremely small. Our contemporary assumes a speed of 30,000 revolutions per minute, and estimates that, if a disc of 30in. in diameter were employed, the "effective area which can be fluxed" would be 35 sq. in., through which it should not, it says, be difficult to thread 35,000 lines of force. An effective voltage of 1·75 would be generated, perfectly adapted to some kinds of plating work. But by increasing the diameter of the disc as much as possible without endangering it from a mechanical standpoint, a voltage of 15 or 20 is predicted, and it is suggested that two such machines in series might often prove useful.

The Royal Society.—The following is a list of the Council elected for the ensuing year:—President, Lord Lister; treasurer, Mr. Alfred Bray Kempe; secretaries, Prof. Michael Foster and Prof. A. W. Rücker; foreign secretary, Sir Edward Frankland; other members of the Council, Prof. T. G. Bonney, Capt. E. W. Creak, Prof. D. J. Cunningham, Prof. James Dewar, Prof. William D. Halliburton, Prof. William A. Herdman, Mr. Victor A. H. Horsley, Dr. J. Larmor, Prof. N. S. Maskelyne, Sir Andrew Noble, Prof. E. B. Poulton, Mr. W. J. Russell, Prof. Arthur Schuster, Mr. Dukinfield H. Scott, Dr. G. J. Stoney, and Prof. J. J. Thomson. The Rumford medal has been awarded to Prof. Oliver J. Lodge for his researches in radiation and in the relations between matter and ether; and a Royal medal to Dr. John Kerr for his researches on the optical effect of electrical stress, and on the reflection of light on the surface of a magnetised body.

Opening of the Düsseldorf-Crefeld Light Railway.—On Nov. 10 the light railway between Düsseldorf and Crefeld and the new bridge built for it across the Rhine near Düsseldorf were officially opened. The line, which has been built by Messrs. Siemens and Halske in conjunction with the Rhenish Railway Co., of Düsseldorf, has a total length of 14 miles, the length of the track being 18½ miles. The steepest gradient is only 2·5 per cent. As it will to a certain extent carry trucks between private sidings and the State railways it has been built standard gauge. Two sizes of motor cars are used, those for local traffic being fitted with two motors of 20 H.P., while those for long distance work contain two 35 H.P. motors. A power station of 360 kilowatt capacity furnishes current to the overhead line, and an accumulator sub-station has also been erected containing two batteries each of 118·8 kilowatt capacity. A speed of 25 miles an hour will be attained on some sections of the line. We are indebted to the *Elektrotechnische Zeitschrift* for the above particulars.

Mica Discoveries in India.—The annual report of the Geological Survey for India contains an interesting account of Mr. T. H. Holland's recent explorations in Coorg. The discovery of pegmatites amongst the minerals of Mecara led to the institution of a careful search for mica, with the result that, in five or six localities, sheets above the average market size have been obtained. The largest were found on Elk Hill, where the outcrop of the vein is immediately beneath the soil, the sheets being quite free from warping, and measuring some 30in. in width. All the samples are of good colour, and, says the *Engineering and Mining Journal*, show a high degree of elasticity, though the value of some is reduced by the presence of ferruginous inclusions between the cleavage planes and occasional warping. The extent of depreciation in value resulting from these defects is now being ascertained in London. It seems extremely unlikely that the best veins should have been struck first in such a completely soil-covered area, but there is sufficient evidence that the mica-bearing pegmatites extend over a wide area, and, if worked with discretion, should be a source of considerable profit.

Electric Dumb Waiters.—The new public library of the city of Chicago is equipped with a system of dumb waiters, operated by electric motors, for delivering books from one department to another. Most of these waiters, says the *Electrical Engineer* of New York, travel simply in a vertical direction like an elevator, though some have recently been put in that travel in a variety of angles. The vertical dumb waiters are controlled from any floor by the movement of a pointer on a semicircular dial. The pointers on all the floors are connected together mechanically, so that if one of them is moved, all move. These pointers are intended to be moved by hand. If an attendant on the fifth floor wants the waiter at his floor, he moves the pointer to 5, and if all is right the waiter comes to his floor. If he wants to send it to the first floor, he moves the pointer to 1, and so on. To avoid confusion and accidents, the controller of the waiter motor is always locked when any door to the waiter shaft is open. The motors are arranged so as to avoid the necessity of counter-weights. They are series wound, about 1 H.P. in capacity, and run when at full speed at the rate of about 500 revolutions per minute. Being of such small power and low speed, no starting resistance is used with them, but the current is snapped on at full voltage. In order to prevent these series wound motors from running away with the car going down heavily loaded, part of the current is shunted around the armature through a resistance. This, of course, has the effect of so increasing the field strength by the greater volume of current passing through the fields that the counter electromotive force of the motor is very high for a given speed, and little current can flow through the motor. When the waiter is going up the connections are altered so that part of the current is shunted by a resistance around the fields, which has the effect of weakening the field strength of the motor, reducing the counter electromotive force at a given speed and permitting the motor to run faster than with full field strength. A brake solenoid locks the armature shaft when the motor is not running, releasing the break on the armature shaft whenever current is turned through it to supply the motor.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, December 2nd.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read: "The Sunlight Gold-Bearing Reef, Lydenburg, Transvaal," by C. B. Sauer.

MONDAY, December 5th.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

SOCIETY OF ENGINEERS.

7:30 p.m. Ordinary Meeting at the Royal United Service Institution Whitehall.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture III.—"Acetylene," by Prof. Vivian B. Lewes.

SOCIETY OF CHEMICAL INDUSTRY.

8 p.m. Meeting of the London Section in the Rooms of the Chemical Society, Burlington House, when the following Papers will be read: "On Ozone and its Commercial Applications," by Col. W. J. Engledue, and two Papers by Arthur Marshall on (1) "An Improved Apparatus for the Estimation of Carbonic Acid in Minerals, &c."; (2) "The Preparation of Standard Solutions of Sulphuric Acid."

TUESDAY, December 6th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed: "The Effect of Subsidence due to Coal Workings upon Bridges and other Structures," by Stanley R. Kay. Should time permit, the following Paper will be read: "The Ventilation of Tunnels and Buildings," by Francis Fox.

RÖNTGEN SOCIETY.

8 p.m. General Meeting at 11, Chandos-street, Cavendish-square, when Papers will be read by Ernest Payne and Dr. Walsh on "Dermatites in Relation to Röntgen Ray Work."

THURSDAY, December 8th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Papers to be read: "Improvements in Magnetic Space Telegraphy," by Prof. Oliver Lodge, F.R.S., and, time permitting, "Telegraphy by Magnetic Induction," by Sydney Evershed.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting at the Grand Hotel, Aytoun-street, Manchester. Paper to be read: "Superheated Steam and its Application on Steam Engines," by Paul Schou.

FRIDAY, December 9th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Agenda: (1) "Longitudinal Vibrations in Solid and Hollow Cylinders," by C. Chree, F.R.S.; (2) "On the Thermal Properties of Normal Pentane," by J. Rose-Innes and Sydney Young, F.R.S.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Ordinary Meeting at the Westminster Palace Hotel. Paper to be read: "British Cable Tramways and their Construction," by E. A. Heath.

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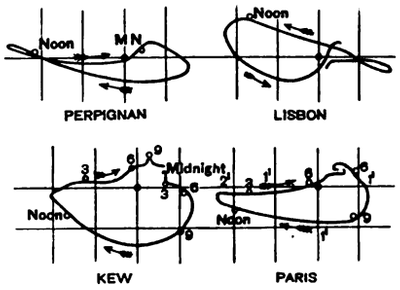
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Temporary Magnetic Observatories.—In order to solve the momentous question whether the forces producing the phenomena of terrestrial magnetism have a potential in the earth's surface it is necessary to increase the present (diminishing) number of reliable magnetic observatories. The report presented by Prof. Von Bezold and Gen. Rykatschew to the British Association points out that the divergences from the above hypothesis are greatest between 40deg. and 45deg. of northern latitude. Since the largest number of records are available for just those latitudes, it seems probable that the apparent absence of divergences of more than 8 per cent. for the other latitudes is due to lack of material. If the phenomena of terrestrial magnetism were exclusively due to constant forces in the space outside the earth, the diurnal oscillations should be the same for any given latitude. This cannot be satisfactorily determined with the present arrangements, since there is only one observatory (Batavia) in the specially important tropical belt between 10°N. and 10°S., and only one (Melbourne) south of 35°S. The latitudes of 38°N. and 40°S. should also be narrowly watched. The report proposes the establishment of temporary observatories at Taschkent, Peking or Vladistock, Mount Hamilton, Quito, Para, Colombo, Cape Town, St. Paul and Cape Horn.

[Bezold and Rykatschew, *Terr. Mag.*, September, 1898.]

Compound Magnetic Variation Curves.—By plotting the diurnal movement of the north-seeking pole of a magnetic bar supposed to be suspended by its centre of gravity, J. B. Capello obtains curves which are distinctively characteristic of



the place where they are obtained. The diagrams (*see* Fig.) illustrate the diurnal variations of the declination and dip at Kew, Paris, Perpignan and Lisbon. It will be seen that as the latitude decreases the curves become flatter. At Perpignan a loop appears, and at Lisbon this loop is enlarged so as to present a retrograde movement. It would be useful to find some means of automatically recording such curves.

[Capello, *Terr. Mag.*, September, 1898.]

The Azores as a Magnetic Station.—In the course of his studies of the Azores Archipelago as a meteorological station for weather predictions, Prince Albert of Monaco thought that any observatories established there might be of service to other branches of science, and more especially to terrestrial magnetism. The islands are situated near the important latitude of 38°N. They are removed from all electrical tramways and other sources of disturbance which are harassing the older magnetic observatories; and since their geographical position is intermediate between the old world and the new they are capable of furnishing a valuable link between the records taken in the eastern and the western hemispheres respectively. The Prince, therefore, approached the Portuguese Government with a view of sending Capt. Chaves, director of the meteorological observatory of Ponte Delgada, to Paris to study the arrangements at Parc Saint-Maur. He at the same time undertook to make a preliminary magnetic survey of the archipelago, with a view of fixing upon the most favourable situation for the combined magnetic and meteorological observatory. His suggestion was acted upon, and Capt. Chaves is to enter on his work in April next.

[Albert of Monaco, *Terr. Mag.*, Sept., 1898.]

Wireless Telegraphy Across Paris.—E. Ducretet describes some experiments made in transmitting wireless messages from the Eiffel Tower to the Pantheon. The distance is 2½ miles, and the view across is interfered with by a good many aërial structures. The results obtained were perfectly clear, even in a thick fog. The transmitter was stationed on the third platform of the Eiffel Tower; it consisted of a coil of 25cm. spark-length, worked by a Ducretet motor-interrupter. One of the three spheres of the oscillator was attached to the radiating wire, suspended in space and reaching nearly down to the second platform. Since the wire in the vicinity of the metallic tower acquired a great capacity, the length of sparks in the oscillator was greatly diminished. The receiver, installed on the balcony over the colonnade of the Pantheon, contained a Branly "radio-conductor" and liquid resistances, and a collecting wire 44m. long was connected with it. The signals could be read by their sound with great ease, or could be recorded on the Morse system. In endeavouring to transmit from the Pantheon to the Eiffel Tower no result was obtained, owing to the masses of metal in the latter; but signals could be exchanged between the Pantheon and a mast erected on the roof of the author's laboratory in the Rue Claude Bernard, and projecting 20m. above the surrounding houses.

[Ducretet, *Comptes Rendus*, Nov. 7, 1898.]

Electric Dispersion.—K. F. Löwe has made some experiments to clear up certain points left doubtful after the work of Thomson, Lecher and Drude. It will be remembered that the latter traced a close connection between anomalous electric dispersion and anomalous electric absorption, the former never occurring without the latter. The relation between the numerical values may be represented by

$$a = \tan\frac{\phi}{2}, \text{ where } \tan\phi = \frac{1}{k}\sqrt{(k_\infty - k)(k - k_0)},$$

k being the dielectric constant, and a the corresponding absorption for a given wave-length. Löwe tests the validity of this formula for some esters, organic acids, and glasses. The esters of the fatty acids and benzoic acid show no anomaly either in absorption or dispersion, and so furnish a negative confirmation of Drude's rule. A large number of other esters and alcohols, when examined by means of Nernst's nickel condenser, exhibited what may, by a stretch of generosity, be termed an agreement with Drude's formula. In the glasses, the relation between dispersion and absorption is still less defined. A highly dispersive crown glass showed also the highest absorption. An interesting aspect of the question is the comparison between the absorptions in the solid and the liquid state respectively. This is being pursued by the author.

[Löwe, *Wied. Ann.*, No. 11, 1898.]

Contact Electricity.—A. Coehn recently put forward the statement that the contact electrification between two bodies is determined by their dielectric constants, bodies with a higher dielectric constant being positively charged by contact with a body of a lower dielectric constant. This rule, if universal, furnishes a ready means of determining dielectric constants of substances by their contact electricities with other substances. Even if it is not universal, it will serve the useful purpose of stimulating inquiry. A. Heydweiller has followed up the question by introducing minutely subdivided metals into a narrow tube containing an electrolyte. The electrolyte was made up by mixing water and acetone, or acetone and chloroform in various proportions, thus obtaining liquids with dielectric constants ranging from 5 to 70. The contact electrification between the metal and the liquid was indicated by the motion of the metallic fragments in the tube on passing the current. Thus platinum showed positive electrification in pure chloroform, but negative in all other dielectrics. Gold, tin, cadmium, zinc and aluminium were increasingly positive. So far, then, Coehn's rule was confirmed. But in the alcohols, all metals showed + electrification, and in amyl acetate, with a dielectric constant of 5, they showed − electrification. Perhaps this is due to the solution of positive instead of negative ions, or to some factor not at present taken into account.

[Heydweiller, *Wied. Ann.*, No. 11, 1898.]

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Solution of Noble Metals.—M. Margules recently described (see *The Electrician*, Vol. XLI., p. 541) a method of disolving gold and platinum by an electrolytic process. He has since devised a simpler apparatus, consisting of a revolving commutator which alternately sends the current through the cell and short-circuits it. A suitable spacing of the conducting and non-conducting portions of the commutator enables the operator to regulate the ratio of current to short circuit. Another device consists of a hammer interrupter, to which a separate contact piece is attached. At every oscillation, the contact piece produces a short circuit of the cell, or sends a current through the cell in opposition to the first current. Under these circumstances, platinum dissolves at the electrode which is the anode for the stronger current or the greater electric quantity. The behaviour of gold is very different from that of platinum. The latter cannot be dissolved even in hydrochloric acid by means of a constant current, whereas gold is easily dissolved in hydrochloric, strong nitric, and sulphuric acid, under the influence of a constant current. The protection of the noble metals is evidently connected with some phenomenon of polarisation. Eliminate the polarisation, and the nobility disappears.

[Margules, *Wied. Ann.*, No. 11, 1898.]

Selenium Coherers.—Considering that selenium shows a diminution of resistance under the influence of ordinary light, it would not be surprising to find that it was peculiarly effective as a coherer substance. B. Agostini has investigated its properties in this respect in a variety of ways, but so far with negative results. In the interior of a glass tube about 1·5mm. diameter, and between copper electrodes fitting easily in the tube, he placed small fragments of amorphous selenium. By heating the tube to the fusing point of selenium and lightly compressing the substance, he obtained a solid cylinder of selenium in the centre of the tube, which adhered to the electrodes. Sixteen such tubelets were prepared and tied in a sheaf, and the whole brought into a thermostat, which allowed of the maintenance of any temperature from 195deg. downwards. While the resistance in the dark was 111,000 ohms, and under the influence of light 62,000 ohms, the resistance increased, under the influence of electric waves from a Righi short-wave oscillator provided with a parabolic mirror, by about 1,000 ohms. Testing with a Lippmann capillary electrometer instead of a galvanometer, a slightly larger increase, about 1·6 per cent., was obtained. In other cases there was a diminution of about the same amount. The changes are within the limits of experimental error, and are probably accounted for by temperature variations, leaving nothing for a coherer action proper.

[Agostini, *Nuovo Cimento*, August.]

ELECTROMAGNETIC THEORY.—CX.*

BY OLIVER HEAVISIDE.

(Continued from page 786.)

§ 442. The product of ϵ^x and ϵ^{-x} is 1. If, then, the product of the same when generalised came to 2 or to x, we could be sure there was something wrong. But we need not expect that the product should reduce to 1 in a plain manner. The product, say Q, of the generalised series for ϵ^x and $\epsilon^{-x}\cos r\pi$ makes the power series

$$Q = \ldots + x^{2r}\phi(r) - x^{2r+2}\phi(r+1) + x^{2r+4}\phi(r+2) - \ldots, \quad (189)$$

where $$\phi(r) = \frac{1}{\lfloor r \rfloor^2}\left\{1 - \frac{2r}{r+1}\left(1 - \frac{r-1}{r+2}\left(1 - \frac{r-2}{r+3}\left(1 - \ldots\right\}, \quad (190)$$

which may be transformed to

$$\phi(r) = \frac{1}{\lfloor r \rfloor^2}\frac{(1-r)(2-r)(3-r)\ldots}{(1+r)(2+r)(3+r)\ldots} = \frac{1}{\lfloor r \rfloor^2}\frac{(1-1)^r}{(1+1)^r}. \quad (191)$$

So $\phi(r)$ is 0 when r is +, and is ∞ when r is −, unless integral. Q is 1 when r is 0, and is −1 when r is 1, and so on. But when r is fractional, Q assumes the indefinite form of a succession of infinities, not plainly reducible to $\cos r\pi$.

Write (140) thus,

$$w = \Sigma\frac{x^r}{\lfloor r}\frac{1}{\cos r\pi}. \quad (192)$$

When x is +, w is ϵ^{-x}. Differentiate to r, then

$$w' = \Sigma\frac{x^r}{\lfloor r}\frac{1}{\cos r\pi}\Big(\log x + \mathrm{G}(r) + \pi\tan r\pi\Big). \quad (193)$$

This is zero when x is +. Compare with u and u' before considered, representing ϵ^x and 0. The $r=0$ case of (193) is

$$w' = \epsilon^{-x}(\log x + \mathrm{C}) - \left(\frac{1}{x} + \frac{1}{x^2} + \frac{2}{x^3} + \ldots\right) + \left(x - \frac{x^2}{\lfloor 2}(1+\tfrac{1}{2}) + \ldots\right). \quad (196)$$

Compare with (93) above. That, by (97), makes a rapid approximation to the value of C. The present formula does not, for the same figures are differently arranged, which makes the l.c.t. large.

Since u satisfies $(\Delta - 1)u = 0$, it must be $A\epsilon^x$, where A is a function of r. This being 1 when x is +, if it is different when x is −, it is made a function of x. So there seems to be an irreconciliabity, requiring some modification of ideas, perhaps. But u', u'', &c., also satisfy the characteristic, and so does

$$X = u + A_1u' + A_2u'' + A_3u''' + \ldots. \quad (195)$$

Moreover, the value of X is simply u, or ϵ^x, when x is positive. Similarly, the characteristic $(\Delta + 1)w = 0$, is satisfied by

$$Y = w + B_1w' + B_2w'' + B_3w''' + \ldots, \quad (196)$$

and the value of Y is w, or ϵ^{-x}, when x is positive. When x is negative, or complex, we do not know what they are. As the A's and B's may be various, we may have transitions from X to Y. Here is one. Say

$$\epsilon^{-x} = w + Bw'. \quad (197)$$

Put $x = -z = zi^2$. Then we get

$$\epsilon^z = \Sigma\frac{z^r}{\lfloor r}(1 + i\tan r\pi)$$

$$B\Sigma\frac{z^r}{\lfloor r}(1 + i\tan r\pi)\,(\log z + \mathrm{G}(r) + i\pi + \pi\tan r\pi), \quad (198)$$

which splits into equations which may be written

$$\epsilon^z = u + Bu', \quad (199)$$

$$0 = \left(1 + B\frac{d}{dr}\right)\Sigma\frac{z^r}{\lfloor r}\tan r\pi. \quad (200)$$

Whether this be a proper transformation or not, equations (197) and (199) are consistent. For with z positive and therefore x negative, both equations are true, if (197) is true for x negative as well as positive. But further investigation is reserved.

§ 443. We may derive a power series for the logarithm of x from the binomial theorem

$$\frac{(1+x)^n}{\lfloor n} = \Sigma\frac{x^r}{\lfloor r \lfloor n-r}. \quad (201)$$

Differentiate to r. Then

$$-\log x = \Sigma\frac{x^r}{\lfloor r \lfloor n-r}\Big(\mathrm{G}(r) - \mathrm{G}(n-r)\Big). \quad (202)$$

In the simpler case of $n=0$ this is

$$-\log x = \Sigma\, x^r\frac{d}{dr}\frac{\sin r\pi}{r\pi} = \Sigma\frac{x^r}{r}\left(\cos r\pi - \frac{\sin r\pi}{r\pi}\right). \quad (203)$$

When $r=0$ this makes

$$-\log x = \Sigma\frac{x^r}{r}\cos r\pi, \quad (204)$$

without the zeroth term for $r=0$. That is,

$$\log x = x - x^{-1} - \tfrac{1}{2}(x^2 - x^{-2}) + \tfrac{1}{3}(x^3 - x^{-3}) - \ldots, \quad (205)$$

that is, the sum of the logarithms of $1+x$ and $(1+x^{-1})^{-1}$ according to the common formula.

In the case $r = \frac{1}{2}$,

$$\log x = \frac{1}{\pi}\Sigma\frac{x^r}{r^2}\sin r\pi; \quad (206)$$

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or, putting $x=y^2$,

$$\frac{\pi}{2}\log y = y - y^{-1} - \tfrac{1}{3}(y^3 - y^{-3}) + \tfrac{1}{2\,5}(y^5 - y^{-5}) - \dots . \quad (207)$$

The two formulæ (205) and (207) both lead to $\log i = \frac{1}{2}i\pi$.

Differentiating (204) to x, we get

$$-\frac{1}{x} = \Sigma\, x^{r-1}\left(\cos r\pi - \frac{\sin r\pi}{r\pi}\right), \quad (208)$$

Multiply by x and use the result (43); we then reduce to

$$0 = \Sigma\, x^r \cos r\pi. \quad (209)$$

The $r=0$ case is $\quad 0 = (1+x)^{-1} - x^{-1}(1+x^{-1})^{-1}. \quad (210)$

Also (208) seems to give a power series for x^{-1}. But it is only a particular form of (209).

Differentiating (209) to x gives

$$0 = \Sigma\, x^r \sin r\pi. \quad (211)$$

Equation (206) may be used numerically. I have also verified that the more general formula (203) goes when $r=\frac{1}{4}$, the error vanishing when $x=1$.

Put $y=xi$ in (207). We get the well-known

$$\frac{\pi}{4}z = \sin z - \tfrac{1}{3}\sin 3z + \tfrac{1}{2\,5}\sin 5z - \dots . \quad (212)$$

Again, putting $x=\epsilon^{\pi i}$ in (203) we get

$$-z = \Sigma\,\frac{x^r}{\lfloor r}\left(\cos r\pi - \frac{\sin r\pi}{r\pi}\right), \quad (213)$$

which, when $r=0$, makes the well-known

$$\tfrac{1}{2}z = \sin z - \tfrac{1}{2}\sin 2z + \tfrac{1}{3}\sin 3z - \dots . \quad (214)$$

Although these substitutions of imaginary for real values are successful in the special cases chosen, they are only experimental, for the *theory* of generalised functions is *in nubibus* as yet.

§ 444. In § 433 this formula, equation (80), was arrived at from the binomial theorem *viâ* the logarithmic function :—

$$(1+x)^{-1} = \Sigma\, x^r g(r) g'(-r-1). \quad (215)$$

Put Δ^{-1} for x and algebrise with unit operand; then we get

$$\epsilon^{-x} \;||\; \Sigma\, x^r [g(r)]^2 g'(-r-1). \quad (216)$$

Do the same again, and we get

$$J_0(x) \;||\; \Sigma\,\frac{(\frac{1}{2}x)^{2r}}{(\lfloor r)^2}\, g'(-r-1). \quad (217)$$

Here || is used to indicate a possible or apparent equivalence; it may not be one, or it may. The method is a very speedy way of generating new formulæ, and sometimes gives true equivalences, at other times only partial ones.

Now (217) is easily seen to be incorrect. What about (216), then? And is not (215) to be suspected? It may be readily tested. Multiply by $1+x$. The result is

$$1 = \Sigma\,\frac{x^r}{\lfloor r}\Big(g'(-r-1) + r g'(-r)\Big), \quad (218)$$

which is identically the same as

$$1 = \Sigma\,\frac{x^r}{\lfloor r\,\lfloor -r} = \Sigma\, x^r \frac{\sin r\pi}{r\pi}, \quad (219)$$

which formula was obtained before equation (43). It asserts that $\epsilon^{\Delta}1 = 1$, and often turns up as a connecting formula. It satisfies the characteristic

$$(1+x)\Delta u = 0, \quad (220)$$

i.e., $\Delta u = 0$, therefore u is constant as regards x. Numerically considered, however, it can only be used when x is near to 1. When $x=1$, we have such series as

$$(r=\tfrac{1}{2}) \quad \frac{\pi}{4} = 1 - \tfrac{1}{3} + \tfrac{1}{5} - \tfrac{1}{7} + \dots, \quad (221)$$

$$(r=\tfrac{1}{4}) \quad \frac{\pi}{4}\sqrt{2} = 1 + \tfrac{2}{1\,5} - \tfrac{2}{6\,3} + \tfrac{2}{1\,4\,3} - \tfrac{2}{2\,8\,3} + \dots . \quad (222)$$

There is no reason, so far, to doubt (215).

Passing to (216), see on what the satisfaction of the characteristic of ϵ^{-x} by the right member depends. The result is

$$0 \;||\; \frac{d}{dx}\Sigma\,\frac{x^r}{\lfloor r}\,\frac{\sin r\pi}{r\pi}. \quad (223)$$

If the || can be replaced by $=$, then (216) will go. Integrating to x,

$$1 \;||\; \Sigma\,\frac{x^r}{\lfloor r}\,\frac{\sin r\pi}{r\pi} = v, \text{ say}, \quad (224)$$

because it is 1 for a special case, though the left side might be a function of r. On numerical testing, v seems to be 1 very closely. Thus take $r=\frac{1}{2}$; then $x=5$ makes $v=0{\cdot}9993$ by a long sum of about 20 terms. But this x may not be small enough to show an auxiliary satellitic function, if it exists. Now $x=2$ makes $v=1{\cdot}009$ with, and $1{\cdot}0009$ without the l.c.t. Again with $x=1$, I get $1{\cdot}063$ with and $1{\cdot}0093$ without the l.c.t. The error rule seems to fail here; for example, the last result is nearly 1 per cent. more than the size of the l.c.t. would allow. However, passing to $x=\frac{1}{2}$, the rule is satisfied, and also with $x=\frac{1}{4}$, although now the error itself has become large.

Testing (223) in the same way, with the same values of r and x, the value 0 comes out right (within the error limits) all through. Also with $x=3$. Unless, therefore, errors in calculation are involved, it would seem that the error rule, by which the l.c.t. finds the error, is not a complete rule.

Try with $r=\frac{1}{4}$. Here

$$g^2(\tfrac{1}{4}) = 1{\cdot}21690, \qquad g(\tfrac{1}{4}) = 1{\cdot}10313,$$

by the formula (188) above with $n=0$, and $r=\frac{1}{4}$. Applying these to (224), with $x=2,\ 1,\ \frac{1}{2},\ \frac{1}{4}$, the results are a little less than 1 throughout, and within the error limits. We can say that v is certainly closely equal to 1 save when x is small, when the l.c.t. is too big for any certain conclusion.

But that (224) is not a real equivalence is to be seen by differentiating it to r. Thus

$$v' = v\log x + \Sigma\,\frac{x^r}{\lfloor r}\mathrm{G}(r)\frac{\sin r\pi}{r\pi} + \Sigma\,\frac{x^r}{\lfloor r}\,\frac{\cos r\pi - (r\pi)^{-1}\sin r\pi}{r}. \quad (225)$$

Where $r=0$, this reduces to

$$v' = \log x + \mathrm{C} - \left\{x - \tfrac{1}{2}\frac{x^2}{\lfloor 2} + \tfrac{1}{3}\frac{x^3}{\lfloor 3} - \dots\right\} \quad (226)$$

$$= -\epsilon^{-x}\left\{\frac{1}{x} - \frac{1}{x^2} + \frac{\lfloor 2}{x^3} - \frac{\lfloor 3}{x^4} + \dots\right\}. \quad (227)$$

Here v' is zero only when $x=\infty$. So $v \;||\; 1$ is only an apparent equivalence. The characteristic of v is

$$(\Delta+1)x\Delta v = 0, \quad (228)$$

$$\therefore\ v = a\int\frac{\epsilon^{-x}}{x}dx = \mathrm{A} + a\left[\log x + \mathrm{C} - \left(x - \tfrac{1}{2}\frac{x^2}{\lfloor 2} + \dots\right)\right], \quad (229)$$

where C, or G(0), is brought in to make $[\dots]=0$ when $x=\infty$. A and a are functions of r. From the preceding A is 1, and a is periodic. To harmonise with (226), we may write

$$v = 1 - \frac{\sin 2\pi r}{2\pi}\left[\left(x - \tfrac{1}{2}\frac{x^2}{\lfloor 2} + \dots\right) - (\log x + \mathrm{C})\right]. \quad (230)$$

So $v=1$ when r is integral and midway between, and is nearly 1 for any r, if x is over 1.

The sine function thus reached may also be utilised thus. Equation (228), by (224), means the same as

$$\Sigma\,\frac{x^r}{\lfloor r}\,\frac{\sin r\pi}{\pi} = a\epsilon^{-x}. \quad (231)$$

Divide by $\pi^{-1}\sin r\pi\cos r\pi$. Then

$$\Sigma\,\frac{x^r}{\lfloor r}\,\frac{1}{r\cos r\pi} = \frac{2\pi a}{\sin 2\pi r}\epsilon^{-x} = \epsilon^{-x}. \quad (232)$$

Comparing with (140), we see that the present investigation leads to the generalised ϵ^{-x} formula which harmonised the Bessel functions. Numerically tested, the formula (230) goes with $x=1,\ \frac{1}{2},\ \frac{1}{4}$.

§ 445. Passing now to the generalised formula

$$\mathrm{W} = \epsilon^{x}\pi^{\frac{1}{2}}\Sigma\,\frac{(\frac{1}{2}x)^r}{(\lfloor r)^2\,\lfloor -\frac{1}{2}-r}, \quad (233)$$

before obtained, equation (53). First test that W satisfies the characteristic of $I_0(x)$ identically. It therefore involves I_0 or

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K_0, or both. But can K_0 come in at all? W is the convergent I_0 when $r=0$, and is the equivalent divergent $\frac{1}{2}H_0$ when $r=\frac{1}{2}$. Now when r is arbitrary, we may, by the use of the corresponding generalised ϵ^x series, reduce W to an integral power series. But the solution of the characteristic equation of I_0 in an integral power series was shown to split into two series (even and odd terms), which satisfy the characteristic separately, and are, moreover, equivalent. This strongly suggests that W does not involve K_0 at all, but is $I_0(x)$ a periodic function of r, which is 1 when r is 0 and $\frac{1}{2}$. Or, in terms of the even and odd series, $W=aA+bB$, where A is $I_0(x)$ and B is the equivalent series in odd powers as in (44), (45). I tried to test this numerically, to fix a and b. But the series to find a and b are divergent with wide error limits, so it was no good this way.

In order to detect the satellite, take $r=\frac{1}{4}$. The result (numerically) is that W is sensibly I_0 when x is big, but falls slightly below I_0 as x is reduced to 1, $\frac{3}{4}$, $\frac{1}{2}$. Then take $r=-\frac{1}{4}$, and test. As x is reduced W now *rises* slightly *above* I_0. This difference, + or − as the case may be, increases as x decreases.

The form of W is therefore probably I_0-cK_0, as in the case of U before, and c has to be found. Finding the result of reducing W to an integral power series difficult to manage, try another way. Use the ordinary ϵ^x series in (233). The result is then

$$W=\Sigma\, y^{\frac{1}{4}r}\phi(r), \tag{234}$$

where $y=\frac{1}{4}x^2$ and the step of r is 1, whilst

$$\phi(r)=2^r\pi^{\frac{1}{2}}\left\{\frac{2^r}{(\lfloor r)^2\lfloor -r-\frac{1}{2}\rfloor 0}+\frac{2^{r-1}}{(\lfloor r-1)^2\,-r+\frac{1}{2}\rfloor 1}+\ldots\right\}. \tag{235}$$

This is a stopping series, and is convergent, so can be closely calculated. With r integral, we get $I_0(x)$. With $r=$ integer $+\frac{1}{2}$, we get a result reducible to

$$W=\tfrac{1}{2}(U_{\frac{1}{2}}+U_{-\frac{1}{2}})=\tfrac{1}{2}H_0(x). \tag{236}$$

In general, (234) makes

$$W_r=AU_{\frac{1}{2}r}+BU_{-\frac{1}{2}r}, \tag{237}$$

where A and B are functions of r to be found. Understand that U is the previous $U_{n,r}$ function, with $n=0$, as in § 439.

In the case of $r=\frac{1}{4}$ the result is

$$W_{\frac{1}{4}}=0{\cdot}8525\,U_{\frac{1}{4}}+0{\cdot}1460\,U_{-\frac{3}{4}}, \tag{238}$$

where

$$U_r=\tfrac{1}{2}(H_0-\sin 2\pi r\,.\,K_0)(x). \tag{239}$$

This makes

$$W_{\frac{1}{4}}=\tfrac{1}{2}H_0-\tfrac{1}{4}K_0, \tag{240}$$

very closely. Note that (238) is an identity, subject to the use of the ordinary ϵ^x series; whilst (240) is a conveniently substituted equivalence.

The general identical formula corresponding to (238) is

$$W_r=U_{\frac{1}{4}r}\cos^2\tfrac{1}{2}\pi r-U_{-\frac{1}{4}r}\sin^2\tfrac{1}{2}\pi r. \tag{241}$$

I have verified it numerically for eight values of r, namely, 0, $\frac{1}{8}$, $\frac{1}{4}$, &c., up to $\frac{7}{8}$. Using (239) in it, the result is

$$W_r=\tfrac{1}{2}(H_0-\tfrac{1}{2}\sin 2\pi r\,K_0)(x). \tag{242}$$

The satellite for W_r has only half the mass of that for U_r. The value of $\phi(r)$ in (235) is

$$\phi(r)=[g(\tfrac{1}{2}r)\cos\tfrac{1}{2}\pi r]^2. \tag{243}$$

The reduction of W_r (involving K_0) to an integral power series, before referred to, implies that the series, which satisfies the characteristic as a whole, does not do so in two independent ways. The expansion (137) above illustrates this. Both the even and the odd powers have to be included to satisfy the characteristic. The characteristic is

$$(DyD-1)K_0=0, \tag{244}$$

if $D=d/dy$, and this is satisfied because the odd power series when operated upon by $(DyD-1)$ gives $-D\Sigma y^r[g(r)]^2$, with $r=\frac{1}{2}$, whilst the even power series gives + (the same), with $r=0$. On addition, therefore, (244) is obeyed.

Of course, when W is expanded in the form (234), it does split into two series, as in (241), which separately satisfy the characteristic. But it seems that this is the exceptional case, and that there is no double satisfaction when the generalised ϵ^x is used.

The satellitic terms in both cases, U and W, become very important when x nears the origin. But then the series cannot be used for calculation, on account of the largeness of the possible error. So, practically, both U and W are apparently I_0; and the small correction may be eliminated by using two values of r; thus,

$$I_0(x)=\tfrac{1}{2}(U_r+U_{-r})=\tfrac{1}{2}(W_r+W_{-r}). \tag{245}$$

§ 446. If the characteristic be of the third order, its three solutions will be all included in one generalised solution, and will be separable therefrom by giving special values to r. If $r=0$ makes the primary, the other two solutions are likely to enter satellitically in the general solution. Similar remarks may apply to higher orders, but there is some work to be done to investigate fully.

The apparent equivalence

$$I_0(x)\,\|\,\Sigma\frac{y^r}{(\lfloor r)^2} \tag{246}$$

arises from $\epsilon^{D^{-1}}1=I_0(x)$; where $D=d/dy$, and $y=\frac{1}{4}x^2$. If we change y to Δ^{-1}, and algebrise again, with unit operand, we obtain

$$1+y+\frac{y^2}{(\lfloor 2)^3}+\frac{y^3}{(\lfloor 3)^3}+\ldots\,\|\,\Sigma\frac{y^r}{(r^3)}=w_r. \tag{247}$$

The characteristic is now

$$(DyDyD-1)w=0. \tag{248}$$

It has three independent solutions. One of them, w_0, with $r=0$, is the left member of (247). All three are included in w_r. Nevertheless, $w_0\,\|\,w_r$ is an apparent equivalence.

Taking $r=\frac{1}{2}$, the original equation (246) is a true equivalence, but (247) is not. (Besides $r=0$, $\frac{1}{3}$ and $\frac{2}{3}$ are probably the important values.) For w_0 is a little greater than $w_{\frac{1}{2}}$ when $y=1$, the ratio being about 0·967. Increasing y improves the equivalence; $y=3$ and above making $w_{\frac{1}{2}}$ a little greater than w_0, the ratio being 1·001 when $y=8$.

Going a step further in the same way to the fourth order, say

$$w_r=\Sigma\frac{y^r}{(\lfloor r)^4}, \tag{249}$$

and comparing w_0 with $w_{\frac{1}{2}}$, the numerical equivalence is so close as to make one think it may be an exact one here specially. Still $w_{\frac{1}{2}}$ is the smaller when $y=1$, though a trifle greater from $y=2$ up to 9.

Passing on to

$$w_r\,\|\,\Sigma\frac{y^r}{(r)^8}, \tag{250}$$

there is a falling off in agreement; for as y increases from 1 to 36, the ratio $w_{\frac{1}{2}}/w_0$ falls continuously from 1·37 to 0·907.

One more case to show further falling off. Let

$$w_r\,\|\,\Sigma\frac{y^r}{(\lfloor r)^{16}}. \tag{251}$$

The peculiarity here (and in the last case less markedly) is the very large ratio, namely 2^{16}, of the coefficient of $y^{\frac{1}{2}}$ to that of $y^{-\frac{1}{2}}$ in the series $w_{\frac{1}{2}}$, whereas the succeeding ratios are quite small. This may affect the determination of the error in a complete rule. Anyhow the tendency shown in the last case is now more marked, for $w_{\frac{1}{2}}/w_0$ falls from 3·3 to 0·75 as y goes from 1 to 100. There is equality at about 49.

The above series of formulæ are such good apparent equivalences at the beginning, though so bad later on, that it is suggested to examine the formulæ which arise from the equivalence $1=\Sigma\, x^r(r\pi)^{-1}\sin r\pi$, equation (219), in a similar way. The first one, turning x to Δ, and algebrising, is the apparent equivalence (224) above, shown to be excellent. But others, of the types

$$w_r=\Sigma\, x^r\left(\frac{\sin r\pi}{r\pi}\right)^n, \qquad w_r=\Sigma\frac{x_r}{\lfloor r}\left(\frac{\sin r\pi}{r\pi}\right)^n, \tag{252}$$

with n integral and greater than 1, are found by a cursory examination not to furnish apparent equivalences, at least as regards $r=0$ and $\frac{1}{2}$.

(To be continued.)

[Errata. § 438: Between (133) and (134) *for* $\frac{1}{000}$ *read* $\frac{1}{1000}$. § 441: In equations (184) and (185), *for* cos *read* sin; and in equation (186) *for* $n\frac{1}{2}$ *read* $\pi^{\frac{1}{2}}$.]

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THE LANGDON-DAVIES MOTOR WORKS.

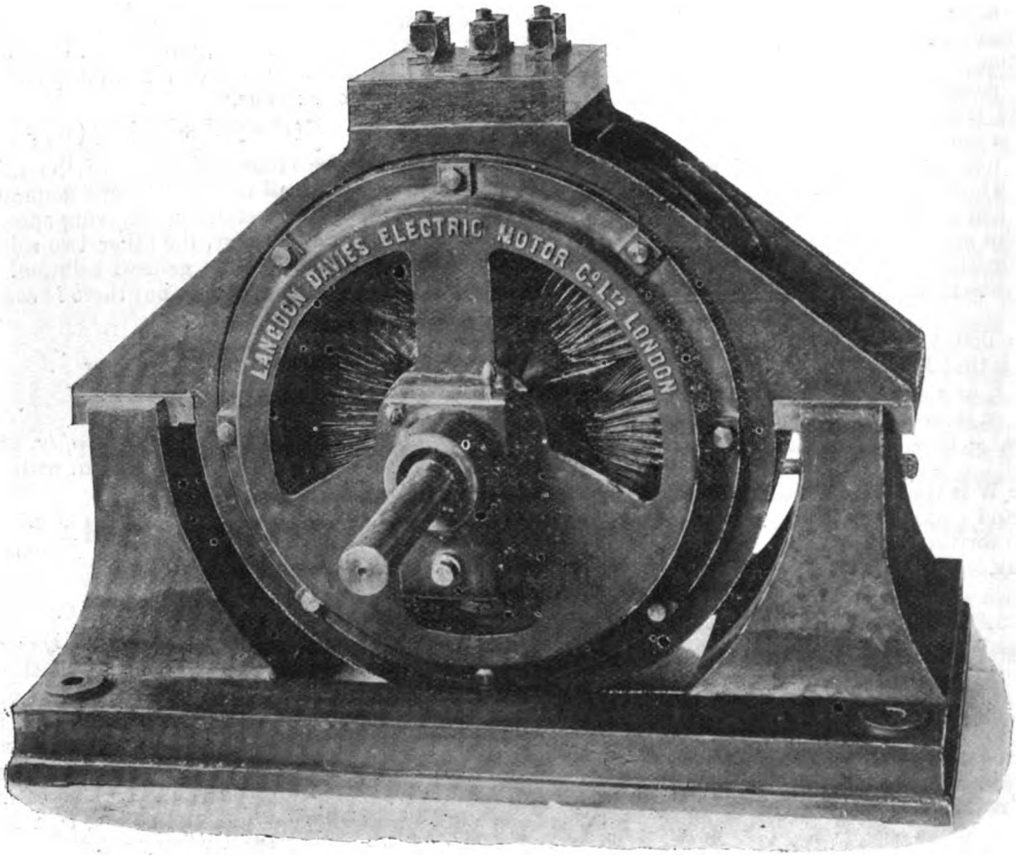

FIG. 1.—25-H.P. LANGDON-DAVIES MOTOR.

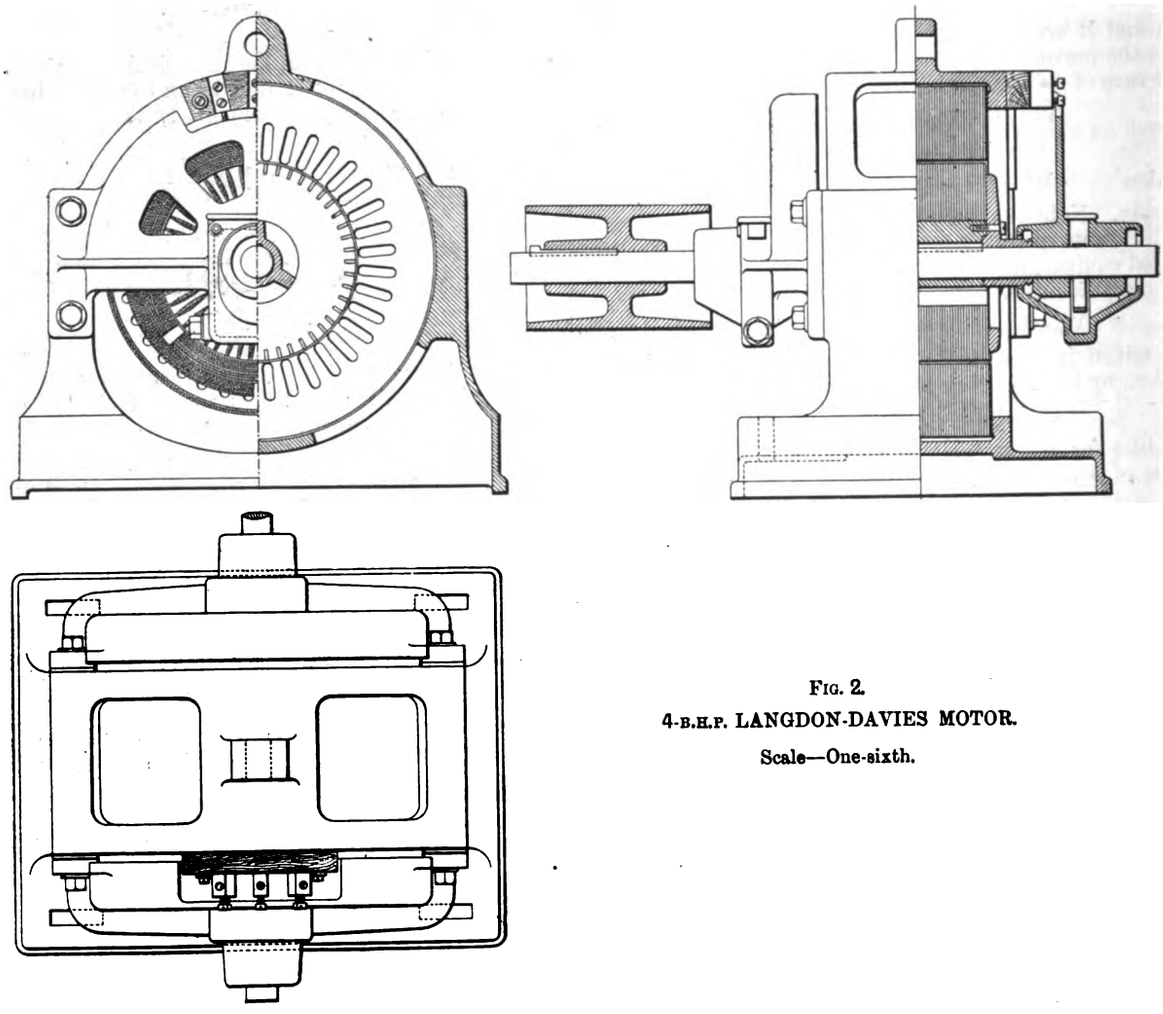

FIG. 2.
4-B.H.P. LANGDON-DAVIES MOTOR.
Scale—One-sixth.

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THE LANGDON-DAVIES MOTOR WORKS.

We have had an opportunity of visiting the works of the Langdon-Davies Electric Motor Co., in Southwark-street, and the activity that prevails there should quite dispel the idea that an alternating-current supply station may hope in vain for a motor load unless it is prepared to lay down a subsidiary continuous-current network. The two disadvantages of an alternate current motor, viz., its inability to start under a heavy load, and the power-factor, are counterbalanced to some extent in the Langdon-Davies motor by its absence of brushes. The power-factor is a difficulty which cannot be got over; with regard to the first defect, however, the makers rightly point out that a gas-engine is in a worse plight, being not even self-starting. This article is not intended, however, to consider critically and at length the merits and demerits of single and alternating currents from the supply engineers' or consumers' point of view, and we will confine ourselves to a description of the motor itself, and of the works where it is constructed.

Two years ago* we entered fully into the theoretical considerations underlying the design of this machine, and it is unnecessary to repeat them now. It will suffice to recall the fact that the rotating part of the motor is merely a number of short-circuited coils wound on an iron core carried on the motor shaft, while the position and proportions of the stator coils are such as to produce a rotating field, a starting winding being added which is switched off as soon as the motor has attained its full speed. From Fig. 2 a clear idea of the mechanical construction of the motor can be obtained. The stator coils are wound in slots in the laminated core held in the cast-iron carcase of the motor. They are insulated from the iron by a thin lining of vulcanised fibre being given to the slots, and the various windings are insulated from one another by "presspan," or by a thin sheet of other insulating material. The bearings are a particularly noticeable feature; they are of cast iron, no bushes being used within the brackets. The ring lubrication used is clearly seen in the figure; slight grooves are cut in the bearing, so that the oil is kept continuously circulating along the shaft and back to the oil bath. The rotor coils are embedded in slots milled in the rotor core, which is held by a gun-metal spider in the customary manner. These slots, it may be mentioned, are not parallel to the shaft, but slant with what may be called a one-bar pitch; that is to say, the imaginary line joining the front end of one slot with the back end of the adjacent one is parallel to the spindle. An ingenious method is employed to fit the stator without the necessity of machining the interior of its core. The stampings are clamped up in a "jig," which has an axle just as the motor spindle, and this is held in position in the stator frame by the bearing brackets which have already been fitted. A cast-iron ring is then put on, clamping the stampings in position, and this is fixed to the carcase, and the

* See *The Electrician*, Vol. XXXVII., p. 247.

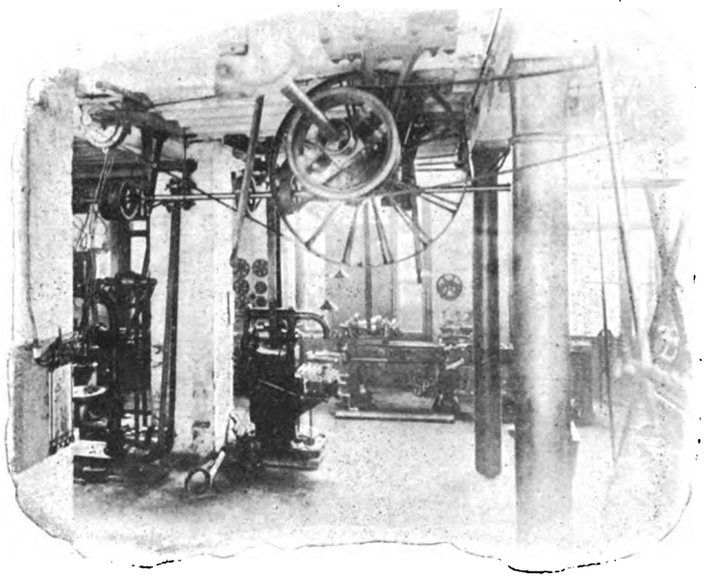

FIG. 3.—Corner of Machine Shop driven by 3-B.H P. Motor.

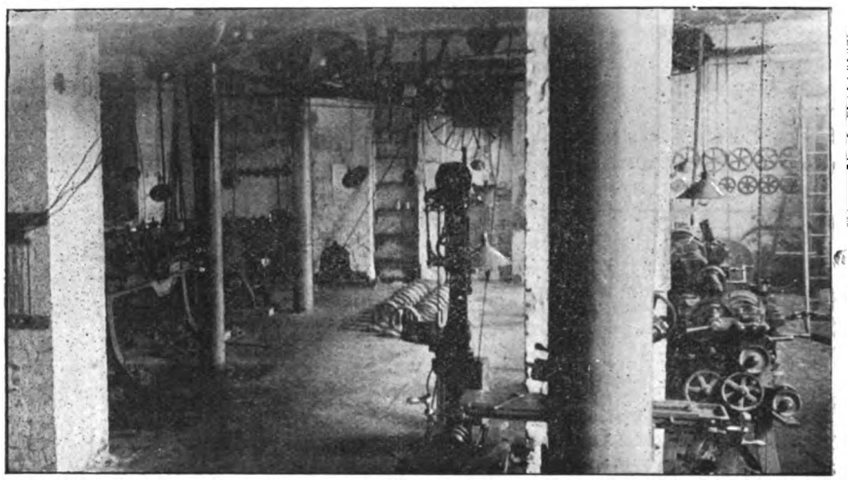

FIG. 4.—View of Machine Shop showing 6-B.H.P. Motor.

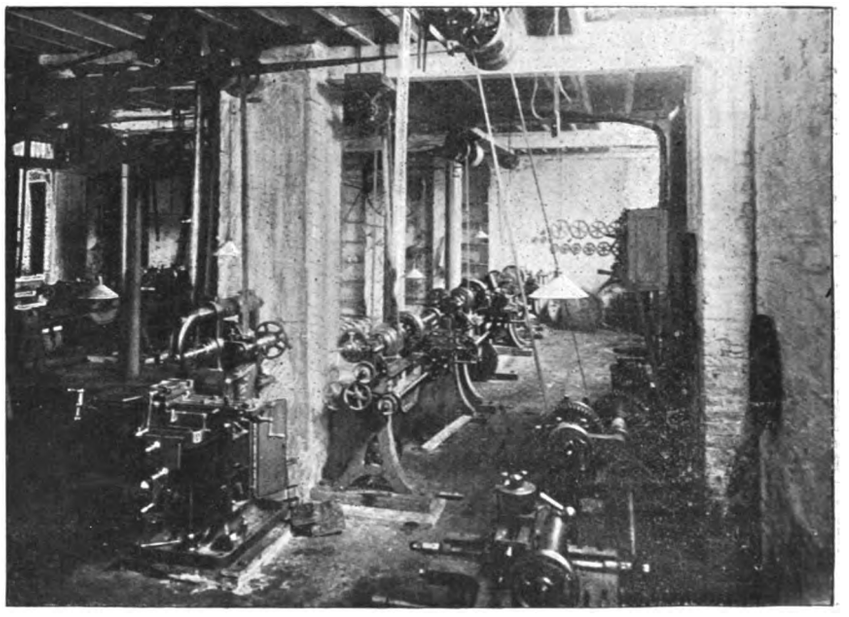

FIG. 5.—Another View of Machine Shop.

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jig then removed, leaving the stampings clamped concentric with the motor shaft. Before either the rotor or stator are wound, the former is put in position and run for a considerable time to test the bearings. The air-gap is in the neighbourhood of $\frac{1}{32}$in. Fig. 1 is a view of a 25 H.P. motor, all sizes above 9 H.P. being built on this pattern. The frame of this motor is supported in such a way that the whole machine may be moved bodily with the loosening of only a single screw, for the purpose of tightening the belt.

FIG. 6.—Testing a Motor.

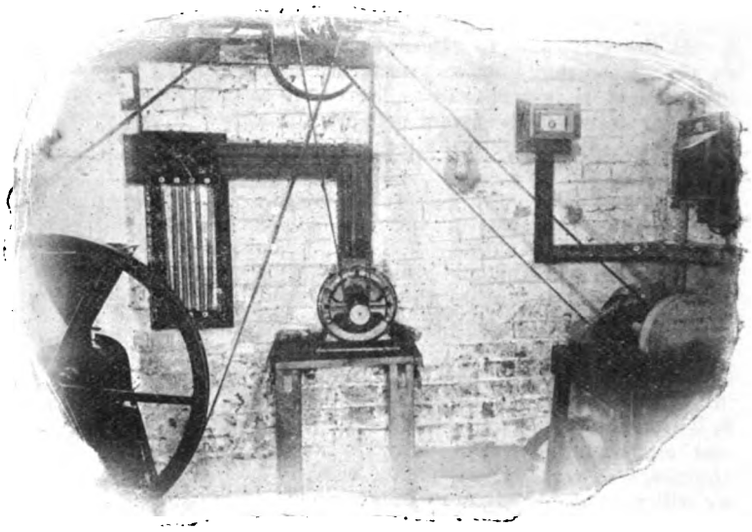

FIG. 7.—Coffee Grinder and Sausage Machine driven by Langdon-Davies Motor.

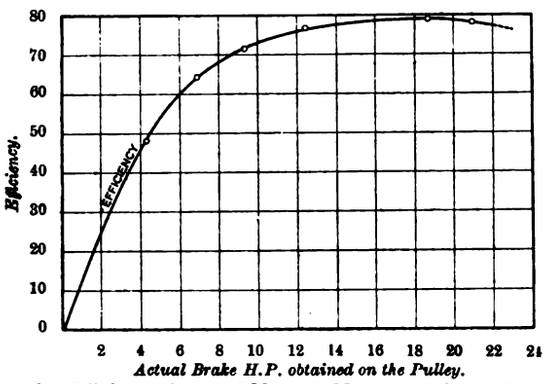

FIG. 8.—Efficiency Curve of 20 B.H.P. Motor, tested at 100 volts and 87 ∽ per sec.

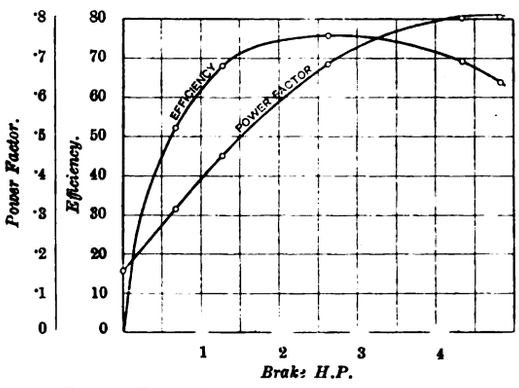

FIG 9.—Power Factor and Efficiency of 4 B.H.P. Motor.

The works of the Langdon-Davies Electric Motor Co. are, we believe, the only ones in this country which are exclusively devoted to the manufacture of motors, their switches and resistances. All the machinery, with the exception, we believe, of one foot-lathe, is driven by Langdon-Davies motors, supplied from the London Electric Supply Corporation's mains at 100 volts pressure and 88 ∽ per second frequency. The premises are also lit electrically, and there is a lift driven by a Langdon-Davies motor. A separate transformer and meter is provided for each of these three purposes. The lift is intended to convey material weighing up to one ton. It is driven by an 8 H.P. motor, and moves at about 40ft. per minute. The motor is connected to the winding drum by belt gearing through a countershaft, the use of an ordinary and a crossed belt providing for the changes in direction. As the lift is not being used continuously the motor is normally at rest, and has first to be run up to speed on a loose pulley.

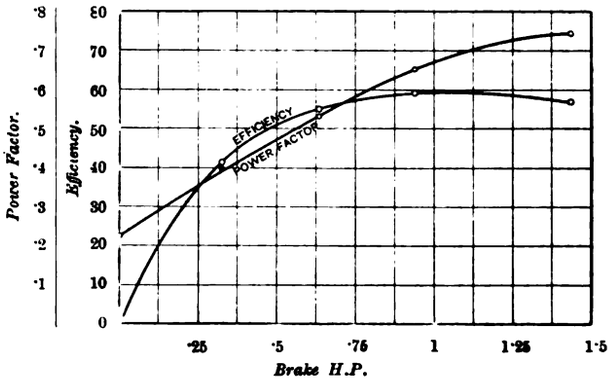

FIG. 10.—Power Factor and Efficiency of 1 B.H.P. Motor.

The machine shop is in the basement of the building, and is driven by a 3 H.P. and a 6 H.P. motor. The former (Fig. 3) is fixed just under the ceiling, and suffices for a planing machine and a 12in. lathe; it runs at 2,400 revolutions per minute and

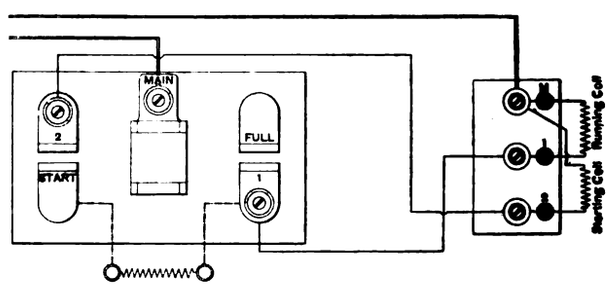

FIG. 11.—Connections of Starting Switch.

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drives the countershaft at about 150. When we inspected the works the planing machine was working on a moderately heavy casting, and in spite of the cut being of a fair depth it was interesting to note the enormous rise of the current through the ammeter in the motor circuit during the faster back stroke. It may here be mentioned that every motor on the works is provided with an ammeter so that the load may be observed at any time. The 6 H.P. motor (Fig. 4) is placed on the floor, and drives eight lathes, two milling and two drilling machines. The ground floor of the building is devoted to the offices of the Company, and the other floors to the winding, fitting, testing and pattern shops. All are light and airy, and well provided with electric light. Our illustrations give an idea of the arrangement of some of the shops. One of the machines not shown in them is a mangle adapted for the purpose of lacquering the core-discs; it is said to do this better and quicker than a paint brush. A 3 B.H.P. motor in the pattern shop does its fair share of work, driving two lathes, a saw and a grindstone. A simple yet convenient switchboard is provided in the testing shop, being fitted with ammeters, voltmeters and wattmeters to measure what is supplied to the motors, and a Soames absorption dynamometer (see *The Electrician*, Vol. XL., p. 524) is used to measure the output.

The curves in Figs. 8, 9 and 10 show the efficiencies and power factors of three different sizes of motors, and Fig. 11 indicates the connections of the starting switch. The switch is of the change-over type, and is first put to the left, connecting the starting coil directly to the mains and the running coil to the mains through a resistance. As soon as the motor has run up to speed the switch is put over on to the right-hand contact, which connects the running coil directly to the mains. The motors are always fitted with double-width pulleys, so that they may be started on a loose pulley on the counter-shaft and the belt thrown over to the fast pulley at full speed. The resistance of the starting coil and the added resistance to the running coil, however, prevent more than the full-load current from flowing at starting.

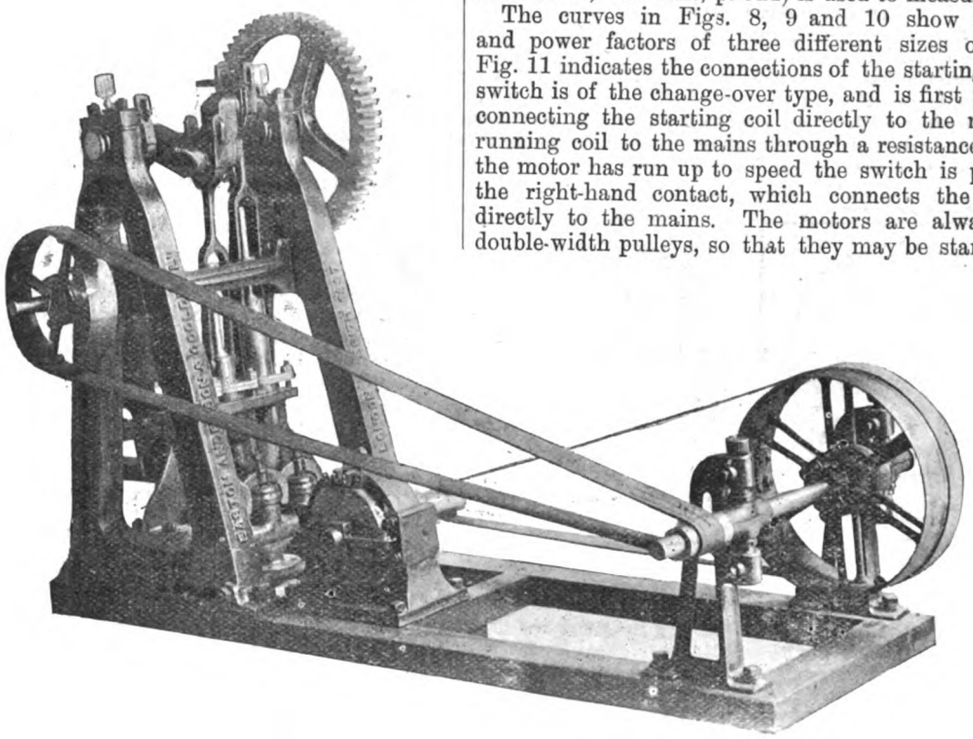

FIG. 10.—Direct-Acting Pump driven by Langdon-Davies Motor.

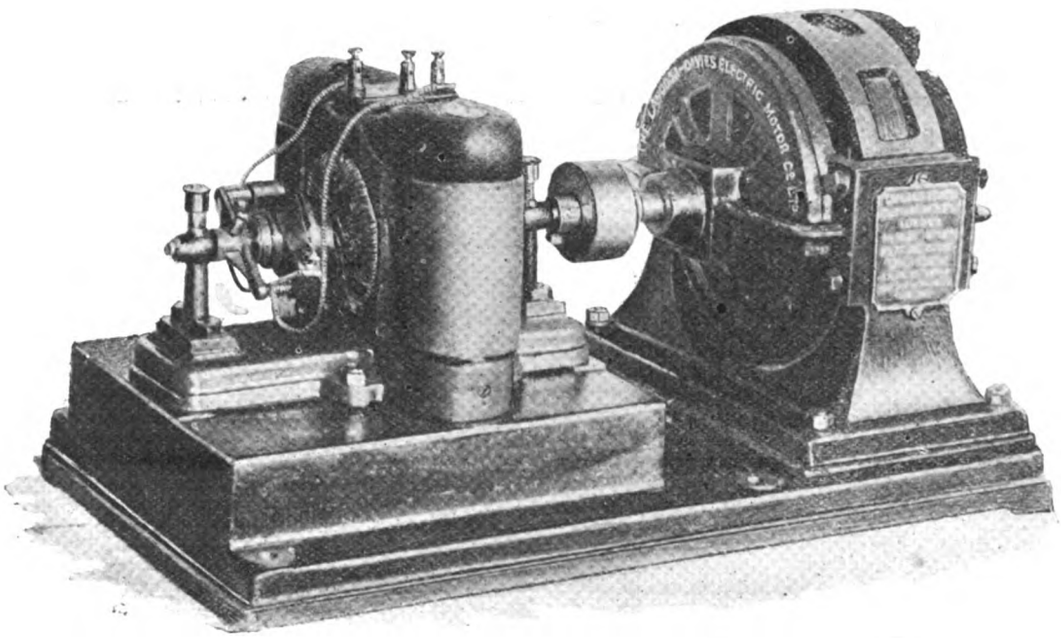

FIG. 11.—Dynamo Coupled to Langdon-Davies Motor.

In conclusion, we may notice one fact that speaks volumes for the efficiency of the methods employed at the Langdon-Davies works. The prices of the motors are now comparable with those of continuous-current motors.

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ROTATORY CONVERTERS.*

BY PROF. SILVANUS P. THOMPSON.

(Concluded from page 165.)

Amongst continental firms Messrs. Alioth, of Basle, have been prominent in the application in the industry of rotatory converters, which they designate as *commutatrices*. Mr. R. B. Ritter, one of their engineers, has kindly furnished many particulars of these machines and of their application. Articles by him on this subject have appeared in *L'Industrie Électrique* for 1896. He points out that in the application of these machines to charge accumulators from an alternating-current supply means are necessary for changing the voltage as between charge and discharge. There are several ways of meeting this need—by the use

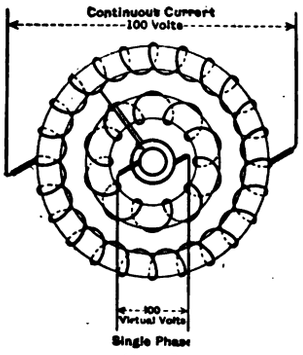


FIG. 9.

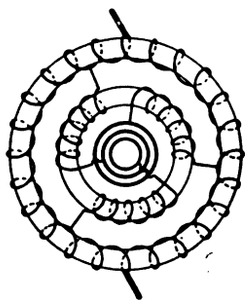
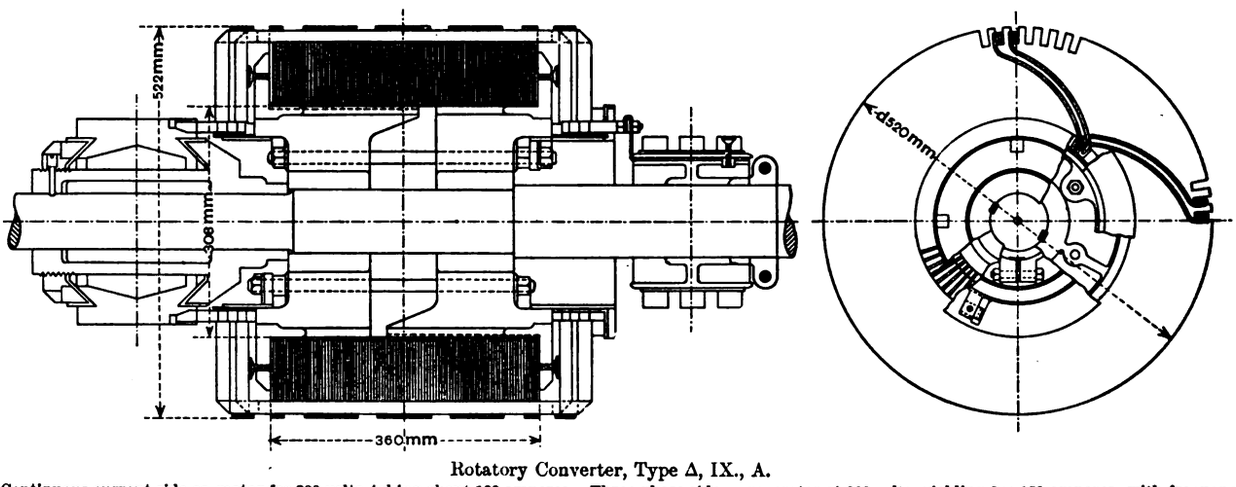


FIG. 10.

of choking coils, or of auto-transformers of variable ratio in the alternating side of the circuit, or by throwing in or out of circuit of a supplementary armature. The solution preferred by M. Ritter is the latter, a small auxiliary continuous-current machine in series with the continuous-current side being either mounted on the same shaft or driven by a pulley from it. The desired variations of voltage can be obtained by varying the excitation of the separate field-magnet provided for this auxiliary machine. A large 100-kilowatt two-phase converter, constructed by Messrs. Alioth for Geneva, is described in *The Electrician* of January 8, 1897, with sectional drawings. This is a 14-pole ring armature machine, having an armature 1 metre in diameter, running at 385 revolutions per minute. As it is designed to supply continuous currents to a three-wire distribution, it is wound with two independent converter windings, each capable of supplying 450 amperes at 110 volts; and is furnished with four slip rings, and with a commutator at each end. It has an efficiency of 90 per cent.

The problem of changing into convenient simple ratios the awkward percentage numbers which subsist between the voltages at the two sides of a converter has engaged the attention of several engineers. Mr. Heldt has described† an ingenious method of obtaining any desired ratio by the device of including on the alternating-current side additional windings between the slip-rings and the points where these rings are connected up to the armature winding proper. Fig. 9 illustrates the case of a single-phase converter. Here auxiliary windings (in two parallel circuits) are joined in so as to bring up the 70·7 volts on the alternating side to 100 volts, so as to make the voltages alike at both sides of the machine. To adapt this suggestion to the case of a three-phase converter, three sets of auxiliary windings must be intercalated between the three slip rings and the points of connection to the ring winding; these auxiliary windings being chosen, as to number and position, so as to add the desired supplementary voltage. It will be seen that this is equivalent to using a mixed star and delta winding; the delta part being that which alone constitutes the true converter winding. It is uniformly distributed around the core, and is symmetrically connected to the commutator.

Another solution of the problem, of more limited application, lies in so altering the distribution or concentration of the magnetic field at the poles as to change the irregular ratios into more regular ones. It was pointed out above that any concentration of the field will alter the conversion ratio. For example, the ratio in the case of the three-phase converter with sine distribution being 61·23 per cent., if the poles are narrowed a little, this may be raised to 66·6 per cent., so that a machine which is a 300-volt machine on the continuous-current side will be a 200-volt machine on the three-phase side. An example of this is afforded by a four-pole 55-kilowatt converter constructed by the Oerlikon Company, the description of which has been kindly furnished by Dr. Behn-Eschenburg. Drawings of this machine are given in Figs. 11 and 12. It was designed to receive continuous current at 300 volts, and to run at 600 revolutions per minute. Its armature is a two-circuit multipolar drum 522mm. in diameter, 360mm. long, having 117 slots and two conductors per slot. It has four sets of carbon brushes, set at zero lead. It runs quite sparklessly at all loads. As originally constructed, the poles were furnished with pole-pieces (as shown) each of about 72deg. span, therefore having a breadth about 80 per cent. of the pole-pitch; the chord across the tips being 335mm. So shaped, the coefficient of conversion was found to be 57·7 per cent., as against the 61·23 per cent. if sine distribution had been present. When supplied at 300 volts on the continuous-current side, its open-circuit three-phase voltage was only 173 volts. The pole-tips were then cut away, as shown in Fig. 12, so that the arc of pole-span was reduced to a little under 50deg.; the chord across the tips being now 228mm., and the pole-breadth being 54 per cent. of the pole-pitch. This had the effect desired of bringing the conversion ratio up to 66·6, the open-circuit three-phase voltage being now 200. The ratio of conversion was constant within 2 per cent. at all loads. Fig. 13 gives a plot of the performance of the machine under different excitations. It will be seen that the ratio of the ordinates is approximately that of 3 : 2. Two other points plotted show the demagnetising reaction due to wattless currents. They affect, of course, the speed and heating of the machine, but practically have no influence upon its ratio of conversion when the excitation of the field magnets is normal. In its original shape, when operated as continuous-current motor at 300 volts with an excitation of 2·1 amperes, without load on the three-phase side, it ran at about 470 revolutions per minute. When loaded so as to give out 153 amperes per phase on an inductionless circuit the speed fell, in consequence of reactions, to 440 revolutions per minute. At this speed



Rotatory Converter, Type Δ, IX., A.

Continuous-current side as motor for 300 volts, taking about 190 amperes. Three-phase side as generator at 200 volts, yielding 3 × 159 amperes, with frequency, 20 periods. Core-discs 117 slots, with two conductors per slot. Conductors 2·4, net section, 2·2 × 1·6 mm. Diameter of core-discs, 520 mm. Commutator 117 bars. Brush-holders, four sets, with five carbon brushes per set. Revolutions per minute, 600.

FIG. 11.—Armature of 75 H.P. Rotatory Converter, by the Oerlikon Company. Scale, 1 : 10.

* Paper read before the Institution of Electrical Engineers, November 10, 1898.

† See *Electrical World*, Vol. XXVIII., 68, July 18, 1896.

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the measurements were: Continuous-current side, 295 volts, 153 amperes; on the three-phase side, 165 volts, 3 × 153 amperes. Then the output was changed to one of 235 amperes per phase of lagging current on a load of induction motors running light. The speed went up to 640 revolutions per minute (showing a weakening of the field), and the instruments measured :—Continuous-current side, 298 volts, 32 amperes; on the three-phase side, 157 volts, 3 × 235 amperes. To keep the speed, and therefore the frequency, constant under such conditions, the (shunt) excitation would need to be adjusted in accordance with the load and its lag. The pole-cores and yoke of this machine are of cast steel, each pole being wound with 3,200 turns of a copper wire of 2 sq. mm. section; the total resistance of the shunt winding being 80 ohms. The armature resistance from brush to brush is 0·028 ohm. The machine runs sparklessly with zero lead of the brushes. It will also run as a synchronous motor delivering continuous current sparklessly, with or without excitation of the field magnet, and with brushes set at zero, or set with either a large forward or a large backward lead. With a large backward lead, running synchronously, without excitation, at 627 revolutions per minute, giving out 46 amperes at 100 volts,

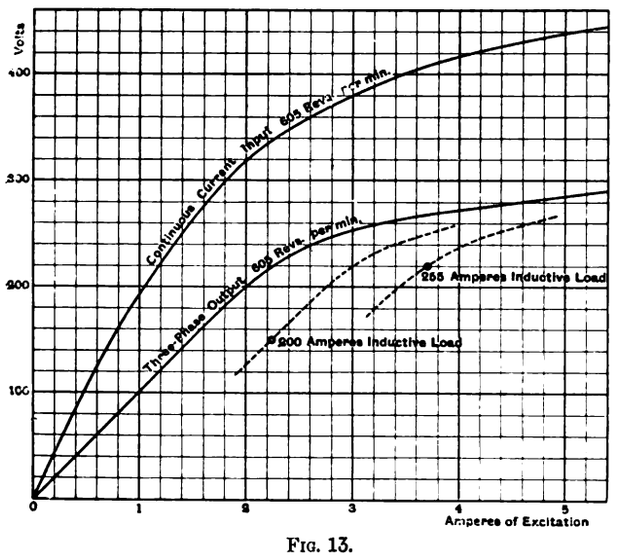

FIG. 13.

it took in three currents of 155 virtual amperes (largely wattless) at about 100 virtual volts at the three-phase side. The reactions in this curious case are exceedingly complicated.

Quite recently Mr. Gisbert Kapp* has re-examined the question of the influence on the conversion ratio and on the efficiency of changes in the distribution of the flux. With the theoretical case of a sine-law distribution he compares analytically other cases, equally unreal in fact, namely, those of a distribution of supposed uniform density over a limited arc of polar span. From his calculations it may be deduced that the conversion ratio will be the same as for the sine-law distribution if the poles are such that the breadth of their faces is about 70 per cent. of the pole-pitch. If the faces are broader the voltage ratio for a single-phase machine will be lower than 70·7 per cent., and the ampere ratio higher than 141·4 per cent. If the pole-breadth is reduced

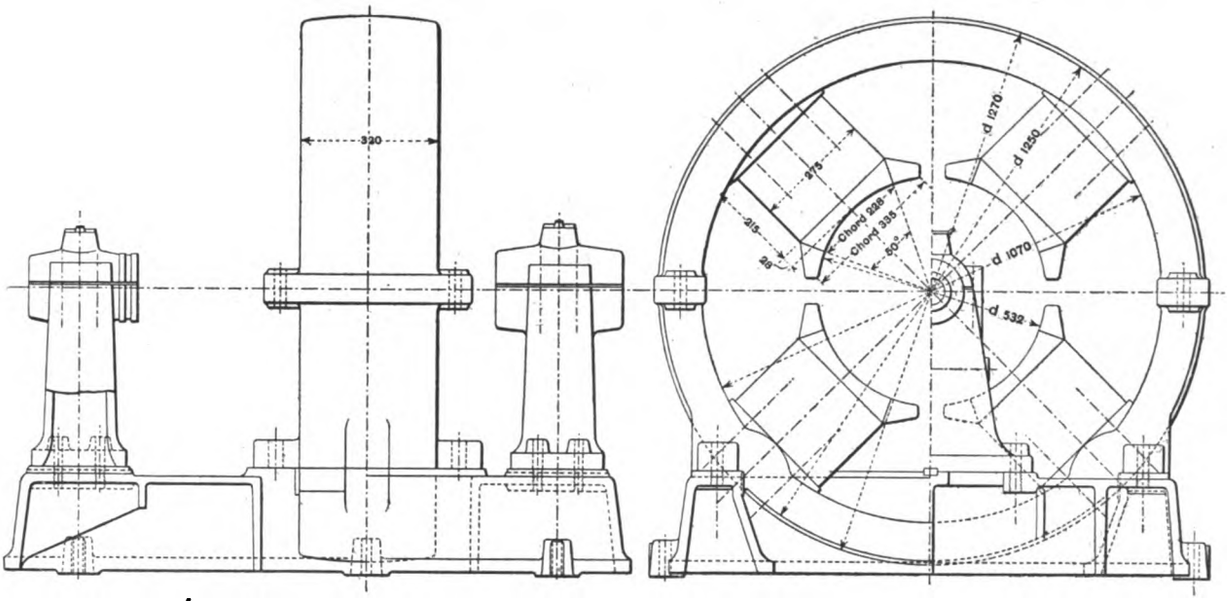

FIG. 12.—75 H.P. Rotatory Converter (Continuous Three-Phase), constructed by the Oerlikon Company.

to ⅔ of the pole-pitch, or to ½ the pole-pitch, the respective voltage percentages becomes as in Table VI. :—

Table VI.

Voltage for	Sine law.	Pole ratio, ⅔	Pole ratio, ½
Continuous current	100	100	100
Single-phase	70·7	75	82
Two-phase	70·7	75	82
Three-phase	61·2	65	71
Four-phase	50·0	53	58
Six-phase	35·35	37	42

M. Routin* has made another study of the effect of varying the pole-breadth, in a mathematical Paper, in which also he assumes the uniformity of the field beneath the poles. In the Oerlikon converter above described the pole-breadth was only 55 per cent. of the pitch, yet the voltage ratio was 66·6; showing that the field does not distribute itself uniformly, but is less concentrated, with fringing at the pole-tips.

Mr. Kapp has further treated the question of the limit of output for equal heating, for different pole-breadths, and for different angles of phase displacement in the currents. When the phase displacement is zero, the limiting output of a single-phase converter armature was (*see* above) 85 per cent. of that when used as a continuous-current armature simply, if the sine law is assumed. For pole-breadths of ⅔ and ½ respectively Kapp finds this increased to 88 and 95 per cent. This is equivalent to saying that if by concentration of field one makes the midway coils relatively more active, there will be for equal output less heating of the coils next to the connectors, and a less total heating. If there is a phase displacement such that cos $\phi = 0{\cdot}8$ ($\phi = 35$deg.), the percentage output for sine-law distribution is 69, but with pole-breadths ⅔ and ½ respectively this is raised to 73 and 80 per cent. But in practice the fringing of the field will reduce these latter values. For the more favourable cases of two-phase and three-phase converters these percentages of output for equal heating of the armature are greatly raised. The three-phase converter, assuming sine distribution and no phase displacement, has a limiting output 134 per cent. of that of the simple continuous-current armature. With pole-breadths of ⅔ and ½ the output rises to 138 and 144 per cent. respectively; and, if there is a phase dislocation such that cos $\phi = 0{\cdot}8$, to 117 and 126 respectively. For a two-phase converter the limiting output of 164 per cent., for the case of sine distribution and cos $\phi = 1$, becomes 167 and 170 per cent. respectively for pole-breadths of ⅔ and ½; whilst, when cos $\phi = 0{\cdot}8$, these numbers fall to 144 and 153 per cent. respectively.

* *Elektrotechnische Zeitschrift*, Vol. XIX., p. 621, Sept. 15, and following numbers of Sept. 22 and 29, 1898.

* *L'Éclairage Électrique*, Vol. XI., p. 531, June 12, 1897.

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A four-pole 30-kilowatt two-phase converter, constructed by Messrs. Brown, Boveri and Co., has been described to me by Mr. M. B. Field, who designed it for that firm. The armature is wound according to the scheme shown in Fig. 14. It has four poles (two wound, two unwound), and runs at 1,200 revolutions per minute, giving a frequency of 40 periods per second. Its efficiency is about 90 per cent. The input being two currents, of 415 working amperes each, in quadrature at 40 volts, the output is 500 amperes at 60 volts. The armature is a cylindrical drum-wound, in 56 slots, with two conductors per slot, as a singly re-entrant double winding, being cross-connected at the slip-rings to give four parallel circuits. At normal load, the excitation is such as to give a flux-density in armature core body of 7,800 lines per square centimetre, and in the teeth of 10,700 to 14,900. It runs (as exciter for some two-phase alternators) in parallel with some turbine-driven exciters and with a two-phase to continuous motor-generator. The ratio of conversion when running as two-phase motor did not alter greatly with the excitation, as the figures in Table VII. show:—

Table VII.

Exciting current.	Virtual volts between slip-rings.	Volts at commutator.	Ratio of conversion percentage.
2	18·5	30·0	60·8
3	27·0	43·0	62·7
4	34·0	53·0	64·2
5	41·0	62·0	65·1
6	46·5	68·5	67·8
8	53·0	77·0	68·5
10	56·5	82·0	68·8
12	59·0	86·0	68·6
14	62·0	88·5	71·0

It is, however, in America that the converter has found its application on the largest scale, for the purpose of supplying continuous

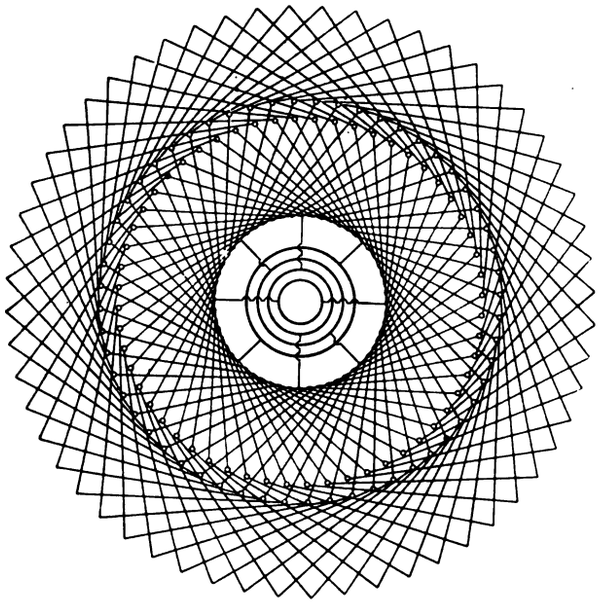

Fig. 14.

currents for tramway circuits, electric lighting systems, and electrolytic processes from distant power stations, whence the transmission is accomplished by polyphase currents at high voltage. These high-voltage currents, when they reach the receiving end, are first passed through transformers to reduce the pressure to a suitable lower voltage, and are then passed through the converters. The first large converters of the General Electric Co. were designed by Mr. Parshall on the lines of ordinary multipolar continuous-current generators, with powerful field magnets, and performed their functions well. Later, some designs were tried with relatively weaker field magnets, on the assumption that, in view of the lesser amount of armature reaction, commutation might be effected sufficiently well, in spite of a lighter construction. But, though a three-phase converter will, without any winding on the field magnets, operate by virtue of the armature reactions peculiar to the synchronous motor, the regulation in such machines leaves much to be desired, and the later designs exhibit a return toward the construction usual for multipolar continuous-current generators. By the kindness of Mr. Parshall and of Mr. Steinmetz, information as to a number of such large converters is available. At Niagara, where the Cataract Company generates two-phase current at 5,000 volts, converters are employed to supply continuous current for certain electrolytic processes—for the manufacture of caustic soda, and of aluminium. For the Pittsburg Reduction Co.'s aluminium works the General Electric Co. constructed a number of large converters. The two-phase current is first reduced by transformers to a pressure of 115 volts. At this pressure it is led into the converters, which give out the continuous current at 160 volts; the plant having a total capacity of over 10,000 amperes, equivalent to an output of about 2,000 H.P. At Schenectady were also constructed the six three-phase converters of 200 kilowatts each, for use in the power house at Brooklyn. As these machines are fairly typical of American practice, some information of their general construction is of interest. They are eight-pole 200-kilowatt machines, running at 375 revolutions per minute, the frequency employed being 25. The voltage on the three-phase side is 82·8; that on the continuous-current side 125, with an output of 1,600 amperes. The armature is 48in. in diameter, its core-length being 7in. between heads. This gives 4·95 sq. in. of peripheral surface per kilowatt.* The core-discs have 240 slots, with two conductors in each slot. Each lap of the drum winding is over 30 teeth. The gap measures 0·25in. from iron to iron. The commutator is 36in. in diameter, with 240 bars. The three slip-rings are each 18in. in diameter, 3½in. broad, and 1in. deep. The brushes are of carbon, eight sets of nine brushes each, and each brush with 1¼ sq. in. of contact surface. The brushes on the three-phase side are of copper. The flux through each pole-face is designed to be 4,380,000 lines at full load, the flux-density in the cast-steel pole-cores being then 80,000 lines per square inch. In the gap the pole-face density at full load is no less than 51,300 lines per square inch. In the teeth it reaches 135,600, and in the core-body 61,300. When running as a converter the brushes have no lead. When running on test as a continuous-current generator a lead equal to four bars of the commutator was necessary. The pole-breadth is 64·7 per cent. of the pole-pitch, and the voltage ratio of conversion

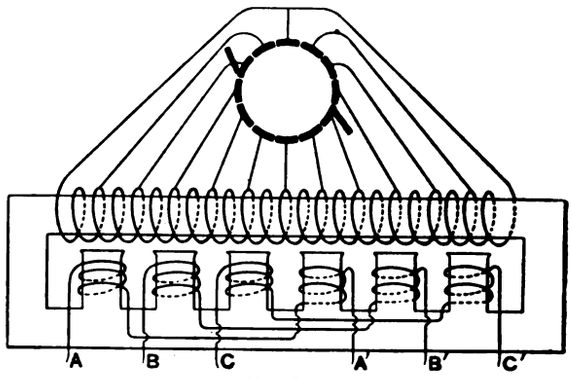

Fig. 16.

63·3 per cent. The C^2R loss in the converter armature at full load is 3,500 watts; it would be 6,250 if used as a continuous-current generator. The total armature loss as converter is 6,005 watts; as continuous-current generator, 9,130 watts. The temperature rise of the armature at full load is 27°C. as converter; as continuous-current generator it is 47°C. The temperature rise of the commutator at full load is 36°C. as converter; as continuous-current generator, 52deg.

Another three-phase converter, also constructed at the Schenectady works, is a 16-pole, 600-kilowatt machine, running at 188 revolutions per minute. In this machine the pole-breadth is 72 per cent. of the pole-pitch, yet the ratio of conversion is 71·8; the voltages at the respective sides being 115 and 160. The armature diameter is 100in., the core-length 8·25in., giving 4·3 sq. in. of peripheral surface per kilowatt. The temperature rise after 17 hours with a conversion output of 575 kilowatts was 15°C. in the armature, 23°C. in the field magnets. The average flux-density in the gap was 69,000 lines per square inch. To the same class of machines belong the four three-phase converters recently designed by Mr. Parshall (Fig. 15†) for the Central London Railway. These are 12-pole 900-kilowatt machines, running at 250 revolutions per minute. Each weighs about 30 tons; and their guaranteed efficiency will be 95 per

* The number of square inches of peripheral surface per kilowatt of output gives a basis for estimating to what degree in the design of an armture the specific utilisation of its materials has been carried. Modern dynamos of over 100 kilowatts output have from 4in. to 12 sq. in. per kilowatt. Old and small machines vary from 10 to as many as 25 sq. in. per kilowatt. In this estimate, the working part only of the peripheral surface is counted, being the length round the periphery multiplied by the total (gross) thickness of iron parallel to the shaft. These values apply to alternators and motors as well as to continuous-current dynamos.

† This cut is reproduced by the courtesy of *Engineering*, from the description given in that journal of the Central London Railway.

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cent. at full load, 93 per cent. at half load. They are designed to take in their three alternating currents of 1,800 virtual amperes each at 310 virtual volts; the output on the continuous-current side being at 550 volts. The armature in each is a multipolar drum with 432 slots, and two conductors per slot; and, being lap-wound, has 24 circuits in parallel. It is connected down at 18 symmetrical points to the three slip-rings, there being six such connectors to each ring. Owing to the conditions imposed by the relations between voltage, speed, and size, it has been the practice in the States to design converters to operate at a frequency of 25, or at most 30, periods per second. But some of the General Electric Co.'s converters have been constructed for frequencies as high as 60, so as to be capable of being operated from lighting circuits. One such, a 16-pole 400 kilowatt two-phase converter, running at 450 revolutions per minute, has been recently described in the *Electrical World* (May, 1898).

One difficulty which has been experienced when operating converters in their application on the large scale—a difficulty which could hardly have been foreseen from the working of small isolated machines—is a tendency for them, when grouped in parallel, to set up a see-sawing interference of slow period, probably in consequence of armature reactions, similar to those which in certain types of alternators trouble their parallel running. Another puzzling defect is a similar tendency to hunt, observable

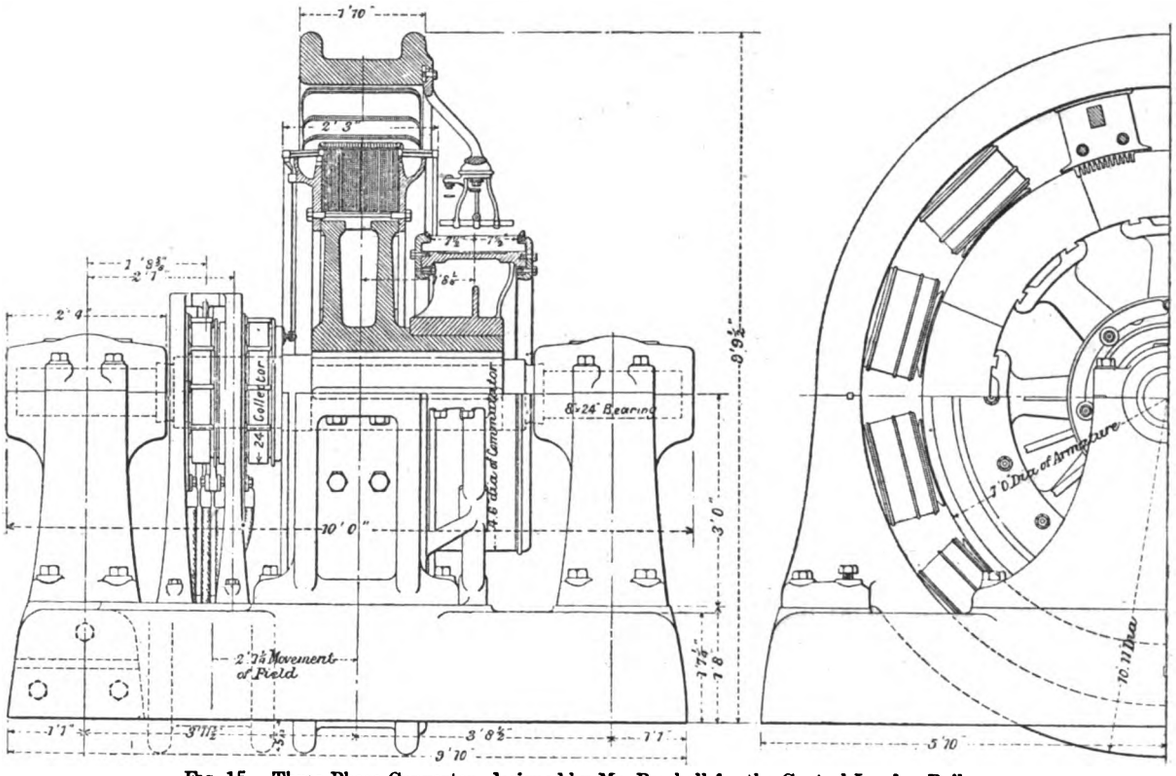

FIG. 15.—Three-Phase Converter, designed by Mr. Parshall for the Central London Railway.

when two converters are arranged in series at the two ends of a long three-phase line for the purpose of feeding continuous currents from one point to another. The cure for these troubles will probably be found in an analagous treatment to that adopted for securing good parallel running in alternators, namely, careful design, so as to prevent armature reactions from unduly distorting the magnetic field. But the point demands further investigation.

Before quitting the subject of converters, it is but right to refer to the existence of another class of rotating machine for effecting the same aim, and to which, for distinction, the name of *permutators* may be allotted. In this category are comprised those machines in which alternating currents (of one, two, or three phases) are first transmitted through a stationary part of the apparatus (a species of transformer), where they create in a re-entrant sectional winding a series of alternating currents which differ from one another in phase by small successive phase-angles; these currents being then led off to a commutator and commuted, section by section, into a continuous current. To fix ideas, consider Fig. 16, which is adapted from a recent article by Dr. J. Sahulka, in the *Zeitschrift für Elektrotechnik*. The lower part of the diagram represents the stationary transforming apparatus, having three pairs of projecting poles, wound with three circuits, A A', B B', and C C', to which are brought the three-phase primary currents. The action of these three-phase currents is to produce travelling polarities along the row of poles, and induce electromotive forces in the coils wound around the portion of the core above the six pole-faces. This winding, it will be observed, is electrically the precise equivalent of a Gramme ring. In an ordinary Gramme dynamo the ring revolves between two poles. Here, instead, the two polarities travel past the re-entrant winding. Under these circumstances, seeing that the commutator stands still, it is necessary that the brushes should be rotated synchronously in order that they may collect the continuous current. An apparatus essentially upon this principle was patented* by Zipernowsky and Deri in 1888, the brushes of this machine being rotated by a synchronously revolving unwound field magnet. How sparking was obviated does not appear. A further development in permutating machines was made by Messrs. Hutin and Leblanc, who turned the difficulty of the revolving brushes by the following device:—Upon the shaft of the synchronous motor is fixed the commutator and a series of slip-rings equal in number to the bars of the commutator, so that, though the commutator revolves, each segment may still be in connection with its corresponding point on the stationary re-entrant winding. The brushes may then be fixed as in ordinary machines. In *L'Electricien* of April 21, 1894, a detailed account is given by M. Aliamet of the further ideas of these inventors. It appears that 18 slip-rings are necessary in practice. A further account of an installation at Epinay is given by M. Guilbert in *La Lumière Electrique* of June 16, 1894. The sole advantage of machines of this type seems to be that they can transform and convert the three-phase currents from a high voltage without requiring the interposition of any other transformer. Their disadvantage in requiring many slip-rings is obvious. It is also very doubtful whether under varying conditions of use the sparking would not be excessive. Nevertheless, this type of converting machine is well deserving of the further attention of engineers. Probably there are cases where it is to be preferred to either the motor-dynamo group or the rotary converter proper. The motor-dynamo can transform the voltage as well as change the species of current. The converter can change the species of current, but only by adopting a fixed ratio of voltages. As it is inexpedient to operate a commutator at voltages over 1,000, the converter cannot be used in conjunction with a high-voltage polyphase transmission, except by the addition of a step-down polyphase transformer. It then becomes a question whether it is cheaper (regard being had to efficiency of operation as well as to prime cost) to instal the converter with the step-down transformer, or to substitute a pair of coupled machines as motor-dynamo. Experience shows that, at any rate in cases where the frequency of the supply is already sufficiently low, the former is generally the more economic. But it is quite probable that there are cases where the economic conditions of the problem may point to the permutator as affording a solution preferable to either motor-dynamo or converter.

* Specification No. 12,856 of 1898.

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A THREE THOUSAND KILOWATT DYNAMO.

(*Communicated.*)

The rapid development of electric power for various purposes has made a demand for larger and larger units in the generating stations where this power is produced. A few years ago generators of 100 to 200 kilowatts capacity were considered enormous machines. There soon appeared, however, direct driven generators of 750 kilowatts, to be used in large railway plants in such cities as Chicago, Boston, St. Louis and Brooklyn. At the World's Fair, in 1893, the first 1,500 kilowatt generator made its appearance in the Intramural railway station. This machine was then considered a monster. This unit was soon adopted for many of the large street railway stations, notably in Chicago and Boston, and finally machines of 1,600 kilowatt were placed in the Kent Avenue Station in Brooklyn.

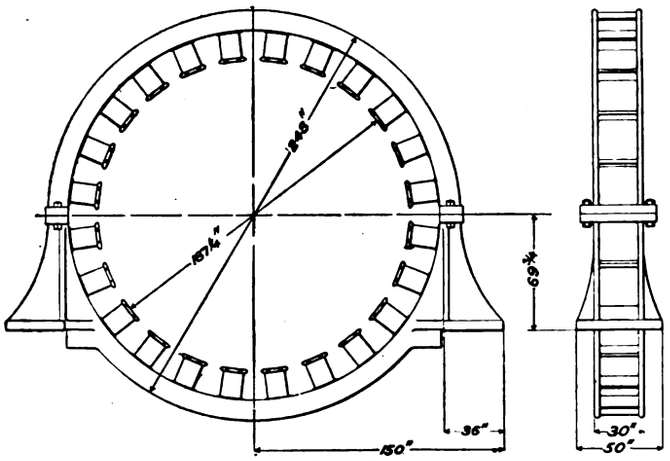


FIG. 1.—Frame of 3,000 Kilowatt Machine.

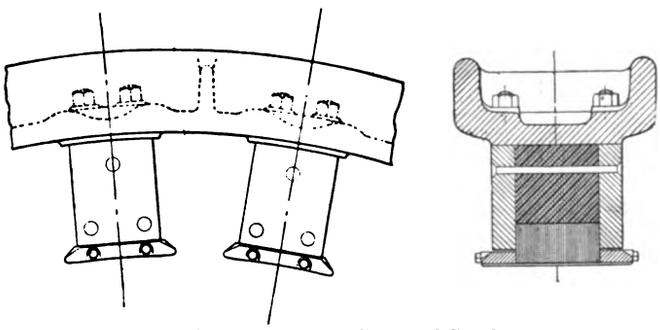


FIG. 2.—Field Magnet Cores and Spools.

Still later Louisville, Ky., purchased a 2,200 kilowatt generator. The Metropolitan Street Railway Co. of New York has recently placed an order for a number of 2,500 kilowatt alternating machines, and but a few months ago the Boston Elevated Railway Co., which succeeded the West End Street Railway Co. of that city, gave to the Walker Company of Cleveland the order for a 3,000-kilowatt machine.

All of these large machines are made to run at the very slow speed of from 75 to 80 revolutions per minute. It is true that the alternating-current machines built for the Cataract Construction Co., at Niagara Falls, have an output of 5,000 H.P. each, while the monster ordered by the Boston Elevated Railway Co. has an output of but 4,000 H.P. Nevertheless the 4,000 H.P. machine being built by the Walker Company is much larger than the alternators in use in the Niagara Falls power house, as the speed of the Boston machine is 75 revolutions per minute, while that of the Niagara machines is somewhere in the neighbourhood of 300 revolutions per minute.

As the construction of this 4,000 H.P. generator marks an era in the development of dynamo-electric machines, it may be interesting to electrical engineers, and those using electrical apparatus, to know its dimensions and general design. The total weight of the complete machine is 111½ tons. The frame is made of cast steel, and is circular in form, the diameter over all being 21ft. 7in. The weight of the frame alone, without the field-magnet cores for magnet spools, is about 25 tons. To the inside of the magnetic ring or frame are bolted 24 laminated steel magnet cores or pole-pieces, the total weight of which is about 15 tons. The inside diameter of the bore of these pole pieces, completed, is 15ft. 6in. The magnet cores are each provided with magnet spools, wound with shunt and series coils, in the usual way. The pole pieces are arranged to hold the magnet spools in place, and each core is bolted by four 3in. bolts to the inner surface of the magnet frame. The magnet frame is divided in halves, on a horizontal plane, and is mounted upon the foundation plates in such a manner that the whole frame may be made to slide lengthwise of the engine shaft far enough to uncover the armature windings, or to allow the individual magnet cores or field spools to be removed without separating the magnet frame.

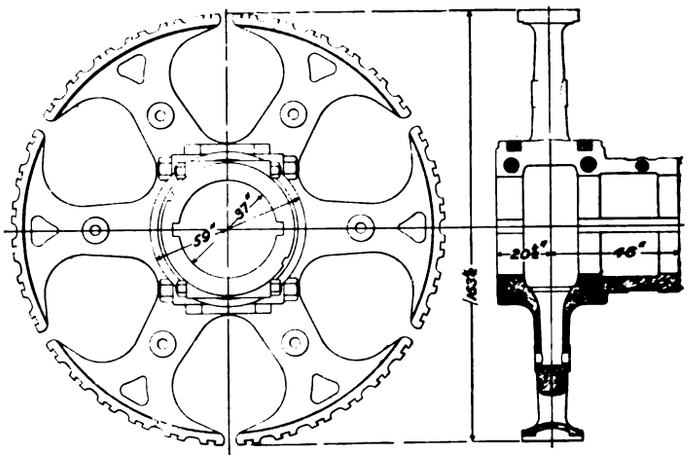
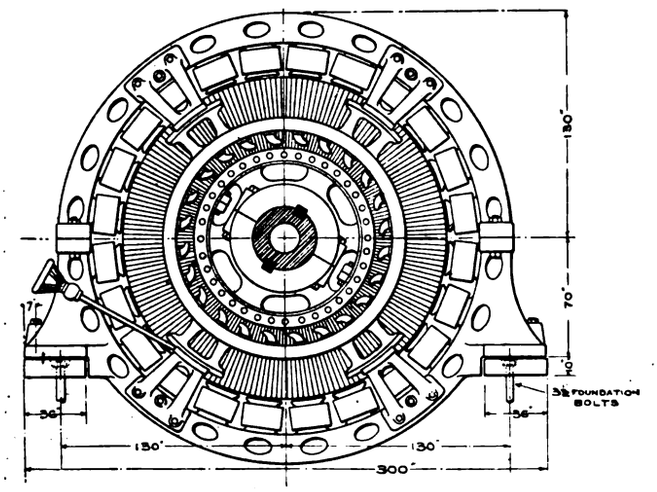


FIG. 3.—Armature Spider.

The armature spider of this machine is an interesting part of its construction. It is made in halves, like the hub of a flywheel, to be bolted together upon the shaft of the engine after it reaches its destination. If it had been made in one piece no railway car could be found large enough to ship it from Cleveland to Boston. The



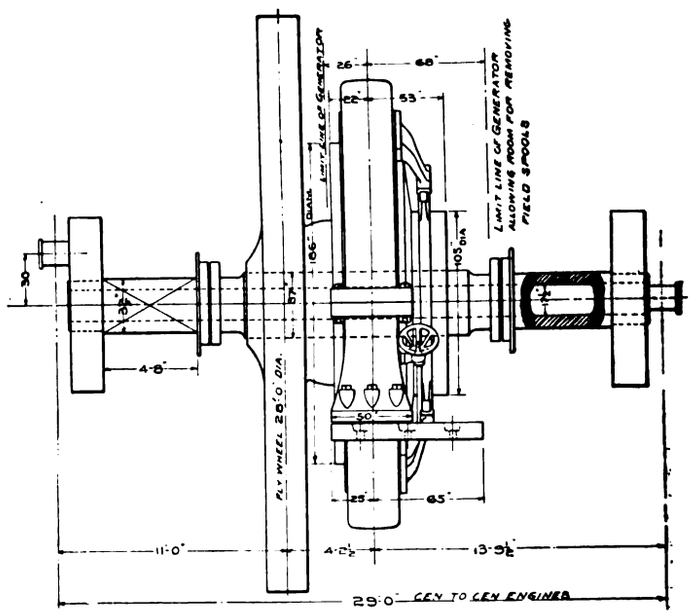


FIG. 4.—General Arrangement of 3,000 Kilowatt Generator.

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armature hub weighs complete about 20 tons, and has an outside diameter before the laminations are in place of 13ft. After the engine is upon its foundations in Boston this armature spider will be mounted upon the engine shaft, which is itself 37in. in diameter. The laminations which form the armature core, the total weight of which is about 15 tons, will then be built upon the periphery of the armature spider. The slotting in the armature laminations will register accurately and provide, when completed, 594 slots. Insulation and windings will then be fitted into the slots and connected with the commutator.

The commutator itself is made up of 1,188 bars, and is 105in. in diameter. It is divided into halves for the purpose of shipment and ease of handling, and will be placed upon an extension of the armature hub after the latter is secured to the engine shaft. The great flywheel of the engine will be bolted directly to the armature hub near its periphery, in order that the regulating force of the wheel shall not be transmitted wholly through the shaft of the engine. This will relieve the armature shaft and its keys from the enormous strain to which they would otherwise be subjected.

The machine has been most carefully designed and an unusually large factor of safety provided for every part subjected to mechanical or electrical strain. Because of this the machine will be able to take twice its normal load for short periods of time without injury, and to carry a 50 per cent. overload for several hours. The greatest care has been taken to secure from the generator a higher percentage of efficiency than has thus far been attained in units of large size.

There seems to be no limit to the capacity to which these large generators can be carried. The development that has taken place thus far is an interesting study in view of what must ultimately come when we are compelled to provide means for the transmission of power for those large schemes of propulsion which are awaiting the application of electricity in place of steam. What will be the limit to the size of machines required when our main-line steam railways are operated by electricity?

INSTITUTION OF ELECTRICAL ENGINEERS REVISED ARTICLES OF ASSOCIATION.

At a Special General Meeting of Members only, held on November 3rd, a revised set of Articles of Association were considered and passed, and at a subsequent Special General Meeting on November 18th, this resolution was duly confirmed. The new Articles come into force on January 1, 1899. The following are some of the more important alterations and additions; in some cases the new and the old Articles are arranged in parallel columns to facilitate comparison:—

Abreviated Titles.

9. The authorised abbreviations indicating the class in the Institution to which any honorary member, member, associate member, associate, or student belongs shall be as follows:—For an honorary member, *Hon.* M.I.E.E.; for a member, M.I.E.E.; for an associate member, A.M.I.E.E.; for an associate, A.I.E.E.; and for a student, *Student* I.E.E.

Diplomas.

10. Subject to such regulations as the Council may from time to time prescribe, the Council may issue to any member or associate member a certificate showing the class to which he belongs. Every such certificate shall be according to the form F in the schedule, or such modification thereof as may from time to time be approved by the Council, and shall remain the property of, and shall on demand be returned to, the Institution.

Qualification and Election of Members, &c.

Old Articles.	New Articles.
9. *Members.*—Every Member shall come within one of the following descriptions:—	12. *Members.*—Every new member (*i.e.*, members not on the register as members on December 31, 1898) shall, whether admitted by election or transfer, be at least 25 years of age, and come within one of the following descriptions:—
(*a*) He shall have been regularly educated as a telegraph engineer, or electrical engineer or electrician (according to the usual routine of pupilage), and have had subsequent employment for at least five years in responsible situations;	(*a*) He shall have been educated as an electrical engineer or electrician in a manner which shall satisfy the Council, and either (1) shall have had subsequent employment in the application of electricity for at least five years in situations of superior responsibility, and shall be actually engaged in such a situation at the time of his application for election or transfer, or (2) shall be in practice, and shall have practised on his own account in the profession of an electrical engineer or electrician for at least five years, and shall have acquired sufficient eminence in the same; or
(*b*) Or he shall have practised on his own account in the profession of a telegraph engineer, electrical engineer, or electrician, for at least two years, and have acquired a degree of eminence in the same;	(*b*) being, either in a position of superior responsibility, or in practice on his own account in the profession of an electrical engineer or electrician, he shall have held such responsible position or positions, or shall have so practised on his own account that he has acquired sufficient eminence in the said profession, during a period or periods which, singly or in the aggregate, shall amount to seven years; or
(*c*) Or he shall be so intimately associated with electrical or telegraph science that the Council consider his admission to membership would conduce to the interests of the Institution.	(*c*) being an associate member, he shall have gained the senior premium in any year for a paper read at an ordinary general meeting of the Institution; or
	(*d*) he shall be so prominently associated with the objects of the Institution that the Council consider his admission to membership would conduce to its interests.
10. *Associates* shall, except in the case of those transferred from the class of students, be persons of more than 21 years of age; and all associates, whether so transferred or not, shall be persons who are connected with electrical or telegraphic science or engineering, either professionally or otherwise, or who are so intimately associated with electrical or telegraphic science that the Council consider their admission as associates would conduce to the interests of the Institution.	13. *Associate Members.*—Every associate member shall be either an electrical engineer or an electrician, and shall be at least 25 years of age, and, whether admitted by election or by transfer, shall come within one of the following descriptions:—(*a*) He shall have been on the register as an associate on December 31, 1898; or (*b*) he shall have been educated as an electrical engineer or electrician in a manner which shall satisfy the Council, and either (1) he shall have had subsequent employment for at least two years in a responsible situation as an electrical engineer or electrician, and shall be actually engaged in such a situation at the time of his application for election or transfer; (2) he shall have been engaged for at least five years in one of the branches of electrical engineering, and shall be actually so engaged at the time of his application, and shall afford satisfactory proof to the Council of his fitness for election; or (3), being an associate, he shall have gained a premium in any year for a paper read at an ordinary general meeting of the Institution.
	15. *Associates.*—Associates shall be persons, more than 21 years of age, who are interested in, or connected with, electrical science or engineering or who are so associated with the application of electricity that the Council consider their admission as associates would conduce to the interests of the Institution.

The qualifications for foreign members and honorary members remain the same. A student may not remain in the student class for longer than three years, unless he has not attained the age of 22 (not 21 as formerly), at the end of that time.

Formerly, every candidate for election into the Institution (except as honorary member) needed only a proposer and seconder, both members. Now:—

If he be proposed for election to the class of members or of foreign members, by three members or by two members and two associate members; or,

If he be proposed for election to the class of associate members, by two members or by one member and two associate members; or,

If he be proposed for election to the class of associates, by two members or by three associate members or associates.

This rule may, however, be waived in the case of candidates residing abroad, if they be nominated by the Local Honorary Secretary and satisfy the Council as to their eligibility. Students need only one member as proposer.

As regards transfers, the old rules read:—

The Council shall decide upon the application for transferring any candidate from one class to another.

In the new Articles the following is added:—

but, except as hereinafter provided, every candidate for transfer to any class shall be duly nominated for such transfer, in writing and from personal knowledge, by two members; and his candidature shall be supported, in writing, by as many members, associate members, or associates as would have been required by Article 18 had he been a candidate for direct election to the class to which he seeks to be transferred. [Excepting that an associate who shall have been on the register as an associate on December 31, 1898, and who can prove to the satisfaction of the Council that he is duly qualified according to the preamble of Article 13, may be transferred to the class of associate members on receipt of his personal application alone, in writing.]

Facilities are also given to candidates abroad, as in the the case of election.

Contributions to the Funds.

The yearly contributions to the funds remain the same for those who are already connected with the Institution, and do not wish to be transferred. For those elected after December 31, 1898, the existing subscriptions in pounds are to be paid in guineas, with the exception of students whose annual sub-

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scription is raised from a half to a whole guinea. The entrance fee for members is raised from £3 to 3 guineas, and for associates diminished from 30s. to 1 guinea. Associate members are to pay 2 guineas entrance fee, and a like sum as annual subscription. As before, lower fees are payable by those living abroad nine months in the year. Associates now transferred to associate membership will have to pay 12s. to make up the 2 guinea entrance fee, and pay the annual 2 guineas subscription, just as newly-elected associate members.

The fees for life-membership have been considerably raised:—

Old Articles.	New Articles.
25. Any member elected before December 31, 1891, may compound for his annual subscription by the payment to the Institution in one sum of £21 if resident in the United Kingdom, or, if resident abroad, by the payment in one sum of £10. Any member elected after the said date may compound by the payment in one sum of £25 if resident in the United Kingdom, or, if resident abroad, by the payment in one sum of £10. Any associate elected before December 31, 1891, may compound for his annual subscription by the payment in one sum of £10; or, if elected after the said date, by the payment in one sum of £12. 10s. if resident in the United Kingdom, or of £10 if resident abroad. Any foreign member may similarly compound by the payment in one sum of £10. .	28. Any member, associate member, foreign member, or associate may, after December 31, 1898, compound for his annual subscription by the payment to the Institution in one sum of £42. Provided that if any such member, associate member, foreign member, or associate has, as a member, associate member, foreign member, or associate, paid to the Institution or its predecessors more than ten annual subscriptions, such sum of £42 shall be reduced by the deduction of £1. 1s. for every year after the tenth year during which he shall have paid such annual subscriptions. . . . Provided that any existing member, foreign member, or associate may, until the date of the annual general meeting in 1899, compound upon the terms specified in Article 25 of the existing Articles of Association.
22. An associate resident in the United Kingdom who has compounded by payment of £10 shall, if transferred to the class of members before December 31, 1891, pay either an additional composition of £11 or an annual subscription of £1. 1s. If transferred after the said date, he shall pay either an additional composition of £15 or an annual subscription of £2.	30. An associate resident in the United Kingdom who has compounded by payment to the Institution or its predecessors of £10 or of £12. 10s. shall, if transferred to the class of members before December 31, 1891, pay an annual subscription of £1. 1s.; if transferred after the said date and before December 31, 1898, pay an annual subscription of £2; or, if transferred after the last-named date, either directly to the said class of members or after passing through the class of associate members, he shall pay an annual subscription of £2. 2s.; if transferred to the class of associate members, he shall pay an annual subscription of £1. 1s. . . .

Annual General Meeting.

The Annual General Meeting is to be the last meeting of the session (on or about June 1st) instead of the meeting next previous to Christmas Eve.

Local Sections.

65. The Council may, at their discretion, upon receipt of a request to that effect from a sufficient number of honorary members, members, associate members, foreign members, or associates, resident in any district, create a local section of the Institution in such district, and they shall also have power to dissolve such section at any time after it has been formed.

66. Each local section shall be constituted, and its affairs shall be carried on, in accordance with the rules and regulations to be laid down from time to time by the Council, and it shall elect annually for its chairman or president a member of the Institution, who, during his period of office as chairman or president of the section, shall be *ex-officio* a member of Council.

67. The Council may, at their discretion, upon receipt of a request to that effect from any local society with objects kindred to those of the Institution, arrange for the union, alliance, or incorporation of such society with the Institution; and may also, if they think fit, remit or reduce the entrance fees of the members of such society at the time of union, alliance or incorporation.

The Council are empowered to publish Papers read at the meetings of the local sections, just as in the case of Papers read at ordinary meetings.

Copyright of Papers.

73. Every Paper presented to the Institution, and accepted for reading or for publication in the *Journal*, and the copyright thereof, shall be the property of the Institution, unless there shall have been some previous arrangment to the contrary. But the Council, in such cases as they may think fit, shall have power to release or surrender their rights in respect of any such Paper, or the copyright thereof.

Common Seal.

76. The Council may provide a common seal of the Institution, and make rules for the safe custody of the same, and for the use thereof, and it shall never be used except by the authority of the Council previously given, and in the presence of two members of the Council at the least, who shall sign every instrument to which the seal is affixed, and every such instrument shall be countersigned by the secretary, or some other person appointed by the Council.

77. The Institution, acting by the Council, may exercise all the powers given by the Companies' Seals Act, 1864.

ELECTRICITY WORKS ACCOUNTS.

The Newcastle and District Electric Lighting Co. (Limited).

Our tables this week present the analyses of the accounts of the Newcastle and District Electric Lighting Co. and of the Norwich Electricity Co.:—

The electric lighting undertaking of the former Company started working in January, 1890. Good progress continues to be made in almost every respect—viz., in custom, economy of working and in the financial results.

The authorised share capital of the Company stands at £100,000, while the borrowing powers are to the extent of half the paid-up capital. The share capital paid up and received is £60,501, and the loans stand at £8,900, making a total received capital of £69,401. Up to December 31st last the total expenditure had reached £76,799, representing £60·4 per kilowatt of generating capacity of plant installed.

During 1897 an equivalent of 5,000 8-c.p. lamps had been added to the circuit, raising the total lamp connection to 33,000 (8 c.p.). The output for the year was 600,972 units sold, being an increase of 13 per cent. over the output of 1896.

While the nominal price charged has not been altered, the average price obtained has *risen* from 4·4d. to 4·5d. per unit. Economies in the management and property charges have, in spite of increased works costs, reduced the total costs from 2·29d. to 2·26d. per unit. Generation costs have decidedly risen.

A working profit of £5,675, representing 8·04 per cent. of the mean expended capital, has been made. Out of this and the balance of £140 from 1896 £600 has been carried to the depreciation fund, £282 to the reserve fund, and £522 paid as interest on loans, leaving a balance out of which a dividend of 7½ per cent. per annum has been paid.

An idea of the progress which has marked the undertaking may be gathered from the following record of the output:—In 1891 the number of units sold was 206,000; in 1892, 290,500; in 1893, 388,500; 1894, 431,000; 1895, 472,000; 1896, 541,139; and in 1897, 600,972.

The Norwich Electricity Co.

Starting supply in October, 1893, the Norwich undertaking has completed its fourth year of working.

The total authorised capital is £100,000, of which £71,150 has been received, £45,650 from the paid-up share capital; £19,500 upon the Four per Cent. Debenture Bonds, and £6,000 by a bank loan. The total expenditure as capital has amounted to £79,502, or about £89 per kilowatt capacity. During the year 221 consumers have been connected to the mains, thus raising the equivalent 8 c.p. lamp connection from 21,000 to 29,000, or 38 per cent. The corresponding output was 572,000 units sold, representing an increase over that of 1896 of 31 per cent. An average price per unit of 4·86d. has been obtained, as compared with 5·29d. for 1896. The total costs per unit have fallen slightly through economies in works costs since the management and property charges have risen.

Owing to the reduction in the revenue, the ratio of costs to revenue has risen slightly to 41·2 per cent. However, a working profit of £6,801 has been made, and this, together with £444 from 1896, has enabled £2,500 to be set aside to the depreciation fund, £1,000 to the reserve fund and £805 to be paid as interest on loans. A balance available for distribution has thus been left of £2,940, out of which a dividend of 5½ per cent. for the year has been paid, and £452 carried forward.

To promote custom, the Directors have introduced a system of free wiring, charging to customers so acquired 8d. and 4d., instead of 7d. and 3½d. per unit. Motors are also supplied on the three years' hire-purchase system. During 1897 20 additional motors, representing an aggregate of 60 H.P., were connected, being a larger increase than that of any preceding year.

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	NEWCASTLE-ON-TYNE.		NORWICH.	
Undertaking Worked by	The Newcastle and District Electric Lighting [Co., Ltd.		The Norwich Electricity Company.	
Date of Commencement of Supply	1890.		1893.	
System of Supply	Alternate-current transformers.		3-wire continuous-current, with batteries.	
Chief Engineer	W. D. Hunter.		F. M. Long.	
YEAR ENDED	DEC. 31, **1896.**	DEC. 31, **1897.**	DEC. 31, **1896.**	DEC. 31, **1897.**
QUANTITIES—				
Units generated	900,197	1,041,729	542,000	702,000
„ **SOLD (TOTAL)**	541,139	600,972	436,050	572,000
„ sold to consumers	—	561,222	436,050	572,000
„ sold for public lighting, &c.	—	39,750	nil	nil
„ used on works	—	41,997	—	—
UNITS SOLD PER 8 C.P. LAMP CAPACITY	13·6	15·1	19·80	20·57
Maximum supply demanded	460 kilowatts	559 kilowatts	536 kilowatts *	660 kilowatts *
Number of public lamps	10 arc	10 arc	nil	nil
Number of consumers	—	—	675	896
Connections to mains in 8-c.p. lamps	28,000	33,000	21,000	29,000
CAPACITY OF PLANT IN 8-C.P. LAMPS	39,700	39,700	22,000	27,800
CAPACITY OF PLANT IN KILOWATTS	1,270	1,270	703	890
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£127,522 / £100·4	£130,250 / £102·6	£100,000 / £142	£100,000 / £112
Share	100,000 / 78·8	100,000 / 78·8	50,000 / 71·1	50,000 / 56·2
Loan (including Debenture charges)	27,522* / 21·65	30,250* / 23·8	50,000 / 71·1	50,000 / 56·2
RECEIVED (TOTAL)	63,944 / 50·4	69,401 / 54·6	62,550 / 89·0	71,150 / 79·9
Share	55,044 / 43·3	60,501 / 47·6	43,050 / 61·3	45,650 / 51·3
Loan (including Debenture charges)	8,900 / 7·01	8,900 / 7·01	19,500 / 27·8	25,500 / 28·7
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	63,578 / 50·0	60,849 / 47·9	37,450 / 53·3	28,850 / 32·4
Share (unissued)	820 / 0·646	820 / 0·646	6,950 / 9·89	4,350 / 4·89
Share (uncalled)	44,136 / 34·7	38,679 / 30·46	— / —	— / —
Loan (including Debentures)	18,622 / 14·66	21,350 / 16·80	30,500 / 43·4	24,500 / 27·5
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	718 / 0·566	1,000 / 0·788	— / —	1,000 / 1·12
DEPRECIATION FUND	4,000 / 3·15	4,600 / 3·62	4,000 / 5·69	6,500 / 7·30
EXPENDED (TOTAL)	64,505 / 50·8	76,799 / 60·4	65,662 / 93·4	79,502 / 89·3
Lands and buildings	6,615 / 5·20	10,518 / 8·28	12,699 / 18·1	14,621 / 16·4
Plant	41,239 / 32·5	47,130 / 37·1	26,833 / 38·2	35,493 / 39·9
Mains	15,916 / 12·54	18,417 / 14·5	24,183 / 35·3	29,388 / 33·0
Miscellaneous	735 / 0·579	735 / 0·579	1,948 / 2·77	— / —
BALANCE OF CAPITAL ACCOUNT	−561[d] / −0·442	−7,398[d] / −5·82	−3,112[j] / −4·43	−7,492[j] / −8·41
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£9,941 / 4·410d.	£11,326 / 4·525d.	£9,613 / 5·290d.	£11,578 / 4·862d.
Revenue from supply	9,327[a] / 4·140d.	10,662[a] / 4·260d.	9,205 / 5·070d.	11,423 / 4·793d.
„ meters, &c.	612 / 0·272d.	664 / 0·265d.	259 / 0·143d.	
„ public lighting	— / —	— / —	— / —	— / —
„ sale of lamps, &c.	— / —	— / —	29 / 0·016d.	12 / 0·005d.
„ miscellaneous sources	3 / 0·001d.	1 / —	120 / 0·066d.	142 / 0·060d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£5,160 / 2·290d.	£5,651 / 2·257d.	£3,863 / 2·125d.	£4,776 / 2·003d.
WORKS COSTS	3,633 / 1·611d.	4,150 / 1·658d.	3,077 / 1·694d.	3,550 / 1·490d.
Generation of electricity	*3,139 / 1·393d.*	*3,623 / 1·447d.*	*2,752 / 1·515d.*	*3,550[k] / 1·490d.*
Fuel (including cartage, &c.)	1,388 / 0·616d.	1,629 / 0·651d.	1,338 / 0·736d.	1,819 / 0·764d.
Oil, waste, water, stores	416 / 0·185d.	495 / 0·198d.	137 / 0·075d.	
Wages at station	1,050 / 0·466d.	1,090 / 0·436d.	749 / 0·412d.	1,011[c] / 0·424d.
Repairs and maintenance at station	285 / 0·127d.	407 / 0·163d.	528[a] / 0·291d.	720[d] / 0·302d.
Distribution of electricity	*494 / 0·219d.*	*528 / 0·211d.*	*325 / 0·179d.*	— / —
Wages, &c.	494 / 0·219d.	528 / 0·211d.	325 / 0·179d.	— / —
Repairs, renewals of mains, &c.	— / —	— / —		
Public lighting	— / —	— / —	— / —	— / —
Attendance	— / —	— / —	— / —	— / —
Renewals	— / —	— / —	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	1,527 / 0·678d.	1,501 / 0·600d.	786 / 0·433d.	1,226 / 0·514d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*607[b] / 0·269d.*	*556[b] / 0·222d.*	*127 / 0·070d.*	*272[e] / 0·114d.*
Management	*920 / 0·408d.*	*945 / 0·378d.*	*659 / 0·363d.*	*954 / 0·400d.*
Salaries	550 / 0·244d.	520 / 0·208d.	419 / 0·231d.	718 / 0·301d.
Stationery, &c.	197 / 0·087d.	342 / 0·137d.	39 / 0·021d.	144 / 0·060d.
Establishment charges			49 / 0·027d.	
Law charges, &c.	173[c] / 0·077d.	83[e] / 0·033d.	152[b] / 0·084d.	92[f] / 0·039d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£4,781 / 7·86%	£5,675 / 8·04%	£5,870 / 9·82%	£6,801 / 9·36%
Sum carried to Depreciation Fund	1,000 / 1·64%	600 / 0·849%	2,500 / 4·18%	2,500 / 3·44%
Sum carried to Reserve or Sinking Fund	— / —	282 / 0·399%	— / —	1,000 / 1·38%
Net interest on loans (incl. Debenture charges)	717 / 1·18%	522 / 0·739%	780 / 1·305%	805 / 1·11%
BALANCE FROM LAST ACCOUNT	117 / 0·192%	140 / 0·198%	119 / 0·199%	444[g] / 0·612%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	3,181 / 5·23%	4,411 / 6·25%	2,590 / 4·33%	2,940 / 4·05%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	7% / —	7½% / —	4½% / —	5½% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	51·9%	49·9%	40·2%	41·2%
Expenditure per kilowatt capacity	£4. 1s. 2d.	£4. 9s. 0d.	£5. 9s. 11d.	£5. 7s. 5d.
REVENUE PER KILOWATT CAPACITY	£7. 16s. 7d.	£8. 18s. 5d.	£13. 13s. 6d.	£13. 0s. 0d.
Expenditure per 8-c. lamp capacity	2s. 7¼d.	2s. 10d.	3s. 6d.	3s. 5¼d.
REVENUE PER 8-C.P. LAMP CAPACITY	5s. 0d.	5s. 8½d.	8s. 9d.	8s. 4d.
REVENUE PER 8-C.P. LAMP CONNECTED	7s. 1¼d.	6s. 10½d.	9s. 1⅞d.	7s. 11⅞d.
Price charged for lighting, per unit	6d.[f]	6d.[f]	7d. to 3½d.[h]	7d. to 3½d.[h]
Price charged for power, per unit	3½d.	3½d.	3d. to 2d.[i]	3d. to 2d.[i]
Price charged for public lighting	By contract	By contract	—	—

NEWCASTLE-ON-TYNE. — REMARKS — * Being one-half of the paid-up capital. *a* Includes revenue from public lighting. *b* Inclusive of insurance. *c* Includes auditing, £50. *d* Over-expended. *e* Includes auditing, £54. *f* Subject to discounts varying from 5 per cent. to 25 per cent.

NORWICH. — REMARKS — * At consumers' terminals. *a* Includes £24 to extension of engine room, "lamp account" £39, and "special items" (under generating charges) £32. *b* Includes £28 to auditing and £97 to insurance. *c* Includes salaries and wages in respect of distribution. *d* Includes repairs and maintenance of mains, &c. *e* Includes also insurance charges. *f* Includes auditing £11, and Board of Trade fees £24. *g* After deducting Directors' fees, £500. *h* The charge is 7d. per unit only during hours of heavy load; at other times, 3½d. *i* 3d. per unit for the first 800 units per quarter; 2d. per unit after. *j* Over-expended. *k* Including distribution costs.

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The Electrician.

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All letters for insertion in "The Electrician," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

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THE INSTITUTION OF ELECTRICAL ENGINEERS.

Considerable changes have been effected in the Articles of Association of the Institution of Electrical Engineers, changes which should increase the importance and prestige of the Society, and confer benefit on its individual members. We publish in another column a fairly complete *resumé* of the alterations which will come into force on January 1, 1899, and it will at once be noticed that those which are likely to bear most fruit are the introduction of the new class of Associate Members, and the proposed formation of "Local Sections" of the Institution. With regard to the former, it will be recognised that our younger Institution is again flattering the progenitor of all engineering societies by an imitation of its methods. Men who are in the future to be elected as Associate Members must be electrical engineers or electricians by training and by occupation, and the restrictions in the new Article 15 make it essential that they should have had considerable experience in their profession. Exceptions are made only in the case of those Associates who have shown superior merit by obtaining a premium for a Paper read before the Institution, and of those who are at present on the register. The latter exception is, it must be admitted, a fair one, for although no one who was ineligible as Associate under the old regulations is eligible under the new, the better men who would be Associates under the old rules are offered a higher rank, and this will necessarily in the course of time cause the Associate class to loose caste, as it were. It will also be noticed that the qualifications for membership have been placed higher by requiring a five years' occupation of situations of *superior* responsibility under the first clause, or, in the optional clause, by raising the time the candidate must have practised on his own account from two to five years. A minimum age limit has also been added. This equality of conditions for those who are employed in responsible posts and those who are their own masters is commendable, and is representative of the spirit pervading the engineering world at the present time. The superior qualifications required for membership will also, of course, leave many better men in the Associate Member

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class who would not previously have remained Associates. One question may in all fairness be put, however. What advantages will the Associate Member have over the Associate in return for his greater ability and higher fees, except the right of increasing by one the number of letters following his name? The Member has always had the advantage of being able to vote on questions of change of the Articles of Association, but the Associate Member will not possess this privilege, he and the Associate being, it appears, exactly on a similar footing so far as voting power is concerned. In the Institution of Civil Engineers the Associate Member has all the voting powers of a full Member, while the Associate (except in the case of some few individuals) is not entitled to the privileges of corporate membership. This is certainly more just, as the difference drawn outside the Institution between a M.Inst.C.E. and an Assoc.M.Inst.C.E. is much greater than that between an Associate Member and an Associate. The class of Associates of the Institution of Electrical Engineers has one more point of dissimilarity with that of the Institution of Civil Engineers. In the latter Institution a civil engineer by profession who cannot or will not qualify for an Associate Member, cannot belong to the society as an Associate, for this class is confined to those who are not professional engineers. In the Institution of Electrical Engineers anyone connected with electrical engineering can be an Associate if the Council approve of him.

We come now to the other important advance, viz., the creation of local sections. This should certainly be encouraged; in fact, it should have been encouraged at least five years ago, before the formation of the Northern Society of Electrical Engineers. The Northern Society was formed with no idea of rivalry or opposition to the older institution, but merely to give electrical engineers in the North, who were prevented from attending the meetings of the Institution in the metropolis, an opportunity of assembling and exchanging views. Had there been a possibility of forming a "Local Section" in 1893, the Northern Society would probably have taken that form, and, although the quality of the Papers read before this society has always been of a very high standard, it must be allowed that its management might have been better if the Society had been under the motherly wing of the Institution. One cannot help reading in No. 67 of the new Articles, and in the Rule making the presidents of local societies *ex-officio* members of the Council, a distinct offer to the Northern Society of Electrical Engineers.

A radical change of this sort in the constitution of a popular society cannot altogether escape criticism, and there are some cases where real or apparent hardship might be instanced. Among them we may mention the large increase in the sums required from some of those who wish to compound for their annual subscription. For Members, Associate Members and Associates who have no intention of being transferred the matter is more or less a financial speculation and a fair one. But we wish to point only to the case of those Associates who have already compounded for their annual subscription. If they are content to remain in their present class after the best men have moved from it, they need pay no more; but if they feel impelled, as many naturally will, to change their state and become Associate Members they will be obliged either to make up to 40 guineas the sum they have already paid (£10 or £12. 10s.) as a composition for all future subscriptions, or they will have to pay a regular annual subscription of a guinea under Article 30. Students may also complain. Their fee is doubled, while the fees of the other classes are only raised from pounds to guineas. They must remember, however, that the subscription they have paid hitherto has been extremely low, not sufficient to cover the cost of the journal. Students, if they joined before 22 years of age, must, contrary to the custom at the Institution of Civil Engineers, reach associate membership *vid* associateship, the maximum student's age being in some cases 22, while the minimum age for Associate Members is 25. The last fact is, however, unimportant, except in so far as it will increase the number of transfers the Council has to attend to.

We are glad to see the encouragement given to associate members and associates to read premium Papers, by the qualifications for membership and associate membership. These will, no doubt, prove a greater inducement to them to present Papers to the Institution than the mere money value of the premiums themselves. Taken as a whole, the new Articles of Association are a decided improvement on the old ones, and we trust that they will add to the prosperity of the Institution of Electrical Engineers.

ELECTRIC LIGHTING AND TRACTION NOTICES.

Subjoined is a complete list of the electric lighting and traction notices for the session of 1899. Of the Provisional Order notices 13 are metropolitan and 94 provincial, while six of the Bills affect the London area and 21 the provinces. The most noticeable feature on the present occasion is the number of Bills promoted by local authorities already in possession of electric lighting powers, but who are anxious to extend their area of supply, or to obtain additional powers in connection with their electricity supply schemes. In addition to the Bill of the General Power Distributing Co., which is to be resumed at the stage at which it was left in the last session, there are seven other Bills for powers to generate and supply electric current "in bulk," and the Midland Electric Corporation for Power Distribution, no doubt encouraged by their partial success of last year, are endeavouring to obtain a Provisional Order for several towns and districts in Worcestershire and Staffordshire. Three companies are seeking to obtain the right of competing with the City of London Co., while the Vestries of Bermondsey and St. Marylebone, undeterred by the failures of last year, are proceeding by Provisional Order and Private Bill respectively. In the case of Marylebone, overtures have, we understand, been made by the Vestry to the Metropolitan Electric Supply Co. for the purchase of so much of the Company's undertaking as lies within the parish of Marylebone.

As regards electric traction schemes, we need only draw attention to the great increase in the number of notices compared with 1898. There are no Provisional Orders which affect the metropolitan area, and but 15 hail from the provinces; nine of the Bills, however, deal with London and suburban projects, and the remaining 30 are provincial. It would, therefore, appear that applications under the Light Railways Act, so much favoured by companies, have a rather stimulating effect upon municipal authorities, and tend to increase the number of electric traction Provisional Orders and Bills. We give below the figures for the last eight years:—

	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Lighting	34	20	32	32	41	61	98	134
Traction	15	15	17	13	37	61	45	54

ELECTRIC LIGHTING NOTICES.

PROVISIONAL ORDERS.

THE METROPOLIS.

District.	Name of Applicant.
Battersea and Fulham ...	County of London Electric Lighting Co.
Bermondsey	Vestry.
Bermondsey, Rotherhithe, Deptford, Lambeth, Lewisham and Lee	County of London Electric Lighting Co.
Bethnal Green	Vestry.
Chelsea (Kensal Town)	Vestry.

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District.	Name of Applicant.
City of London	Charing Cross and Strand Electricity Supply Corporation and Metropolitan Electric Supply Co. (*see* also under Parliamentary Bills).
City of London, St. Luke's and Holborn	Smithfield Markets Electricity Supply Co.
Kensington	Vestry of St. Mary Abbotts.
Lee	Blackheath and Greenwich Elec. Lighting Co.
Lewisham	District Board of Works.
Plumstead	Vestry.
Stoke Newington, Hackney, Bethnal Green, Poplar & Whitechapel	County of London Electric Lighting Co.
THE PROVINCES.	
Alloa	Corporation.
Ashford	District Council.
Audenshaw	District Council.
Aylesbury	District Council.
Barmouth	District Council.
Barnstaple	Urban Electric Supply Co.
Bexley	District Council.
Bexley, Crayford & Erith	West Kent Electricity Supply Co.
Bognor	District Council.
Broadstairs, Westgate & Birchington	Isle of Thanet Light Railways (Electric) Co.
Brentford	District Council.
Burslem	Corporation.
Camborne	Camborne Electricity Supply Co.
Carshalton (Surrey)	Electrical Power Distribution Co.
Castleford	District Council.
Cheltenham	Corporation (extension of area).
Cheriton	District Council.
Christchurch, Pokesdown and Winton	Bournemouth and Poole Electricity Supply Co.
Clontarf (Dublin)	Town Commissioners.
Cromer	District Council.
Crowborough	Crowborough District Gas Co.
Darfield	District Council.
Dukinfield	District Council.
Durham	Corporation.
East Barnet	District Council.
Eastbourne	Corporation (purchase of Local Co.'s undertaking and increased area).
East Retford	District Council.
Erith	District Council.
Failsworth	District Council.
Farnborough	District Council.
Fenton	District Council.
Finchley	District Council.
Gateshead	Electrical Power Distribution Co.
Glossop	Corporation.
Gorton	District Council.
Grays Thurrock	District Council.
Guildford	Guildford Elec. Supply Co. (extension of area).
Halesowen	District Council.
Handsworth	Corporation.
Haslemere, Shottermill, Frensham & Thursley	Mr. E. O. Preston.
Haslingden	Corporation.
Hartlepool	Corporation.
Hendon	Electrical and General Engineering Co.
Heywood	Corporation.
Hythe	Corporation.
Hythe, Sandgate and Cheriton	Folkestone Electricity Supply Co.
Ilkeston	Corporation.
Inverness	Police Commissioners.
Keighley	Corporation,
Kidderminster	Corporation.
Kilmarnock	Corporation.
Kirkcaldy	Corporation.
Knutsford	District Council.
Leamington	Corporation Midland Electric Light and Power Co.
Longton	Corporation.
Ludlow	Corporation.
Lye and Wollescote	District Council.
Lymington	Lymington Electric Light and Power Co.
Mansfield	Corporation.
Merthyr Tydfil	Merthyr Electric Traction and Lighting Co.
Mexborough	District Council.
Mirfield	District Council.
Musselburgh	Drake & Gorham Electric Light (Pioneer) Synd.
Newcastle-under-Lyme	Corporation.
Newport (Isle of Wight)	Ventnor Electric Light and Power Co.
Newton Abbot	Urban Electric Supply Co.
Partick	Kelvinside Electricity Co.
Pemberton	District Council.
Penzance	Urban Electric Supply Co.
Rawtenstall	Corporation.
Rhyl	District Council.
Romford	District Council.
Rugby	District Council.
Runcorn	District Council.
Ryde	Corporation. Ryde Electric Light and Power Co.
Sandown and Shanklin	Ventnor Electric Light and Power Co.
Shipley	District Council.
Slough and Datchet	Laing, Wharton and Down.
Stourbridge	District Council.
Swinton	District Council.
Teignmouth	District Council.
Twickenham and Teddington	Twickenham & Teddington Electric Supply Co.
Walker	District Council.
Walton-on-Thames and Weybridge	Electric Works Co.
Wath-upon-Dearne	District Council.
Wednesbury	Corporation.
Weston-super-Mare	Weston-super-Mare and District Electric Light [and Power Syndicate.
Winsford	District Council.
West Bromwich, Amblecote, Brierley Hill, Handsworth, Perry Barr, Quarry Bank, Smethwick, Kingswinford, Aldridge, Great Barr, Pelsall and Rushall (in Staffordshire), and Dudley, Lye, Wollescote, Oldbury, Stourbridge and Halesowen (in Worcestershire)	Midland Electric Corporation for Power Distribution.
Worksop	District Council.
Ystradyfodwg (Glam.)	Mardy Electric Lighting Co.

PARLIAMENTARY BILLS.

METROPOLIS.

Name of Applicant.	Powers sought.
Central Electric Supply Co.	To generate and supply electric current in "bulk" and to erect generating station in parish of St. Marylebone.
County of London Electric Lighting Co.	To compulsorily acquire certain lands in parishes of St. James's (Camberwell), Wandsworth, St. Luke's (Middlesex), St. James's (Southwark) and other districts.
Kensington and Knightsbridge Electric Lighting Co. and Nottinghill Electric Lighting Co.	To acquire lands for electricity generating station in parish of Hammersmith and to lay mains therefrom into the areas of supply of both companies.
Marylebone Vestry	To purchase undertaking of Metropolitan Electric Supply Co. in Marylebone district and to generate and supply electric current, &c.
Metropolitan Electric Supply Co.	To supply electric current in City of London. (*See* also Provisional Orders.)
St. James's and Pall Mall Electric Lighting Co.	To acquire land compulsorily in parish of St. James's (Westminster), to erect electricity generating station, &c.

THE PROVINCES.

Barking (Essex) District Council	To purchase, sell and let on hire electric fittings.
Birmingham Corporation	To purchase undertaking of Birmingham Electric Supply Co. and to extend area of supply.
Bootle Corporation	To supply electric current outside Borough area, and to sell, deal and let on hire electrical apparatus.
Cobham Gas Co.	To enable company to obtain electric lighting powers.
Crowborough and District Gas Co.	To incorporate company to acquire undertakings of Crowborough District Gas and Mayfield District Gas Light Companies, and to generate and supply electric current.
Dublin Corporation	To extend electric lighting area, &c.
Hastings and St. Leonards Gas Co.	To accept transfers of any electric lighting powers affecting Hastings or Bexhill.
Highland Water Power Co.	To incorporate company to establish elec. supply works, &c., in Invernesshire, &c.
Lancashire Electric Power Co.	To incorporate company to generate and supply electricity within parts of the counties of Lancaster and Chester (including Liverpool, Manchester, Preston, Burnley, Bolton, Blackburn, Oldham, Widnes, St. Helens, Stockport, Macclesfield, Birkenhead, Salford, Accrington and Darwen).
Leicestershire and Warwickshire Electric Supply Co.	To incorporate company to generate and supply electric current within parts of counties of Leicester, Warwick and Derby (including Birmingham, Leicester, Coventry, Sutton Coldfield, Rugby, Leamington, Warwick, Tamworth, Coleshill, Nuneaton, Burton, Lichfield, Derby, &c.), and to enter into agreements with local authorities and others.
Loughborough Corporation	To supply electric current, sell and let on hire electric motors, &c.
Loughborough Gas Co.	To empower application for Provisional Order.
Manchester Corporation	To light *culs de sac*, purchase and let on hire electric motors and electrical apparatus, establish insurance fund, and to borrow additional capital.

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Name of Applicant.	Powers sought.
Mid Kent Gas Co.	To incorporate and empower company to apply for electric lighting powers, &c.
Rushden and Higham Ferrers Gas Co.	To empower company to apply for Provisional Order.
St. Albans Gas Co. ..	To empower company to take transfer of St. Albans Provisional Order.
Shirebrook & District Gas Co.	To empower company to apply for Provisional Order.
South Lancashire and Cheshire Electricity Co.	To incorporate company, to generate and supply electric current within parts of the counties of Lancaster and Chester (including St Helen's, Widnes, Warrington, Wigan, Liverpool, Runcorn, Eccles, and Bolton), and to enter into agreements with local authorities and others.
Walker and Wallsend's Union Gas Co.	To generate and supply electric current.
Wallasey District Council	To sell, deal in and let on hire electric light fittings.
Whitehaven Corporation	To extend electric lighting area.

ELECTRIC TRACTION NOTICES.

PROVISIONAL ORDERS.

THE PROVINCES.

Barking District Council	To construct, work or lease tramways, to adopt electric traction, &c.
British Electric Traction Co.	To construct electric tramways in Birkdale and Southport, &c.
Burt (Frederick) and Co.	To construct and work electric tramways in Exeter and district.
Clayton District Council.	To construct and work tramways, use mechanical traction, &c.
Dudley and Wolverhampton Tramways Co.	To equip tramways electrically, &c.
Eccles Corporation...	To work tramways, employ electric traction, &c.
Gravesend, Rosherville & Northfleet Tramways Co.	To construct additional tramways, introduce electric traction, to sell undertaking to Drake and Gorham Electric Power & Traction Co., &c.
Ilford District Council.	To construct and work tramways, to employ mechanical traction, &c.
Ilkeston Corporation	To construct and work tramways, adopt mechanical traction, &c.
Ipswich Tramways Co.	To construct additional tramways, to use electric traction, and to sell undertaking to Drake and Gorham Electric Power and Traction Co.
Queensbury District Council.	To construct and work tramways, to adopt mechanical traction, &c.
Reading Corporation.	To construct and work tramways, use electric traction, &c.
Southport Corporation.	To construct and work tramways, to use electric traction, &c.
Weston-super-Mare Tramways Co.	To construct additional tramways, to use electric traction, &c.
Wrexham Tramways Co.	To construct additional tramways, to employ electric traction, and to sell undertaking to Drake and Gorham Electric Power and Traction Co.

PARLIAMENTARY BILLS.

THE METROPOLIS.

Baker-st. and Waterloo Railway Co.	To extend time, to acquire lands, &c.
Brompton and Piccadilly Circus Railway Co.	To construct new railways, to enable Metropolitan District Railway Co. to subscribe and guarantee interest on capital, &c.
Central London Railway Co.	To extend time, to acquire additional land, &c.
Charing-cross, Euston and Hampstead Railway Co.	To construct new railways, alter authorised line, to enter into agreements with Midland Railway and Baker-street and Waterloo Railway Companies, &c.
Great Northern and Strand Railway Co.	To incorporate Co., to construct electric railway from Wood Green to the Fleet-street end of the Strand.
London United Tramways	To employ electric traction, to enter into agreement with London County Council, &c.
London, Walthamstow and Epping Forest Railway Co.	To enable Great Eastern Railway Co. to construct railway, to guarantee interest, &c.
North West London Railway Co.	To incorporate Co. and to construct electric railway from Marble Arch to Cricklewood.
Thames Ferry Co.	To incorporate Co., to construct ferry on sub-merged rails across the Thames, between Greenwich and Millwall, and to use electric traction.

THE PROVINCES.

Birkenhead Corporation	To construct and work tramways, to adopt electric traction, &c.
Blackpool Corporation	To construct tramways, to enter into agreement with Blackpool, St. Anne's and Lytham Tramways Co., as to supply of electric current.
British Electric Traction Co.	To construct electric tramways in Bexhill, Hastings, &c.
British Electric Traction Co.	To construct electric tramways in Airdrie and Coatbridge, &c.
Darwen Corporation	To construct, work or lease tramways, adopt electric traction, &c.
Derby Corporation...	To acquire, work or lease tramways, adopt electric traction, &c.
Gateshead and District Tramways Co.	To construct additional tramways, to employ electric traction, &c.
Glasgow Corporation	To construct and work tramways within and without municipal area, to use electric traction, &c.
Great Grimsby Street Tramways Co.	To construct tramways, use electric traction, &c.
Great Yarmouth Corporation	To construct and electrically equip tramways, &c.
Hastings Corporation	To construct and work tramways, to use electric traction, &c.
Kirkcaldy Corporation	To construct electric tramways, &c.
Leeds Corporation	To construct additional tramways, to adopt mechanical traction, &c.
Liverpool Overhead Tramways Co.	To take on lease and work Waterloo-with-Seaforth and Great Crosby tramways, &c.
Manchester Corporation	To confirm agreements with outside authorities as to leasing tramways, to adopt mechanical traction, &c.
Moss Side District Council	To equip tramways electrically within and without municipal area, &c.
Newcastle-on-Tyne Corporation	To construct new and alter existing tramways, to employ electric traction, to work or lease lines, &c.
Nottingham Corporation	To construct and work tramways, to use electric traction, &c.
Oldham Corporation	To construct tramways, to adopt electric traction, to enter into agreements with neighbouring local authorities, &c.
Salford Corporation	To construct new tramways, to sanction agreements with adjoining local authorities, to employ electric traction, &c.
Southport and Lytham Tramrd. Co.	To incorporate company, to use electric traction, &c.
Southport Tramways Co.	To construct tramways, use electric traction, &c.
South Staffordshire Tramways Co.	To lease tramways, to introduce electric or mechanical traction, &c.
Stockport Corporation	To purchase and work tramways, to introduce electrical or mechanical traction.
Stretford District Council	To equip tramways electrically, &c.
Sunderland Corporation	To construct new and alter existing tramways, to adopt electric traction, &c.
Withington District Council	To equip tramways electrically, &c.
Wallasey District Council	To construct and alter existing tramways, to use electric traction, &c.
Wolverhampton Corporation	To construct, work or lease tramways, to employ electric traction, &c.
Wolverhampton Tramways Co.	To use electric traction, &c.

CORRESPONDENCE.

THE BRIGHTON BREAKDOWN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am among the number of those interested in the above occurrence, and particularly so for two reasons, viz., my previous connection with the Brighton Works, and consequent knowledge of the arrangements, and the fact that similar results have followed the short circuit of shunt-wound dynamos installed here for traction purposes.

In the first case there were two Crompton undertype shunt-wound dynamos (belt driven by independent engines) running in parallel, each being provided with a separate belt-driven shunt-wound exciter, and a *maximum* cut-out. Short-circuits in the culvert happened frequently in wet weather, six in an hour being a not unknown number. A heavy short-circuit almost invariably resulted in both cut-outs opening and in the *demagnetising* of the field of either one or other of the dynamos and *its exciter*. These were again magnetised by connection with the sound machine.

An extra heavy short-circuit often caused, not demagnetisation, but actually *reversal* of the magnetic polarity in one or other of the machines, and, of course, its exciter. Such was the trouble experienced by these reversals that compass pole-indicators were attached to the dynamo circuits.

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The more recent cases have occurred with shunt wound two-pole machines coupled direct (two tandem fashion) to a Parson's turbine. Each dynamo was in itself self-exciting, but the shunts were taken in parallel from the 'bus bars to which both armatures were connected. The dynamo circuits were provided with *minimum* cut-outs. Short circuits had the same effect in this case, with the exception that in some instances *both* machines were demagnetised or reversed. About a year ago these dynamos were compounded and the trouble to a certain extent, though not wholly, obviated. During the last six months two cases of demagnetisation have occurred with exceptionally heavy short-circuits.

Experimentally I have found that a current of 1,000 amperes taken momentarily (their normal maximum being 400) does not result in either demagnetisation or reversal.

It is somewhat difficult to suggest a remedy, except the obvious one of not having severe short-circuits. However, it is quite clear that minimum cut-outs will not act on the faulty machine, and the reason is not far to seek. The time required for their operation is appreciable, and the reversal of current in the armature circuit (assuming a short circuit and not an earth fault to have occurred) being practically instantaneous, before the cut-out has time to open it is again held up by the reversed current.

Assuming the short-circuit is to earth and that one earth connection is in the armature, the other being on the same (say, +) pole as the minimum cut-out but on the lamp side of it. When the faulty portion of the armature is under the negative brush, the leakage current will reach its maximum—its direction through the cut-out being the same as with the sound machines; when the faulty portion of the armature is under the positive brush, the leakage circuit will be parallel to the cut-out branch. It is scarcely probable that the current in the cut-out branch, considering its low resistance, will be rendered inappreciable by being paralleled with the earth circuit; but even were this so, its period of current reduction, with dynamos running at 300 revolutions per minute, would be so short as to render the release of the minimum cut-out impossible.

What we do find under these circumstances is that we have a pulsating current unidirectional with the normal current, and of a frequency equal to the revolutions of the dynamo. The current has *not reversed* in the cut-out branch, nor is it probable that it fell to the minimum necessary, even under normal conditions, for the release of the cut-out.

If we next consider a case in which the earth connection external to the armature is on the opposite (say, −) pole to that to which the minimum cut-out is attached, we shall see that the results are not greatly different. When the armature earth is in contact with the positive brush the leakage current will reach its maximum, but, with a low-resistance fault, the circuit of the damaged armature is completed *viâ* earth, and not through the cut-out branch. In this branch there will be a reversed current from the 'bus bar to the + armature fault. Therefore, with this arrangement of faults we get an alternating, but not necessarily symmetrical, current in the cut-out branch, of a frequency equal to the revolutions of the faulty dynamo.

The only possible conclusion we can arrive at is that minimum cut-outs (or, for the matter of that, maximum, or maximum and minimum) are not calculated to act beneficially in practice as armature protectors. As regards the non-return or reversing cut-out, it would seem that, with faults external to the armature and between it and the cut-out, we might reasonably expect this cut-out to act, but not so with faults giving rise to pulsating or alternating currents, especially when generated by high-speed dynamos.—Yours, &c.,

Electricity Works, Blackpool, Nov. 28, 1898. ROBT. C. QUIN.

THE FINANCE OF ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: No doubt, as you remark, the most interesting portion of Prof. Forbes' Paper, on "Long Distance Transmission of Electric Power," was that relating to the financial proposal, in which he proposes to raise the capital for the conductor by mortgage debentures. Now this proposal was first prepared and supported by an elaborate argument by Mr. B. H. Thwaite in his Paper on "The Electrical Transmission of Power from the Coal Fields." This Paper was read in November, 1892, before the Manchester Association of Engineers, and anyone interested might refer to the particular article, "The Financial Risk Involved in Laying Down Long Lengths of Electric Conductors," which contains the following paragraph:—

"This rate, $3\frac{3}{10}$ per cent., the author proposes, would be a fair rate of interest for the class of security represented by large weights of copper conductors. The author further ventures to suggest that this part of the capital, or the part to cover the cost of trunk transmission lines, should be obtained by the special issue of mortgage debentures at the rate of interest ($3\frac{3}{10}$) stipulated. *Verb sap.*"

The Paper has amongst its illustrations a graphic diagram showing the line of average value of copper (Chilian) for 13 years.—Yours, &c., HORACE ALLEN.

LEGAL INTELLIGENCE.

Williamson and Joseph v. Lawrence and Butcher.

In the Lord Mayor's Court (London) on Monday, plaintiffs sued to recover £11. 14s. 5d. for electrical fittings supplied. Defendants raised a counterclaim in respect of alleged defective materials. Mr. Robert Fisher, secretary to the plaintiffs, said their terms were monthly account, and their pay day was the first of the month. He had applied to the defendants for payment of the account on several occasions, and on the last occasion some complaint was made as to certain lamp holders being defective. These goods had been delivered two months before any complaint was made. Mr. John Hart, plaintiffs' manager, said that no complaint was received from defendants as to the fittings supplied until they were pressed for payment. For the defence, Mr. Lawrence, a member of defendant firm (electric light contractors, Stafford-street, London, W.), said that the four dozen lamp holders used in a contract they were carrying out were defective, the faults being discovered in September. The holders were sent direct to the job and had not been tested before being sent out. He had been waiting to receive a detailed statement from plaintiffs, and within two days after that was received the present action was brought. He had tendered £8. 2s. 5d., being the amount of the account less a sum he claimed as damages for the defective lamp holders. The jury found a verdict for plaintiffs for this amount, and for defendants on the counterclaim for £1. 10s., defendants to return the goods alleged to be defective.

Holliday v. National Telephone Co. (Limited).

Mr. Justice Wills and Mr. Justice Lawrence on Tuesday delivered judgment in this case, an appeal by the company from the decision of the Deputy Judge of the City of London Court, who had entered judgment for plaintiff for £25 under the following circumstances:—The defendant company were laying down telephone wires at the Pavement, Clapham, and entered into an arrangement with a plumber named Highmore, who contracted to do soldering work at so much per joint. The work of soldering had to be performed to the satisfaction of the defendants' foreman. While Highmore was attending to the soldering metal the benzoline lamp used exploded through a defective valve. The molten metal flew about, and some struck plaintiff, who was passing, causing the personal injuries in respect of which he brought the action against the company. Plaintiff alleged negligence on Highmore's part in using a defective lamp, and that as Highmore was the servant of defendants they were liable to pay compensation. The Court now held that Highmore was in no sense a servant of the company, but a master plumber who was in the habit of accepting contracts of this nature. The Deputy Judge was wrong, and the appeal was therefore allowed and judgment entered for the defendant company with costs.

National Telephone Co. v. Commissioners of Inland Revenue.

The appeal of the National Telephone Co. from the decision of Mr. Justice Grantham and Mr. Justice Channell, on Dec. 14 last, will be heard in the Appeal Court I., before Lords Justices A. L. Smith, Rigby and Collins, on Dec. 8.

Morley Electric Co. v. Briscoe.

At Blackburn County Court last week the plaintiffs sued Mr. C. T. Briscoe, electrical engineer, Blackburn, for £45, price of a dynamo. A counter-claim was made for £36. 12s. It was alleged that the dynamo, which had been supplied by the Company to the defendant for a customer, did not work satisfactorily. It was sent to Leeds to be put right, but subsequently further complaints were made about the machine, and ultimately the Company, after much correspondence, sued for the agreed price. It was urged by plaintiffs that the dynamo was made according to the specification. After hearing evidence, Judge Coventry found for plaintiffs on both claim and counter-claim.

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Electric Exploitation Company (Limited) (petition of Sussman Electric Miners' Lamp, Limited).

This case came before Mr. Justice Wright. Counsel for the company stated that it was a petition brought by creditors, but it had been arranged with their consent that there should be an adjournment for three months, as negotiations were pending which it was hoped would result in the company paying the creditor's debt.

His LORDSHIP allowed the petition to stand over for three months, intimating that the other creditors should have notice of the petition.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *November 18.*

Electric Railways in New York City.—Until as late a time as two or three years ago horse-power has been depended on entirely in New York for moving the cars on various street railway lines, while in other cities, even to the smallest, the overhead trolley has been introduced with uniform success and satisfaction. There was a good reason, however, why like improvements were not introduced in this city, for the city ordinances forbade the erection of overhead wires of any description within the city limits. The day came, however, when a satisfactory underground system made its appearance, and the railway companies of this city were not slow to perceive its advantages. As has been pointed out in past correspondence the Metropolitan Street Railway Co. is operating many of its lines on the underground-conduit, open-slot system, and the remainder of its lines are now being equipped in a like manner. All of the street railways in this city are controlled and operated by two companies, the Metropolitan Street Railway Co. and the Third Avenue Railroad Co. The principal lines of the latter have for several years past been operated by cable power, but the limit of capacity of this system having been reached the Company has decided to abandon it and substitute therefor the underground conduit system on all of its lines, some of which are at the present time operated by animal power. Last week the Company commenced the work of introducing the electric system on its two main lines—the Third Avenue-road and the 125th-street line, the latter of which is located in the upper part of the city. The system so laid down will be similar to that used by the Metropolitan Street Railway Co., which is known as the General Electric Co.'s system. On the Third Avenue-road the old cable conduits will be utilised for the electric system, but new 7in. girder rails will be laid. On the rest of the lines entirely new construction will be placed. One noticeable feature of this work, both as regards the Third Avenue improvements and those of the Metropolitan Street Railway Co., is the large number of ducts laid underground alongside of the conduits—a great many more than the Companies have use for. A new company, the New York Gas, Electric Light, Heat and Power Company, has been recently organised with a capital of £5,000,000, but up to the present time it has been impossible to ascertain its object. Various rumours have been in circulation to the effect that its purpose was to buy up or otherwise obtain control of all of the electric lighting interests in Greater New York and conduct the electric light and power business under one management. It is now stated that this concern will rent the ducts not needed by the railroad companies to the subway company, which controls all of the underground conduits in the city.

A Recent Patent of Nikola Tesla.—The daily papers within the past week, by means of startling headlines, announced that Mr. Nikola Tesla would make war so horrible that no nation would care to undertake it. The basis of the story rested on a patent issued to Mr. Tesla on November 8th. The facts, as set forth in the patent, are in brief as follows:—Hitherto the only practical means of controlling the movements of a vessel, such as a torpedo or torpedo boat, at a distance, has been by the use of a cable, the disadvantages of which are obvious. The plan proposed by the inventor is to provide any such craft with a coherer connected between the hull and an elevated terminal, and to so arrange the propelling and steering mechanism which is motor-driven with storage battery supply, that it can be controlled by various relays and auxiliary devices actuated through the agency of the Hertz waves. A single coherer is used. It possesses some elements of novelty designed to yield a more uniform decohering action. It consists of a metal cylinder, with insulating ends and a metal rod passing lengthwise through it. The cylinder normally stands with its axis vertical, and the decohering action consists in inverting it, throwing the particles, which occupy one-fifth of its length, from one end to the other. According to the patent, these granules are manufactured by a special tool, insuring their equality in size, weight and shape, and are uniformly oxidised. This secures equal conductivity of their surfaces, and stops their further deterioration, thus preventing a change in the character of the gas in the space in which they are enclosed. The auxiliary devices consist of ordinary relays, actuating a multiple step-by-step escapement wheel, which, in turn, rotates the brushes and commutators, affecting the various internal circuits of the boat.

Motor-Carriage Contest.—An interesting competition between various types of motor carriages took place at the Charles River Park, Cambridge, Mass., on the afternoon of November 9th, under the auspices of the Massachusetts Charitable Mechanic Association. Prizes to the value of £220 were offered by the management, and a large number of people witnessed the novel spectacle. In the parade were vehicles representing the electric, steam and gasoline methods of propulsion. The first event was the speed contest, a two-mile pursuit race. No electric vehicles took part in this race, which was won by the De Dion gasoline tricycle, in 5min. $1\frac{2}{5}$sec.; the Whitney steam carriage came in second. In the brake efficiency contest the Riker electric carriage, made by the Riker Electric Motor Co., of Brooklyn, took the first prize, stopping at 6ft. 1in., the Haynes gasoline carriage taking second prize. The next contest was as to manageability, and was won by the De Dion tricycle. The Riker Electric carriage, which was 4ft. 8in. wide, did some excellent work in this contest. The severest test of all was the hill-climbing contest, the Stanley steam carriage leading, followed by the Whitney steam carriage. The Riker electric carriage reached over 62ft. in the three trials, the Stanley steam carriage making but one trial on a rush, and covering a distance of 80ft. in $4\frac{3}{5}$sec.

BOOKS RECEIVED.

Transactions of the Ottawa Literary and Scientific Society. No. 1. 1897-98. (Ottawa: E. J. Reynolds).

Proceedings of the Third Annual Convention of the International Association of Fire and Police Telegraph Superintendents and Municipal Electricians, held at Elmira, N.Y., August, 1898.

"German-English-Spanish Electrical and Chemical Dictionary." By Paule Heyne. (London: H. Grevel and Co.). Price 5s.

"Matter, Energy, Force and Work" By Silas W. Holman. (New York: The MacMillan Co.) Price $2.

"Science Abstracts." Nov., 1898. No. 11, Vol. I. Edited by J. Swinburne. (London: E. and F. N. Spon). Price 3s.

"*Proceedings* of the Royal Society of Edinburgh." Session 1897-98. No. 2, Vol. XXII.

"On the Springing and Adjusting of Watches." By F. J. Britten. (London: E. and F. N. Spon). Price 3s.

"The Official Gazette of the United States Patent Office." No. 7. Vol. LXXXV. Published by Authority of Congress. (Washington: Government Printing Office.)

"The Christmas Photogram." December, 1898. No. 60, Vol. V. Edited by E. Snowden Ward. (London: Messrs. Dawbarn and Ward.) Price 3d.

"Transactions of the Institution of Junior Engineers." Vol. VII. Sixteenth Session, 1896-97. Edited by Walter T. Dunn. (London: Published by the Institution.) Price 10s. 6d.

"The Law Specially Relating to Tramways and Light Railways." By Seward Brice. (London: Stevens and Haynes.)

"Nuovi Tipi di Apparecchi di Scaricamento nei Porti." By E. Borgatti and P. Lanino. (Rome: Tip. Lit. Del. Genio Civile.)

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PROJECTED LIGHT RAILWAYS.

During the past six months 54 applications have been deposited with the Light Railway Commissioners for powers to construct light railways, compared with 32 in May and 30 in November last. On the present occasion 34 of the applications are electrical against 18 in May last. Below are given interesting particulars of the electrical schemes, which no doubt will be found useful :—

Name.	Promoters.	Engineer.	Mileage.	Motive Power.	Gauge ft. in.	Estimated Cost.
ENGLAND—						£
Aldershot and Farnborough	Power and Traction (Ltd.)	G. Hopkins and Sons	5¼	Electric	4 8½	64,093
Barnsley and District	British Electric Traction Co., Ltd.	S. Sellon	3¼	Electric	3 6	22,351
Camborne, Redruth and District	Camborne, &c., Light Railway Co., Ltd.	W. T. Pressland	10	Electric	3 6	41,887
Cheltenham and District	T. Nevins	T. Nevins	5¾	Electric	4 8½	46,587
Colchester	British Electric Traction Co., Ltd.	S. Sellon	5	Electric	3 6	33,327
Colne and District	Colne Town Council	T. H. Hartley	5½	Electric	4 8½	81,614
Crystal Palace	Crystal Palace Light Rlys. and Tramys. Co., Ltd.	V. B. D. Cooper	9¼	Electric	4 8½	45,417
Doncaster and District	British Electric Traction Co., Ltd.	S. Sellon	5½	Electric	3 6	37,324
Doncaster Corporation	Doncaster Corporation	W. H. Crabtree	7½	Electric	4 8½	34,500
Dudley and District (Extensions)	British Electric Traction Co., Ltd.	S. Sellon	3¼	Electric	3 6	27,277
East Anglian	Drake and Gorham Electric Traction Co., Ltd.	T. P. Seaton	3¾	Electric	3 6	98,912
Finchley, Hendon and District	Finchley District Electric Traction Co., Ltd.	Sir Douglas Fox	10½	Electric	4 8½	111,185
Hamstead, Finchley, &c.	Metropolitan Tramways Co., Ltd.	V. B. D. Cooper	14½	Electric	4 8½	75,615
Hastings, Bexhill and District	Hastings, &c., Light Railway Co., Ltd.	Kincaid, Waller & Manville	13½	Electric	3 6	63,594
Highgate, Finchley & Wood Green	Metropolitan Tramways Co., Ltd.	V. B. D. Cooper	10¾	Electric	4 8½	54,559
Hounslow and Twickenham	Drake and Gorham Electric Traction Co., Ltd.	A. H. Rowan	6¾	Electric	3 6	47,259
Isle of Thanet (Extensions)	Isle of Thanet Light Railway Co.	Kincaid, Waller & Manville	5¼	Electric	3 6	23,224
London United Tramways, Limited, Light Railway Extensions	London United Tramways (Ltd.)	J. C. Robinson	16¾	Electric	4 8½	199,045
Middlesbrough, &c.	Imperial Tramways Co., Ltd.	J. C. Robinson	7	Electric	3 6	56,340
Middleton (Extension)	British Electric Traction Co., Ltd.	S. Sellon	2	Electric	4 8½	15,108
Nelson and District	Nelson Corporation	B. Ball	1½	Electric	4 8½	15,000
Nelson, Colne, &c.	Greenwood and Batley (Ltd.)	J. H. Rhodes	6½	Electric	4 8½	87,860
St. Helens, Leigh and Bolton	Lancashire Light Railway Co., Ltd.	J. E. Waller	24	Electric	4 8½	102,090
Southend-on-Sea and District	Southend Corporation	A. Fidler	6½	Electric	3 6	40,474
South Staffordshire	British Electric Traction Co.	S. Sellon	4¼	Electric	3 6	28,767
Spen Valley	British Electric Traction Co.	S. Sellon	7½	Electric	4 8½	55,631
Waltham Cross	Metropolitan Trams, &c., Co., Ltd.	V. B. D. Cooper	5¾	Electric	4 8½	27,923
WALES—						
Rhyl and Prestatyn	Rhyl and Prestatyn Light Railway Co.	A. Dickinson and Co.	3¾	Electric	3 6	26,458
Swansea	Swansea Improvements, &c., Co., Ltd.	S. Sellon	7½	Electric	4 8½	55,172
SCOTLAND—						
Ayr, Prestwick and Monkton	Drake and Gorham Electric Traction Co., Ltd.	A. M. Taylor	4¾	Electric	3 6	31,787
Hamilton, Motherwell and Wishaw	Hamilton, &c., Light Railway Co., Ltd.	Warren and Stewart	8¾	Electric	3 6	79,582
Musselburgh	Drake and Gorham Electric Traction Co., Ltd.	Mathew Buchan & Hogarth	4¼	Electric	4 8½	37,303

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London :—

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"'THE ELECTRICIAN' WIREMAN'S POCKET-BOOK."

"The Electrician" Electrical Trades' Directory and Handbook.—An important announcement in connection with the 1899 issue of the "Big Blue Book" will be found in an advertisement on another page of the present issue, to which our readers will please refer.

TENDERS INVITED.

Extension of Time.—The *Salford* Electric Lighting committee invite tenders for the supply and erection of the following: (1) boilers, (2) engines, (3) dynamos, (4) boiler feed-pumps, (5) mechanical stokers, (6) superheaters, (7) economisers, (8) condensers, &c., (9) steam and water pipes, (10) cranes and weighing machines, (11) tanks, &c., (12) switchboards, and (13) booster. Further particulars are given in an advertisement in another column, and specifications, forms of tender, &c., may be obtained from the borough electrical engineer (Mr. C. L. Turner), Walmesley-road, Broughton. Tenders, addressed to the chairman of the Electricity committee, must be delivered at the offices of the town clerk (Mr. Samuel Brown), Town Hall, Salford, *by Dec. 15, not Dec. 1, as originally advertised.*

The Corporation of *Barnsley* invite tenders for the supply and erection of: (1) Lancashire boilers and Green's economiser; (2) engines, dynamos, switchboard, condensers, feed-water pumps, balancing transformers, boosters, piping, tanks, crane, wiring of works, and engine, &c., foundations; (3) secondary batteries and accessories; (4) feeder and distributing mains (solid system); (5) potential leads, network and service boxes and service connections. Further particulars in our advertisement columns, and specifications, &c., can be obtained on application to the consulting engineer (Mr. Thos. L. Miller), 7, Tower-buildings, N., Water-street, Liverpool. The Corporation also invite tenders for the erection of a chimney and engine, dynamo and boiler house, storage rooms and offices. Specification, &c., from Mr. J. Henry Taylor, borough surveyor, to whom tenders should be sent by noon of Monday, Dec. 12th.

As will be seen from an advertisement applications are invited from electrical engineers for preparing specifications, drawings, &c., for the installation of the electric light at the new infirmary at Highgate-hill for the Guardians of St. Mary, Islington. Further information may be obtained of Mr. W. Smith, architect, 65, Chancery-lane, W.C. Applications to the new Infirmary Buildings committee, Highgate-hill Temporary Workhouse, Holloway, N., by 10 a.m., Wednesday, Dec. 7.

The *Shanghai* Council invite tenders for a concession, for a period of thirty years, for the exclusive right of establishing and working a telephone system in Shanghai. Further particulars are set out in an advertisement on another page, and plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary Axe, London, E.C. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, whose telegraphic address is "Dynamo Shanghai." Tenders must be sent to the secretary (Mr. J. O. P. Bland), Shanghai, by noon of Friday, March 31.

The *Shanghai* Council also invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system. Particulars from Messrs. John Pook and Co., 8, Jeffrey's-square, London, E.C. Tenders to Mr. J. O. P. Bland, secretary, by noon of Wednesday, March 15, 1899.

The *Buxton* District Council require tenders for the erection of electricity generating station buildings. Tenders to the clerk.

The *Beckenham* District Council invite tenders for the supply of the following electric lighting plant:—(*a*) Water-tube boilers and economiser; (*b*) steam alternators, transformers and switchboard; (*c*) pipework, feed pumps, overhead tank, feed-water heater, &c.; (*d*) arc lamps, lamp posts, &c.; (*e*) cables and street work; and (*f*) travelling crane. Tenders to Mr. F. Stevens by noon of Dec. 17.

The *Shoreditch* (London) Vestry invite tenders for the supply of six direct-current rotary transformers, with switch gear complete, three of 66 kilowatt and three of 33 kilowatt capacity. Tenders by noon of Tuesday, Dec. 13, to Mr. C. Newton Russell, Electricity Supply Department, Coronet-street, Shoreditch.

Tenders are invited by the *Board of Control, Dublin*, for the supply of the necessary plant, wiring, &c., for the electric lighting of Richmond District Lunatic Asylum. Tenders to Mr. H. Williams, Custom House, Dublin, by 10 a.m. Dec. 5.

The *Great Northern Railway Co.* invite tenders for the supply of new, and the purchase of old, stores for 12 months from Jan. 1. Tenders to Stores Committee, at the Company's offices, King's Cross, London, N., by 10 a.m. on Tuesday, Dec. 6.

The *North-Eastern Railway Co.* invite tenders for the supply of telegraph apparatus, wire and line stores during the six months ending June 30, 1899. Tenders to the secretary (Mr. C. N. Wilkinson), at York, by noon of Monday, Dec. 5.

The *Glasgow* Corporation invite tenders for supplying switchboards and instruments at the new electricity works, Port Dundas. Tenders to town clerk (Sir J. D. Marwick) by Dec. 5.

The *Dublin* United Tramways Co. invite tenders for the supply of general stores, including electrical supplies, car fittings, ironmongery, &c., for the year 1899. Tenders to the chairman of the Company, 9, Upper Sackville-street, Dublin, by 5th prox.

The Municipal Council of *Bucharest* invite tenders for the supply of electrical machinery and electrical pumping plant for the waterworks. Particulars from M. Radu, chief of Department of Studies and Construction, of Strada Mihai-Voda, Bucharest. Tenders by Jan. 10, 1899.

Tenders and plans are invited until Feb. 1, 1899, by the Municipal Authorities of *Heidelberg* for the erection and equipment of an electric lighting station. Tenders to Der Direction der Städt Gas und Wasserwerke, Heidelberg, whence particulars may be obtained for 6s.

TENDERS RECEIVED AND ACCEPTED.

The *Bury* (*Lancs.*) Corporation have accepted the tender of Messrs. Calvert and Co. for wiring the public baths.

The *Bolton* Corporation have accepted the tender of Mr. J. Booth for the construction and erection of an iron roof at the electricity works. The tender of Messrs. Musgrave and Son for the supply of foundation plates for the two new 1,000 H.P. engines has also been accepted. The contract for the new switchboard has been given to the British Thomson-Houston Co.

The *Redditch* District Council have accepted the tender of Messrs. Johnson and Phillips for the supply of two dynamos, at £1,725, to be delivered within four months.

APPOINTMENTS VACANT AND FILLED.

The District Council of Hoylake and West Kirby invite applications for the post of consulting electric engineer to the Council, in connection with the proposed electric lighting project. Applications, on or before Dec. 6, to the clerk (Mr. Roderick Williams), Council Offices, Hoylake, Cheshire. Further information is given in an advertisement elsewhere.

The Hammersmith (London) Vestry require an electrician-in-charge for their electricity supply works. Salary £2 per week. Applications to the resident engineer (Mr. G. G. Bell), 57, Fulham Palace-road, Hammersmith, by Dec. 8. See advertisement.

A competent foreman platelayer is required by the Tramways Department of Manchester Corporation. Further particulars are set out in an advertisement. Applications (addressed chairman of Tramway committee) must be sent in to the town clerk (Mr. Wm. Henry Talbot), Town Hall, Manchester, by Saturday, the 10th inst.

As announced by us last week, the London County Council have appointed Mr. John Young, manager of the Glasgow tramways, chief officer to the London County Council tramways at a salary of £1,500 per annum. Seventy applications were received for the post, out of which number there were selected: Mr. J. Young, Mr. J. Aldworth (of the Isle of Man tramways), and Mr. A. Baker.

Mr. A. Banks Johnston, who has been for ten years engaged in the consumers' department of the Chelsea Electricity Supply Co., was on Wednesday elected prime cost clerk and third assistant clerk in the electricity department of the St. Pancras Vestry.

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Mr. Hanson has been appointed resident electrical engineer to the Fleetwood and District Electric Light and Power Syndicate, Limited.

BUSINESS NOTICES.

Messrs. Hodges and Todd (Limited) are now connected with the National Telephone Co.'s exchange system, No. 5115 Gerrard.

The London offices of Messrs. Ruston, Proctor and Co. have been removed to Stafford House, 27A, Cannon-street, E.C.

Mr. David Stevenson has taken offices at 17, Victoria-street, Westminster. Mr Stevenson was formerly connected with the "E.P.S." Co. and with Messrs. Drake and Gorham. He went to South Africa in 1891, and was for some years a partner in the firm of Edlin and Stevenson, of Cape Town. He will devote himself especially to electrical power distribution in factories and to electro-motor work generally.

The manager's and secretary's offices of the Western and Brazilian and the London Platino-Brazilian Telegraph Companies have been removed to Winchester House, Old Broad-street, London, E.C., where all communications should be addressed. The transfer offices of these Companies and of the Brazilian Submarine Telegraph Co. are now at Blomfield House, London-wall, E.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

The application for the discharge in bankruptcy of A. H. Crump, trading in London with S. G. Trehearne as Trehearne, Son and Crump, electrical engineers, &c., will be heard on 13th inst. at Bankruptcy Buildings, Carey-street, London, W.C.

It has been resolved to wind up the Western Canada Telephone Co. (Limited) voluntarily, and Mr. G. P. Norton, Huddersfield, has been appointed liquidator.

A second and final dividend of 2d. in the £ is announced in the matter of the London Metallurgical Co. (Limited) by the liquidator, Mr. Stewart Bogle, 91-93, Palmerston-buildings, London, E.C.

Catalogues.—Messrs. Babcock and Wilcox (Limited) have recently issued a new edition of their well-got-up catalogue, entitled "Steam." This production is really more than a catalogue, and includes a very practical treatise on steam production and the management of steam generating plant. The treatise, which is strongly bound, opens with an essay on "Economy and Safety in Steam Generation," the illustrations of which show various types and details of the Babcock-Wilcox water tube boiler, and the text of the essay takes the reader through the elements of thermo-dynamics and the theory of heat generators and engines, and also deals with two such practical matters as the best means of producing circulation and good dry steam economically. One of the best illustrations shows Babcock-Wilcox boilers installed in the electric shop at Portsmouth Dockyard working under a pressure of 350lb. to the square inch. Several illustrations of its various forms of the Babcock-Wilcox type of mechanical stoker are also shown. Messrs. Babcock and Wilcox (Limited) are doing engineers and steam users good service by offering copies of "Steam" free of cost.

Messrs. Polland and Co., of 5, St. Nicholas-buildings, Newcastle-on-Tyne, issue a useful sheet of electrical apparatus and accessories which they are importers of and agents for.

A price list and catalogue of "Svea" glow lamps reaches us from Messrs. J. C. Lyell and Co. An interesting introduction deals with the subject "How Electrical Glow Lamps are Manufactured," and is fully illustrated. The list is strong in high voltage lamps.

Messrs. A. Vandam and Co. forward a strongly-bound catalogue of electrical supplies. The catalogue is fully illustrated.

Scientific Apparatus Catalogue.—We have received from Messrs. John J. Griffin and Sons (Limited), 20-26, Sardinia-street, London, W.C., Part 3 of "Griffin's Illustrated and Descriptive Catalogue of Scientific Apparatus," for use in educational establishments. This is the eighth edition of Part 3, which is devoted to magnetism, electricity and galvanism, and comprises 180 large octavo pages, fully illustrated with every variety of apparatus for electro-technical laboratory and general experimental work. The lecturer on electricity and magnetism will find the catalogue indispensable, and the practical worker will also find his requirements catered for.

Railway Guide.—Health seekers and travellers generally will be interested in an illustrated guide and official list of hotels, boarding houses, seaside and farm house apartments, available throughout the extensive district covered by the London and South Western Railway Co. in the Thames Valley and in the south-west of England. Illustrations and text will lend additional attraction to the book, which will be published early in April next by Messrs. Spottiswoode and Co., the well-known London publishing house.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Nov. 23 to Nov. 29, with the ports of destination:—

Argentina—Buenos Ayres, £1,421. *Australasia*—Adelaide, £103 (telegraph material); Brisbane, £191 (including £101 telegraph material); Melbourne, £386 (including £364 telegraph material); Sydney, £1,097. *Belgium*—Antwerp, £35. *Brazil*—Rio Janeiro, £5,136 (telegraph material). *Canada*—Santos, £240 (including £165 telegraph material). *Ceylon*—Colombo, £105. *Chili*—Valparaiso, £1,186 (telegraph material). *China*—Shanghai, £110. *Denmark*—Copenhagen, £26. *Egypt*—Alexandria, £346 (including £150 telegraph cable). *Germany*—Hamburg, £110. *Holland*—Amsterdam, £80. *Hong Kong*—£171. *India*—Calcutta, £1,743. *Italy*—Venice, £230. *Japan*—Yokohama, £474. *Malta*—£30. *Norway*—Christiana, £280 (including £185 telegraph cable). *Russia*—Helsingfors, £20. *South Africa*—Durban, £201 (including £12 telegraph material); East London, £108; Port Elizabeth, £26. *Spain*—Malaga, £70. *Straits Settlements*—Singapore, £243. *Sweden*—Stockholm, £1,785 (including £85 telegraph material). *West Africa*—Senegal, 130 knots telegraph cable). Total, £15,962, against £8,573 in the corresponding week last year (Nov. 24 to Nov. 30).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Airdrie and Coatbridge Electric Tramways.—Having failed to obtain the sanction of the Board of Trade to the order of the Light Railway Commissioners for the construction of the Airdrie-Coatbridge electric tramway, the British Electric Traction Co. have now decided to promote a Parliamentary bill for powers to construct the line. The bill is backed by the Corporations of both Airdrie and Coatbridge.

Alleged Perjury.—John Limbrey Higgs, solicitor, Delahay-street, S.W., again appeared before Mr. Lushington at Bow-street on Tuesday, in answer to the charge of having committed wilful and corrupt perjury in the course of his examination in connection with the liquidation of the I.E.S. Accumulator Co. After evidence had been given by Mr. Ed. Mann, Mr. F. B. Harper and Mr. A. J. Schweder, the hearing was again adjourned.

Aylesbury.—A report from Mr. F. Hastings Medhurst, the Council's consulting engineer, recommending the erection of electricity supply works was discussed at a recent meeting. The total capital expenditure for a supply equivalent to 5,000 8 c.p. lamps is put at about £14,000. It has been decided to apply for a provisional order.

Brighton.—The Local Government Board have sanctioned a further loan of £56,300 for electric lighting purposes.

Costa Rica.—The main streets of San José are lighted by electricity.

The land telegraph lines of Costa Rica consist of 744 miles of lines, and there are 65 offices. Telegraph rates are very low. There is no submarine cable station nearer than San Juan del Sur in Nicaragua. There are 203 miles of telephone wires between the capital, San José and the outlying communities and plantations. The number of calls average about 2,500 daily.

Croydon.—The borough electrical engineer (Mr. T. H. Mitchell) is to report upon the question of extending the electric light mains to South Norwood.

Darwen.—The Corporation have decided to purchase the undertaking of the local tramways company for £48,500. A bill is being promoted by the Council for the construction of additional tramways, for the introduction of electric traction and for other powers. Mr. H. Graham Harris, as the Council's expert, has reported that the track is throughout suited for conversion to electric working.

Dundee.—The Town Council will apply to the Secretary of State for Scotland for power to borrow a further £50,000 for electricity supply purposes. The Tramways committee had a meeting on Wednesday to consider the most suitable form of traction for the local tramways. A communication was received from Prof. Kennedy declining the appointment of consulting engineer, and stating that the conduit system was still in a stage of experiment, and that it would be much cheaper to adopt the overhead system. The meeting concurred in this view, and decided to have plans prepared for the application of electric traction to the Perth-road tramways, and also to have a statement prepared regarding the construction of the new electrical route along Broughty Ferry-road. The preparation was entrusted to the electrical engineer (Mr. Walter H. Tittensor) and the burgh engineer, who are to submit reports as to estimated cost.

Earl's Colne (Essex).—A parish meeting has voted in favour of adopting the Lighting and Watching Acts. Electric lighting finds favour.

Educational.—Mr. E. H. Todd, a matriculated student at the South-Western Polytechnic Day College for Men, has been appointed to an open Exhibition in Physics and Chemistry, at Christ Church, Oxford, of the value of £80 per annum, tenable for four years.

Electricity "in Bulk."—The Council of the Association of Municipal Corporations have appointed a sub-committee to organise

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opposition to the General Power Distributing Co.'s Bill, and all similar schemes for the supply of electricity "in bulk."

Electric Cabs.—The Commissioner of Police, in his annual report, makes the following remarks on electric cabs :—

The vehicles are roomy, the interiors well fitted and the mechanism is well under the control of the driver. Experiments are, however, being made with a view to reduce their weight, &c. Should electric carriages come generally into use, the effect on the traffic of the metropolis will be marked, as such vehicles occupy but a little over one-half the space of that of a similar vehicle drawn by a horse. From a sanitary point of view also a diminution in the number of horses in the streets is a desideratum. The one-stage carriage, propelled by electricity, has not yet been put on the streets to ply for passengers.

Electric Launches.—The Thames Valley Launch Co. (Limited) recently despatched to Colombo, Ceylon, two specially-designed launch electric motors for use in boats which are to be built in Colombo. The full electrical equipment for the launches were included in the shipment. This firm report that they are sending out to the colonies and abroad complete sets of plant for erection into hulls built abroad.

Electrical Concessions in the Turkish Empire.—An imperial iradé has now been issued by the Sultan granting to Sir Ellis Ashmead-Bartlett a concession for the establishment, with a monopoly, of electric lighting systems in the towns of Salonica and Smyrna.

Electric Traction in Germany.—According to the Berlin correspondent of the *Economist*, last year there were built 453 miles of electric railways in Germany, France, Austria, Italy and England together, and of this amount Germany constructed about two-thirds.

Glasgow.—A lengthy memorandum was presented recently to the Tramways committee of the Glasgow Corporation by Mr. John Young, general manager, who has now been appointed to the London County Council Tramways Department. The report deals with conduit and overhead systems of electric traction, and refers at the commencement to the report of the deputation from the Tramways Committee in 1896 in favour of electric working of the town tramways. The main recommendation of that report was that an experimental line on the overhead system should be tried, and the Springburn route was selected. Overhead construction was proceeded with, and rosettes were used instead of side poles, showing the overhead system, as Mr. Young thinks, at about its best. It is only within the last two or three weeks that horse cars have been entirely displaced by electric cars on the Springburn route, and the power station plant has not even yet been completed so as to be taken off the hands of the contractors. The operating figures can, therefore, hardly be taken as normal. The results of the experiment as regards efficiency and economy are, however, described as very satisfactory. For the week ending 12th November ult., the total operating expenses for the electric route were, as near as may be, 6½d. per car mile, while the receipts amounted to 1s. 4½d. Mr. Young continues: "There can be no doubt electric traction does very appreciably increase the revenue. Apart from this consideration, important as it is, financial success is assured by the fact that, during the first full week of operating our small electric installation, working only at half its power, we can show a saving on working expenses, as compared with horse traction, of 2d. per car mile." It has been for a long time past a difficulty to cope with the increasing tramway traffic in Glasgow, but Mr. Young thinks it would be unfortunate at this time of day to propose to build more stables or horse cars :—"The only relief we can otherwise have, until a general scheme for electric traction has been adopted, is to electrically equip the route in continuation of High-street from Glasgow-cross to Govanhill, and across Coplaw-street to Coplaw-hill car works. An electrical connection between the car works and the power station at Springburn is absolutely necessary at any rate. It is calculated that the engines and dynamos now in the power station can operate this extension, and, of course, better results will be shown when full advantage is taken of the power plant. The question is, should this extension be on the overhead or underground system—or, rather, should we have a demonstration of the conduit system before finally discussing a complete scheme of electric traction for the city?" After dealing fully with the statement recently published of the experience with the conduit system in New York, Mr. Young says :—"The extra cost of the conduit system of traction can be better afforded now that electric power can be produced at what a few years ago would have been looked upon as merely a nominal addition to the cost per car mile run. Further, one system for the entire city would certainly be preferable. Otherwise there would be difficulty in determining where one system should end and another begin. To convert the whole track from Glasgow Cross to Dixon Halls for overhead traction would cost about £16,000; for overhead from Glasgow Cross to Rutherglen-road, and conduit beyond, about £27,000; and for conduit throughout, from head of Saltmarket, about £33,000. The overhead lines on Coplaw-street, and in car works and sheds would be about £4,000 additional. Even a small demonstration of the conduit system on this route would mean losing a considerable time in having it electrically operated. For my part (concludes Mr. Young) I should much prefer to have the direct line from the power station to the car works operated throughout on the one system, and to have this carried out at once. If it is desired to have a demonstration of the conduit system, what I would suggest is this :—Proceed at once to equip the Govanhill route, as proposed, on the overhead system throughout, and arrange to demonstrate the conduit system on the Dennistoun route from St. Vincent-place to the terminus. The current for this demonstration could easily be supplied from the present power station, *via* High-street, and the working costs kept quite separate. The Kelvinside cars could simply turn at St. Vincent-place, as in former times, and this would completely isolate the Dennistoun route for this purpose." This recommendation having been duly considered by the Tramways committee, that body decided, on Wednesday, to equip the Glasgow Cross to Govanhill line on the overhead trolley system, and to make an experiment with the conduit system in another part of the city.

Mr. A. R. Bennett has just presented a report to the Glasgow Corporation, in which he states that the estimate prepared by him for the Glasgow telephone inquiry of £100,000 for 5,200 subscribers and call offices actually working, besides 1,200 spare unfinished lines and 587 junction lines, may still be taken as correct. It was, he says, based upon the same type and quality of material as is used by the National Company, but in practice he would not recommend such a close adherence to the National Company's working as was assumed in the estimate for the purposes of comparison. As soon as the Municipal Exchange had 2,000 or 3,000 subscribers successfully talking, which stage should be reached within twelve months, he would expect that new orders would flow in very rapidly, and that by the end of three years the orders already executed and on hand would number 10,000, or, perhaps, 12,000. He would, therefore, recommend the adoption of double the number of lines contemplated, or 10,400 completed and 2,400 spares—12,800 in all—as a basis for the initial scheme, which he estimates at £200,000, or a rental of £6. 17s. 1d. per line. He estimates, however, that all the rental necessary would be £6. 1s., instead of £5. 5s. originally proposed. This 16s. on 10,400 lines would, in twelve years, produce £99,840, which, added to the £72,000 of sinking fund, would, apart from accumulations, amount to £171,840 in 1912. Thus only £28,160 would remain to be recovered by sale to the Post Office or sale of assets. The 16s., he suggests, should be a precautionary contribution to a sinking fund which may or may not be ultimately required, and could be made returnable to the subscriber in 1912 should the licence be extended, or should sale to the Post Office or realisation of assets render the sinking fund superfluous.

The supply of electric light to many private consumers in Glasgow has had to be curtailed. No further applications for Corporation current can be granted. Notice was, some time back, given to new applicants that current could only be supplied on condition that the Corporation could cut it off when it was found necessary. There are 110 consumers of this description, and it is not expected that these will receive full supply until the beginning of the year.

Greenock.—The burgh electrical engineer (Mr. S. E. Fedden) has been requested to report as to the advisability of purchasing the tramways within the burgh area, and also as to the cost of equipping the lines electrically.

Government Purchase of the Telephone.—We recently referred to a suggestion made by Mr. Edward Rae (speaking on behalf of the provincial Stock Exchanges) for the purchase by the Government of the National Telephone Co.'s undertaking. Mr. Rae has further written to *The Times* as follows :—

As a result of my letter of the 16th inst., I have received very many communications, without exception favourable to my proposal, and as the matter is likely to come before public associations for discussion, I am desirous to place the matter, if possible, in a more definite form. I think it is not too much to say that an almost universal feeling exists in favour of nationalisation. This may be attained by one of two courses—first, the absorption, or, secondly, the extermination, of the National Company's undertaking. I venture to think that the former is not only the most just, but also the more profitable course for the country. I think, however, that, before the question can with advantage be discussed further, the National Co.'s board should in fairness make known their views to the public and state

1. Whether they are prepared to negotiate with the Government upon the terms suggested, or upon what terms; and
2. Whether they can give an assurance that the earning possibilities of the Company are not over-estimated in the outline given below.

The purchase money of the National Co.'s system on the basis advocated in my last letter—namely, the average prices of the Company's securities for the three years ending June 30 last—would amount to £6,850,000;

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and this might be met either by unemployed funds in the hands of the Post Office, or by the issue of terminable annuities, or of £6,525,000 Two and a-Half per Cent. Consols at £105 per cent. The following figures, taken from the company's balance-sheets, show the gross receipts, working expenses and net receipts for the three years ended June 30, 1896, 1897 and 1898, and the average figures for the same period respectively:—

	1896.	1897.	1898.	Average.
Gross receipts.....	£853,416	... £916,931	... £1,046,468	... £938,938
Working expenses (excluding royalties.....	441,230	... 507,074	.. 581,736	... 510,013
Net receipts	£412,186	... £409,857	... £464,732	... £428,925

The sole tax upon these net receipts after a Government purchase being the interest charge, which I will take as £165,125 per annum, upon the purchase money, there would remain an average net result, inclusive of royalties, of £265,800 per annum. This annual result, excluding any allowance for the steady progressive increase in the Company's profits—namely, £31,000 per annum on the average of the three years—if placed to a sinking fund at 2½ per cent., would in the year 1911 amount to upwards of £4,000,000, or, including such progressive increase, to a sum exceeding £7,000,000, and even excluding the royalties from consideration as part of the Company's earnings, to a sum exceeding £5,500,000. I think the Post Office would be fortunate in securing the extinction of the Telephone Company's licence upon such terms.

The second course—that of harassing the National Company out of existence—can only be pursued at a serious loss to the public purse and an entire sacrifice of public convenience. I appeal to the ablest experts of the Post Office to say whether this is not so. The Company, it is to be feared, would have only too many facilities during the currency of the licence for thwarting and even paralysing the Post Office Department in their endeavour to supersede them by competition; and I repeat my belief that, of the two courses indicated, the country would prefer to seek a settlement with the National Company upon an equitable basis.

Hammersmith (London).—The number of applicants for electric current to date is 249, representing an equivalent of 19,464 8 c.p. lamps, and of these 190 (13,840 lamps) are connected.

Leatherhead.—The time for sending in tenders for taking over and working the District Council's provisional order has expired, but no tender has been submitted. The Electrical Power Distribution Co. intimate that they will establish large generating works in the neighbourhood and will be able to supply current at a lower rate than the Council itself can generate it. A committee is considering the matter.

Lectures.—The borough electrical engineer (Mr. R. C. Quin) lectured to the Blackpool Literary and Scientific Society last week on "Modern Applications of Electricity." The town clerk (Mr. T. Loftos), who presided, said that Blackpool was the first town in the kingdom to obtain statutory electric light powers, and it was satisfactory to know that the first installation was highly successful, and that the whole cost of it had been paid off. Blackpool was also a pioneer in electric traction, having been the first town to use it in England if not in the United Kingdom. Much of their success in electrical matters was due to Mr. Quin, who had had considerable experience in another well-known health resort. Mr. Quin's lecture treated of electricity as an illuminant, a cooking agent, a telephonic and telegraphic medium, in therapeutics, &c., and the lecturer was accorded a hearty vote of thanks at its termination.

Limerick.—The Town Council have decided to put their provisional order into force, and the Board of Trade have been requested to defer considering the revocation of the order until the election of the new Council.

Liverpool.—The city electrical engineer (Mr. A. Bromley Holmes) has been requested by the Tramways committee to consider and report as to the price to be charged for current supplied for lighting the tramcars.

London County Council.—At Tuesday's meeting loans of £10,490 to Hampstead Vestry for electric lighting purposes, and of £5,690 to Battersea Vestry, for extensions of the Vestry's electric lighting station, were approved.

The appointment of Mr. John Young, the popular manager of the Glasgow tramways, as chief officer of tramways at a salary of £1,500 a year (as announced in our last issue), was confirmed.

Madagascar.—Except a few French officials connected with the telegraph lines, there are no persons engaged in electrical work in Madagascar. A correspondent writing under date Oct. 31 bemoans this fact.

Manchester.—In a communication to the local press the city electrical engineer (Mr. C. H. Wordingham) states that Manchester, in common with other large towns, such as Edinburgh, &c., owning electricity supply works, is now feeling in an acute manner the effects of the dispute in the engineering trades last year. The check to production then given has caused an enormous conglomeration of work, and plant ordered is many months, and in some cases a year or more, overdue. The Electricity committee at Manchester have now on order two large generators, each of 2,500 H.P., and capable of supplying together 100,000 lamps. One of these was guaranteed to be running by October, 1897, the second by September, 1898, and neither of these is yet at work. In spite, therefore, of the foresight of the committee in ordering plant well ahead of the probable demand, they had no more plant capacity than in March, 1897, and the consequences were now being felt by their consumers. Further than this, 10 additional boilers, equivalent in steam-raising capacity to the number now fixed, are also much overdue, and they were thus doubly handicapped. For the last two evenings the pressure on the electric mains was as low as 87 volts on Monday for about an hour, and on Tuesday for about two hours. Everything that was possible to be done had been and was being done. The boilers were being forced to a very large extent, and the whole of the existing plant was greatly overloaded. It might be said that, having in view the inadequacy of the plant, new connections ought not to have been made. Consumers would remember that last winter the connection of new lamps was completely stopped from November, 1897, to February, 1898. Relying on the promises of contractors to complete their work, it appeared perfectly safe to take off this prohibition last spring, and the committee could not have foreseen that there could have been such an utter failure on the part of the manufacturers. Mr. Wordingham is confident that in about a fortnight they would have six new boilers and one of the new generators at work, and in the meantime he asks consumers to bear with the low pressure with as much patience as possible, remembering that every effort is being made on the part of the Electricity committee.

Manchester Improvements.—A deputation waited on Sir Courtenay Boyle, at the Board of Trade last week, to lay before him details of the Corporation's tramways bill. This bill gives Manchester power to lease lines from the Corporations of Salford, Oldham, Stockport, Ashton-under-Lyne, Stalybridge and Eccles, the District Council of Swinton and Pendlebury, and the urban districts between these places and Manchester, and to work them as one system. Authority is sought to utilise different kinds of motive power—electricity, oil, gas, steam, &c. The Corporation seeks a provision for the "postponement of payments to any sinking fund formed for the discharge of moneys borrowed or raised under the intended act, and for the payment of preliminary expenses and interest out of capital, for such period as may be prescribed by the intended act, or sanctioned by some public authority, and to make other provision in regard to the repayment of borrowed money." As it will be some time before the Corporation can obtain possession of the lines, and considerable expense must necessarily be incurred in the laying down of electric plant, purchase of cars, &c., the Corporation do not desire to burden the rates with any of these charges, and consequently wish, until the tramways begin to show an earning capacity for the Corporation, to pay interest and sinking fund charges out of capital. It will be seen that the Corporation wish for such powers as have as yet been granted to no other municipal body in the kingdom.

Niagara Power Co.'s Undertaking.—It is alleged that the Niagara Power Co. have broken the conditions of the agreement under which it was granted its lease. An agreement was made in May, 1892, with the Ontario Government and confirmed by 55 Vic, chap. 8. for the right to take the waters of the Niagara River in Queen Victoria Niagara Falls Park, for which an annual payment of $25,000 per annum for ten years was to be made by the company. The company was required to commence work before May 1, 1897, and to proceed at such speed that water connections for 25,000 H.P. would be completed and 10,000 H.P. ready for supply by Nov. 1, 1897. The company has, it is alleged, failed to carry out this part of its agreement, and the Governor in Council, acting under advice of the Attorney-General, has submitted to the High Court the following points:—(1) Is the agreement void by reason of the failure of the company to carry out its agreement with reference to the development of power? (2) May it be declared void? and (3) If the agreement with the company is not at an end, are the Government or Commissioners of the Park empowered to grant the right to take and use the waters of the Niagara River within the limits of the park?

Rangoon.—Mr. R. Hammond's report upon the establishment of electricity supply works has been submitted to the Municipal Council. Mr. Hammond recommends the laying of mains in the whole of the municipal area, and the total capital outlay involved is estimated at 1,267,367 rupees. The municipal engineer (Mr. Stirrat), however, advises the Council to commence by laying down a small plant, but to make provision for extensions. No decision has yet been come to.

Perth.—The station, shunting yard, &c., are to be lighted electrically. An independent steam plant is to be put down.

Redditch.—At a special meeting of the District Council, held to authorise the acceptance of a fresh tender for the supply of

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dynamos for their electricity works, it was stated that the original contractors (the United Ordnance and Engineering Co.) had gone into liquidation. Correspondence had taken place between their electrical engineer (Mr. McMullen) and the official receiver of the Company, who proposed to carry out the contract at an addition of £200 to the sum originally mentioned, and the committee were prepared to accept the contract at the increased price of £1,638, but as it transpired that the official receiver was not prepared to guarantee any time for delivery, a fresh tender was accepted from Messrs. Johnson and Phillips. (*See* under "Tenders Accepted.")

Speed of Electric Tram Cars.—At Dublin, last week, Sir F. Marindin concluded his inquiry into the application of the Dublin United Tramways Co. for permission to increase the speed of the electric cars between Dublin and Dalkey, *via* Blackrock and Kingston. A mass of evidence was given by residents and others in favour of the application, but opposition was made by the Car Owners' Association and the Dublin and Wicklow Railway Co.

St. Pancras.—At Wednesday's meeting of the Vestry, Dr. Walter Smith moved the report of the Electricity and Public Lighting Committee. The report recommended that the salary of Mr. A. E. Pycraft, chief clerk of the department, should be increased to £300 per annum. Dr. Smith said Mr. Pycraft thoroughly deserved the increase, but an amendment by Mr. Durant that the matter be referred to the Officers committee was adopted by 50 to 12 votes.

Stoke Newington (London).—The Vestry has been asked by the North Hackney Tradesmen's Association to request the Hackney Vestry when laying electric light mains on the east side of High-street to extend them to the west side, for the convenience of Stoke Newington ratepayers.

Telephone Municipalisation.—The Edinburgh Town Council have rescinded their recent resolution in favour of applying for parliamentary powers to establish and work a municipal telephone exchange.

At a meeting of the Common Council yesterday (Thursday) afternoon, Mr. Turner, in reply to Mr. A. C. Morton, said that the Corporation were about to call a conference at the Guildhall of the London Vestries and Local Authorities on the telephone question, and he hoped useful results would follow.

Twickenham.—Now that the Twickenham and Teddington Electric Supply Co. has decided to proceed with its application for a provisional order, the Joint Lighting committee of Twickenham and Teddington have decided upon a course of procedure. The Twickenham Council have unanimously adopted the report of the committee "that in the event of a favourable reply being received from the Board of Trade it is advisable that steps be taken to obtain a joint provisional order for Twickenham and Teddington with a view to proceeding with the electric lighting of the two parishes at an early date."

Walthamstow.—A Local Government Board inquiry has been held into the application of the District Council to borrow £36,490 for the erection of electricity supply works. The clerk (Mr. Gower), who appeared in support of the application, said that a provisional order was obtained in 1895, and there was no doubt a considerable demand for electric current in the district. Mr. J. Enright, the consulting engineer, submitted technical details.

Whitechapel (London).—The District Board of Works have applied to the London County Council for a loan of £25,000 for purchase of land in Osborn-street for a supply station and for the enlargement of the destructor works. Mr. Arthur Wright's report on the electric lighting is now under consideration by the Electric Lighting committee.

Whitehaven.—A Local Government Board inquiry has been held into the application of the Town Council to borrow £12,000 for electric lighting extensions. The Mayor (Mr. J. R. Musgrave) stated that additional electric lighting plant was absolutely necessary to meet the great demand. In 1894 the number of units consumed for public and private lighting was 158,201, and the equivalent number of 8 c.p. lamps was 2,962. In 1897 the figures were 184,176 and 6,081. The present plant was equal to the supply of 6,600 lamps, and they intended to put down additional plant equal to a total capacity of 10,800 lamps. There was no opposition.

Windsor.—The Town Council have decided to light three of the principal streets electrically.

Winsford.—A report from Mr. Wm. Beckett, of Manchester, recommending the erection of electricity supply works, has been discussed by the District Council. The initial cost of a smaller installation is put at £7,700, but a complete scheme for the district is estimated at £12,000. The Council will apply for a provisional order.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom all information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

November 7, 1898.

23,388. J. B. REINER. London. Improvements in and relating to electric arc lamps.

23,397. F. M. LEWIS and THE MUTUAL ELECTRIC TRUST (LIMITED). London. Improvements in enclosed arc lamps.*

23,408. W. B. SAYERS. London. Improvements in or relating to brush holders for dynamo electric machines.

23,411. L. L. HARTIRGSON. London. Improvements in the manufacture of electrical cables for submarine telegraph purposes.

23,420. L. J. STEELE, Sir J. B. MAPLE, Bart., M.P., and J. VERITY. London. Improvements in or connected with incandescence electric lamps.

23,430. W. P. THOMPSON. Liverpool. Improvements in electric controller mechanism primarily adapted for railway motors. (T. von Zweigbergk, United States.)*

23,433. C. VERNIER. London. Improvements in and relating to the construction and arrangement of electric arc lamp cut-outs.

23,436. E. BILHARZ. London. Improved method of attaching the holders of electric incandescent lamps to their bulbs. (Date applied for under Patents, &c., Act, 1883. Sec. 105. June 10, 1898, being date of application in France.)

November 8, 1898.

23,462. G. W. BELL and E. R. ROYSTON. Liverpool. Improvements in or connected with street electric tramways and railways.

23,481. J. BASTICK. Leeds. Improvements in or relating to electric furnaces for the production of calcium carbide.

23,497. W. H. MERRIMAN. Birmingham. Improvements in and connected with electrical tramways, and in the transmission of electricity to the car or vehicles.

23,503. H. H. LAKE. London. Improvements in devices for controlling the operation of electric motors. (H. S., United States.)*

23,510. H. H. LAKE. London. Improvements in insulators for incandescence electric lamps. (A. H. Spencer, United States.)

23,529. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in a method and system for generating and distributing electric energy. (C. M. Green, United States.)*

23,530. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in a method and system for generating and distributing electric energy. (C. M. Green, United States.)*

23,531. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in a method and system for generating and distributing electric energy. (C. M. Green, United States.)*

23,532. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in electric brakes for electric railway cars and other electrically operated mechanisms. (F. E. Case, United States.)*

23,533. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in electric arc lamps. (C. E. Hartham, United States.)*

23,534. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in governors for air compressors driven by electric or other motors. (S. H. Libby and W. B. Potter, United States.)*

23,541. H. LEITNER. London. Improvements in apparatus for controlling electric motors.

23,545. O. P. NAUHARDT. London. Process for obtaining an electrolytic deposit of metallic films on aluminium.*

November 9, 1898.

23,593. H. CHAPMAN. Sheffield. Continuous to alternating electric current transformers.

23,597. J. W. SMITH and W. EVANS. Birmingham. Improvements in apparatus for the electro-deposition of metals.

November 10, 1898.

23,659. D. ROBERTSON, Jun. Glasgow. Improvements in and relating to the electrical propulsion of tramway cars, railway carriages and the like.

23,662. J. H. TUCKER. Birmingham. Improvements in electrical switches.

23,699. R. P. STRACHAN. London. Improvements in and relating to trolleys and trolley-poles used in overhead systems of electric propulsion.

23,716. R. HADDAU. London. Improvements in or relating to secondary or storage batteries. (G. J. Miller, United States.)*

November 11, 1898.

23,728. J. J. BROOKE and F. W. ALLEN. Manchester. Improvements in or connected with incandescent electric lamps.

23,750. S. G. BROWN. Bournemouth. Improvements in electro-dynamic relays for use on telephones and telegraph lines.

23,753. J. A. FLEMING. London. Improvements in electrical measuring instruments called potentiometers.

23,768. A. P. WEIGHT. London. Improvements in rails with cable for electric traction.

23,820. J. TUMA and M. R. KALDEGG. London. Improvements in apparatus for measuring the phase of alternating currents.*

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SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1897.

17,161. HARGREAVES. Means applicable for use in the electrolysis of salts.
21,178. HARGREAVES. Treatment of solutions of carbonatos of soda resulting from electrolysis of chloride of sodium, and in apparatus applicable for use therein.
23,681. MARTINEZ. Mechanism for operating or controlling electric motors at a distance.
24,417. BARKER. Electrical and other recording instruments.
24,833. ROUTIN and BROWN. Electricity meters.
25,076. HANDCOCK and DYKES. Electrical propulsion of barges and boats on canals and rivers.
26,680. TRIBELHORN. Electrical accumulators or storage batteries.
27,598. BYNG. Electrical fusible Cut-outs.
29,235. MOORES and FARRELL. Electrical switches.

1898.

58. BABSCHALL. Rail joints for electric railways.
156. BLACKBURN and WHITE. Method of fixing and suspending bare electric conductors.
13,861. HEYS. (Dumoulin.) Electro deposition of copper and other metals on rotary cathodes.
16,659. HILBERG. Electrolytic process for extracting metals from their halogen combinations.
16,717. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). (Case.) Trolleys for electric railways.
17,598. BOULT. (Busson.) Primary electric batteries.
18,807. WINTON. Electric sparkers for explosion engines..
18,975. TAYLOR. Electric high and low-tension fuse head for blasting, mining and the like purposes.

COMPANIES' MEETINGS AND REPORTS.

British Electric Traction Company (Limited).

An extraordinary general meeting of the members of this Company was held yesterday (Thursday), at Donington House, Norfolk-street, London, W.C., under the presidency of Sir CHARLES RIVERS WILSON, G.C.M.G., C.B.

The SECRETARY (Mr. Geo. Stevens) read the notice convening the meeting.

The CHAIRMAN said: We have called you together to meet the requirements of the Light Railways Act, which in this respect follows the procedure of the ordinary Railways Acts in requiring that the approval of the shareholders should be signified to any applications to Parliament, and for this purpose a special meeting (called a Wharncliffe meeting) must be called. We are met to pass a series of resolutions approving the drafts of several Light Railway Orders which are in process of being promoted by the Company; these are the Light Railway Orders for Merthyr Tydvil, Kinver, Poole and district, South Staffordshire, Doncaster and district, Barnsley and district, Middleton extensions, Colchester, Spen Valley, and Dudley and district (extension). We believe this Merthyr undertaking will be a very satisfactory one, as we not only propose to carry out a light railway or tramway scheme, but to combine with it the business of supplying electricity for lighting and other purposes, and the local authorities have already approved our scheme. The Kinver Order is for an extension of the large scheme of tramways and light railways, which we have been working up in the South Staffordshire district. We are amalgamating a number of tramways which have been working by steam or horse power, and we are making extensions and junctions, and propose to work the whole of the undertakings by electricity on a uniform system, to the great benefit of the districts, and we believe to the benefit of the shareholders in this Company. The Kinver extension will, we think, be especially appreciated because it will extend the tramways of South Staffordshire. The Poole and District Order has also already been approved by the Light Railway Commissioners. The South Staffordshire Order is for making extensions in connection with the scheme I have already referred to. The Doncaster, Barnsley, Colchester and Spen Valley projects are new schemes, which we hope to be able to carry through. The Middleton Order is an extension of that Middleton Order which we have already secured. The Dudley and District Order is for an extension of a light railway which has already been sanctioned by the Board of Trade. The Directors are satisfied that all these Orders, if secured, will bring good business to the Company. As it will probably be three months before the accounts for the year and the General Report of the Directors will be in your hands, I may (although there can be no other business transacted at this meeting than that of which notice has been given) be permitted to say that the general position of the Company is highly satisfactory. The business which the Company is developing is a very large one, and I believe that, when the accounts and Report for the year are before you, you will have every reason to be satisfied with the progress we have made. With regard to profits, as the accounts for the year will not be made up until after the end of December, I cannot yet put any very definite figures before you. I have no doubt that the Directors will be in a position to recommend the payment of a dividend, but you must excuse me if I do not at present indicate what that dividend is likely to be. We are building up a very extensive business, which will require from time to time large amounts of capital; in fact, the larger the capital judiciously expended in the business, the better the results will be for the original shareholders. But in order to carry out this policy, it is important that we should strengthen the position of the Company so that there may be the fullest security for the Debenture holders and Preference shareholders, and the Directors feel that in the best interests of the Company we should work for this object instead of striving to make the largest possible distributions in the form of dividends. Turning to another subject, I need not say that a company working up so extensive and complicated a business has necessarily had many difficulties to overcome. Our negotiations with local authorities have in some instances given us cause for disappointment, and the delays in completing some of our undertakings have been greater than we would like; but on the whole, as I have stated, we have cause to be satisfied with the progress which has been made. I have mentioned to you to-day a certain number of undertakings for which we are asking for powers, but although these are numerous, they are in addition to a very large number of schemes which have already been mentioned to you, and which are already in progress. I will now ask you to express your approval of the resolutions which have been read to you.

Resolutions approving the proposed applications for Orders for Merthyr Tydvil, Kinver, Poole and district, South Staffordshire, Doncaster and district, Barnsley and district, Middleton, Colchester, Spen Valley and Dudley and district were then put to the meeting *seriatim* and approved unanimously.

A SHAREHOLDER: Are there any competitors in this kind of business?

The CHAIRMAN: Yes; there is great competition, but if it were not for this unfortunate disposition on the part of the local authorities to municipalise there would be room for all. Unless municipalities obtain special powers they cannot go outside their own boundaries, but there has been a disposition—at least, on the part of one corporation—to go outside their boundaries. There is that disadvantage we shall have to cope with.

Mr. GARCKE: There will be several Bills before the next session of Parliament which will formally raise the question.

The proceedings then terminated.

London Electrical Cab Co. (Limited).

The Directors of this company have issued their report and accounts for the period from Aug. 20, 1897, to July 31, 1898. The report is as follows:—

The Directors regret the profit and loss account shows a debit balance of £6,207. 15s. 6d. Although the company was incorporated on Nov. 12, 1896, they were unable to run any cabs at all until Aug. 20, 1897, and so were without any means of earning profit, and since the latter date only a very limited number have been on the streets, whereas the whole of the standing charges have continued during that time. The cost of purchasing electricity proved so excessive that the Directors decided to lay down a complete manufacturing plant; this plant is now working, and enormously reduces the cost of electric current. The maintenance of the accumulators and the cost of renewals of rubber tyres have also caused much anxiety and expense, but different arrangements are on the point of being completed which will place these matters on a much more satisfactory basis. The Directors purpose shortly making an issue of £12,000 in Five per Cent. Debentures, which (together with the final call on the recent issue) will, it is believed, be ample to pay all liabilities after the premises, new plant, stock, &c., have been put in thorough working order, and also to provide sufficient working capital.

At the meeting of shareholders on Dec. 5 the chairman will speak very fully as to the past, present and future workings of the business; also as to the policy of the Directors and the position of the company generally; and the works will be open to the inspection of shareholders after the meeting.

NEW COMPANIES, STATUTORY RETURNS, &c.

W. C. BERSEY AND CO. (LIMITED).—This company was registered on Nov. 28 with a capital of £5,000, in £1 shares, to acquire as a going concern the business now carried on by Walter C. Bersey, George E. Thompson, and Charles G. W. Bromfield at 39, Victoria-street, Westminster, and to carry on the business of consulting, mechanical, electrical and general engineers, suppliers of electricity, &c. The first subscribers are: Walter C. Bersey (consulting engineer), G. E. Thompson, C. G. T. Bromfield (engineer), C. Davis, L. H. Hoile, W. J. Wood and Frederick T. Bersey The first Directors are: Walter C. Bersey, G. E. Thompson, Charles G. T. Bromfield and Charles Davis.

NEW ELECTRO-CHEMICAL MANUFACTURERS' ASSOCIATION (LIMITED).—This company was registered on Nov. 22 with a capital of £2,000, in £1 shares, to carry on the business of electricians, electrical, mechanical, metallurgical and chemical engineers, suppliers of electricity, electro-platers, chemical manufacturers, &c. The first subscribers (each with one share) are: Miss E. M. Linstead, A. T. Poole, Miss F. E. Hester, G. H. Humphreys, L. Schramm (electrical engineer), J. Phillips (electrician), and H. E. Matthews.

SOUTH AMERICAN ELECTRIC CO. LIMITED.—This company was registered on Nov. 23 with a capital of £100,000, in £10 shares, to enter into an agreement with the General Electric Co. (U.S.A.) and Charles Bright, to promote and facilitate the development of undertakings for electric lighting, electric power supply, electric communication, and other industrial purposes connected with electricity, and to undertake and carry on mercantile, commercial, trading and financial business of all kinds. The first subscribers (each with one share) are: Charles Bright (engineer), C. H. Bennett, J. Oliver, R. G. Fudge, S. C. Lewis, J. J. Scott, and T. Large.

UNGARISCHE ACCUMULATOREN GESELLSCHAFT.—This company has been formed in Budapest, with a capital of 1,000,000 kroner (about £330,000), for the purpose of acquiring the rights of the Julien accumulator.

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BRUSH ELECTRICAL ENGINEERING COMPANY (LIMITED).—The annual return to Sept. 26, has been filed. The capital is £660,000, divided into 180,000 Ordinary and 150,000 Preference shares of £2 each. 90,000 of each class have been taken up, and the full amount called.

TELEGRAPH MANUFACTURING COMPANY (LIMITED).—The statutory return, to Oct. 12, has been filed. The capital is £200,000, divided into 20,000 Preference and 20,000 Ordinary shares of £5 each. All of these have been taken up, and 6,600 of each class have been issued as fully paid. £3 per share has been called on the remainder.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Oct. 13, 1898). Price of silver 27 7/16d. per oz. (Dec. 1). Consols (2¾ per cent.) 110—110¼ for money, 110¼—110⅜ for account; 2½ per cent. 104⅛—105⅛ (Dec. 1), Stock Exchange Settling Days: Stocks and Shares Continuation Days, Dec. 13 and 28; Ticket Days, Dec. 14 and 29; Pay Days, Dec. 15 and 30; Mining Share Carry-over Days, Dec. 12 and 27.

COMPAGNIE CENTRALE D'ELECTRICITE DE MOSCOU.—This company proposes to increase its capital from 1½ million to 10 million francs, in order to establish electricity works in various towns in Russia. The new capital will be subscribed in Paris and Brussels.

DOULTON AND CO.—It is reported that the famous pottery business of Messrs. Doulton and Co. is about to be turned into a limited liability company. The death of Sir Henry Doulton involved the withdrawal of portion of the capital, and hence the flotation. The capital of the new concern is said to be £1,100,000; but only Debentures and Preference shares will be offered to the public, Mr. Henry Doulton taking the £400,000 ordinary shares in part payment of the purchase price. The business was established nearly a century ago, and the firm have extensive works and office premises on the Albert Embankment, London, and at Rowley Regis, Burslem, St. Helens, Birmingham and Paris.

ELECTRIC AND GENERAL INVESTMENT CO. (LIMITED).—The Directors of this company have declared an interim dividend of 10 per cent. on the capital paid up on the Ordinary shares, being 2s. per share, less tax. The dividend is for the six months to Nov. 30, and is payable on the 15th inst.

ELECTRIC CONSTRUCTION CO. (LIMITED).—A drawing of the Six per Cent. Second Mortgage Debenntres of this company, to be paid on Jan. 1, will take place at the offices of the Electric and General Investment Co., 1 and 2, Great Winchester-street, E.C., on Dec. 5.

ELECTRICITY SUPPLY CO. FOR SPAIN (LIMITED).—The remaining 100 5 per cent. prior lien bonds of £100 each of this Company will be paid off at par at College Hill-chambers, E.C., on and after Jan. 1.

HOWELL'S SIMPLEX ANTI-INDUCTIVE TELEPHONE SYNDICATE (LIMITED).—A meeting (statutory) of this company was held on Tuesday, at 55, Bishopsgate-street, E.C. The proceedings were private.

STOCK EXCHANGE NOTICE.—Application has been made to the Stock Exchange committee to allow the further issue of £414,526 sterling Four per cent. 500 Year Debenture stock of the Commercial Cable Co. to be quoted in the official list.

WESTERN AND BRAZILIAN TELEGRAPH CO. (LIMITED).—This company's traffic receipts for the week ended Nov. 25 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Co., Limited) were £3,140.

WESTERN UNION TELEGRAPH CO.—The annual report of the president of this company for the year ended June 30 last, presented at the annual meeting of stockholders on Oct. 12, 1898, states that the capital stock outstanding is $97,370,000.00, of which $28,850.35 belongs to and is in the treasury of the company, thus showing no change during the year. The bonded debt at the close of the year was as follows:—

Bonds due Mar. 1, 1900, 6 per cent.	$771,282 00
Bonds due May 1, 1900, 7 per cent.	4,920,000 00
Bonds due May 1, 1902, 7 per cent.	1,163,000 00
Bonds due Jan. 1, 1938, 5 per cent.	8,502,000 00
	$15,356,282 00
Less balance of sinking funds appropriations	497,406 48
	$14,858,875 52

During the year £2,000 sterling bonds (due March 1, 1900) were redeemed, and $14,000 of 5 per cent. collateral trust bonds (due Jan. 1, 1938) were issued in exchange for capital stock of the Gold and Stock Telegraph Co., upon which interest was being paid at the rate of 6 per cent. per annum. The total expenses for the year under review were $17,825,581.52. The surplus on July 1, 1897, was $7,647,541.06, and the profits to June 30, 1898, were (after deducting expenses as above) $6,090,151.26, a total of $13,737,692.32; from which there was applied for dividends $4,867,911.25, interest on bonds $896,554.95, sinking funds appropriations $9,991.00 (equal $5,774,457.20), leaving a surplus on June 30, 1898, of $7,963,235.12. There was a decrease during the year of 767 miles of poles, and an increase of 33,418 miles of wire, and of 441 offices. The number of messages transmitted was 4,022,065 more, and the revenue was $1,276,873.62 more than for the preceding year. The amount paid for taxes was $123,980.47 less, because of the settlement during the preceding year of disputed accounts with several States, but was still $144,033.50 more than was paid during the fiscal year 1896. The net increase in expenses for the year was $918,925.49. The average tolls received were 30.1c. per message, the average cost per message 24.7c. The decrease in the average tolls received, and the increase in the average cost per message, are accounted for by the large number of government and press messages, conseqnent upon the war with Spain, transmitted during the latter part of the fiscal year, on both of which classes of messages the tolls are the lowest, although the highest grade of operating service has to be employed for their efficient transmission. The surplus account was increased $315,694.06.

WEST INDIA AND PANAMA TELEGRAPH CO. (LIMITED).—The transfer books of this company are closed until the 14th inst.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
*Birmingham Tramways.	Nov. 26	3,491	+ 324	...	...	...
Blackpool Corporation...	—	—	—	—	—	—
Blackpool and Fleetwood Co.	„ 26	139	...	20	13,706	...
*Bristol Trams & Carriage	„ 25	2,455	+ 115	21	64,172	+ 7,639
City & South London Ry.	„ 27	1,114	- 54	22	21,519	+ 734
Dover Corporation	„ 26	133	+ 48	34	6,435	...
Dublin United (Southern)	—	—	—	—	—	—
Liverpool Overhead Rly.	„ 27	1,317	+ 60	22	34,355	+ 3,059
*Sheffield Tramways.....	„ 27	1,020	+ 113	47	47,741	+ 1,719
*South Staffs. Trams.....	„ 25	560	+ 15	47	29,739	- 124

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Nov. 23.		Price Wednesday, Nov. 30.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Week Ending Nov. 30.	
			ELECTRICITY SUPPLY COMPANIES.					£ s. d.		Highest	Lowest
6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	10½	10⅝	10½	10⅝	—	—	0 7/16	..
6,000	10	4/3 5/16	Do. 4½ per Cent. Cumulative Pref.	10⅝	11¼	10⅝	11¼	4 0 0	—	..	—
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp. ..	11⅛	12⅛	11⅛	12⅛	2 16 0	February & August	..	..
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6⅛	6	6⅛	3 9 3	" "	6 7/16	6⅛
£24,000	5	2/6	Chelsea Electricity Supply Ordinary	8	9	8	9	3 6 8	March	8½	..
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	114	116	114	116	3 18 11	June and December	—	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red)	103	105	103	105	4 15 8	.. ..	..	..
50,000	10	5/0	City of London Elec. Lighting Ord. 40,001 to 90,000	24	25	24	25	5 0 0	February & August	24⅛	24½
10,000	10	1/9	Do. Ordinary 90,001 to 100,000	23½	24½	23½	24½	..	..	24 7/16	..
40,000	10	6%	Do. 6% Cumulative Pref.	16½	16⅝	16½	16⅝	3 11 9	January and July ..	..	..
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	127	131	127	132	3 16 1	June and December	..	..
30,000	10	..	County of London & Brush Prov. Ord. (fully paid)	12½	13½	12½	13⅛	—	—	13	—
10,000	10	..	Do. (£8 paid)	10	11	10	11	..	..	..	..
20,000	10	6/0	Do. 6% Cumulative Preference	14½	15⅛	14½	15⅛	4 0 0	March & September	14 15/16	..
15,660	5	2/6	House-to-House Electric Lighting Supply Ord.	9	10	9	10	2 0 0	.. ..	9⅛	..
12,000	5	3/6	Do. 7 per Cent. Preference	9½	10½	9½	10½	3 6 8	March & September	..	..
15,000	5	10%	Kensington and Knightsbridge Ord.	13	14	13	14	3 18 7	.. ..	..	..
10,000	5	6%	Do. 6% 1st Pref.	7⅞	8½	7⅞	8½	3 12 9	January and July ..	..	..
110,000	3	..	London Electric Supply Ordinary	3⅝	4	3⅝	4	—	—	..	..
48,050	5	..	Do. Preference	6	6½	6	6½	—	—	6 7/16	6⅝
82,400	10	5/0	Metropolitan Electric Supply Ordinary	16½	17½	16½	17½	3 8 7	April and October ..	17 5/16	17
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	121	117	121	3 14 9	June and December	119	118½
6,452	10	6/0	Notting Hill Electric Ordinary	15½	16½	15½	16½	3 12 9	March	16	..
£75,000	1	—	Rand Electric	⅞	1⅛	⅞	1⅛	—	—	—	—
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb	88	93	88	93	5 8 1	—	—	—
150,000	$100	$2	Royal Electric Company of Montreal Shares ...	155	160	155	160	5 0 0	—	..	—
130,900	100	4½%	* Do. 4½% 1st Mort. Debs.	104	106	104	106	4 5 0	April and October	..	..
31,980	5	5/0	St. James and Pall Mall Electric Ordinary	16½	17½	16½	17½	4 11 5	February & August	17⅝	17½
20,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	" "	9 7/16	—
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.)	105	108	105	108	3 15 6	June and December	..	—
65,000	5	..	South London Electric Supply Ordinary (£3 paid).	2⅞	3⅛	2⅞	3⅛	..	..	2 1/8	..
79,900	5	5/0	Westminster Electric Supply Ordinary	16	17	16	17	3 16 6	March & September	16⅝	16 7/16
18,848	5	5%	Yorkshire House-to-House	7¾	8	7¾	8	3 2 6	February and July ..	—	—
18,636	5	5%	Do. (£4 paid)	5¾	6⅛	5¾	6⅛	3 18 5	February and July ..	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Nov. 23.		Price Wednesday, Nov. 30.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 30.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS								
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	104	105	101	105	3 17 0	January and July	..	..
25,000	10	..	Amazon Telegraph	3	4	3	4	—	—	—	—
£125,000	100	5%	Do. 5 per Cent. Debentures	92	95	92	95	5 5 3	—	—	—
£905,560	Stock	15/0	Anglo-American	63	66	64	67	4 10 5	Feb., May, Aug., Nov.	—	—
£3,047,220	Stock	30/0	Do. Preferred	114	115	114½	115½	5 4 7	" "	115½	114⅞
£3,047,220	Stock	..	Do. Deferred	15½	15⅝	16	16½	—	—	16⅝	15⅜
130,000	10	5/0	Brazilian Submarine	15½	15⅝	15½	15⅝	4 15 3	Mar., June, Oct., Dec.	15⅝	—
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	111	115	111	115	4 8 0	June and December	..	..
10,000,000	$100	$12½	Commercial Cable Capital Stock	180	190	180	190	4 4 3	Jan., Apr., July, Oct.	..	..
£918,297	Stock	4%	* Do. 4 per Cent. Debenture Stock	104	106	104	106	3 15 6	" "	105½	104½
16,000	10	8/0	Cuba Submarine Ordinary (Deferred) xd	10½	11½	10	11	6 7 3	February and August	10⅛	..
6,000	10	10/0	Do. Preference 10 per Cent. xd	17	18	16½	17½	5 14 3	" "	—	..
12,981	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October	4⅝	—
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	..	—
£30,000	50	4½%	Do. 4½ per Cent. Debentures	104⅞	107⅞	105⅞	108⅞	4 5 0	January and July	—	—
60,710	20	3/0	Direct United States Cable	11½	12	11⅜	12	5 8 4	Jan., Apr., July, Oct.	—	..
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	102	105	103	106	4 6 8	..	..	—
£4,000,000	Stock	..	Eastern Ordinary	172	176	172	177	3 19 2	Jan., Apr., July, Oct.	174	..
£1,295,000	Stock	17/6	Do. 8% per Cent. Pref. Stock	104	107	104	107	3 5 5	" "	105⅝	104½
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	124	123	124	128	3 2 6	May and November	127	126
£89,900	100	5%	* Do. 5 per Cent. Debentures, 1893	101	104	101	104	4 17 0	February & August	..	..
£500,000	Stock	8/9	Do. Provisional Certificates 50% paid	53	56	53	56	..	..	—	..
250,000	10	2/6	Eastern Extension	17½	17⅝	17⅛	17⅝	3 18 11	Jan., Apr., July, Oct.	17⅝	—
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	129	125	129	3 2 4	February & August	—	..
£16,200	100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900 (reg.)	100	104	101	105	4 17 1	January and July	..	..
£64,400	100	5%	Do. (Bearer)	101	104	102	105	4 17 1	" "	—	..
£35,100	100	5%	*Eastern and S. African 5 p. c. Mor. Deb., 1900 (reg.)	100	104	101	105	4 17 1	" "	—	..
£46,500	100	5%	Do, (Bearer)	101	104	102	105	4 17 1	" "	—	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102	105	103	106	3 16 4	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	102⅞	105⅞	103⅞	103⅞	3 15 9	May and November	..	..
180,227	10	1/9	Globe Telegraph and Trust	12½	12⅝	12½	12⅝	4 0 9	Jan., Apr., July, Oct	12⅝	12½
180,042	10	6%	Do. 6 per Cent. Preference	16½	17	16½	17	3 10 7	" "	17	16⅝
150,000	10	5/0	Great Northern of Copenhagen	28½	29½	28½	29½	3 7 10	January, April, July	..	—
£150,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B"	100	103	100	103	4 17 10	March & September	101½	—
£97,800	100	4½%	Halifax and Bermuda Cable 4½% 1st Mort. Deb. (red)	101	104	101	104	4 7 0	June and December	..	—
17,000	25	12/6	Indo-European	54	57	54	55	4 10 11	May and November	..	—
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	109	112	109	112	5 7 7	March & September	..	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red)	105	108	105	108	3 14 3	June and December	—	—
11,889	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October	—	—
3,381	£100 Cert.	6%	Submarine Cables Trust	133	138	133	138	4 6 11	" "	..	—
15,609	10	—	West African Telegraph	—	—	..	..	..	..	—	—
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	4 18 0	March & September	—	—
80,008	2½	..	West Coast of America	½	⅝	½	⅝	..	..	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	103	106	103	106	3 16 6	June and December	..	—
88,321	10	0/6	West India and Panama	1⅛	1⅜	1⅛	1⅜	—	May and November	1⅛	1⅛
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½	10	9½	10	6 0 0	" "	10	9½
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7	9	7	9	6 13 4	" "	7⅞	—
£80,000	100	5%	* Do. 5 per Cent. Debentures	106	109	106	109	4 12 10	January and July	..	—
64,269	15	5/0	Western and Brazilian Ordinary xd	12½	12⅝	12½	12⅝	4 13 2	May and November	..	—
33,129	7½	3/9	Do. 5 per Cent. Preferred Ordinary xd	8	8½	8	8½	4 8 2	" "	..	—
33,129	7½	1/3	Do. Deferred Ordinary xd	4	4½	4	4½	—	" "	..	—
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	107	110	107	110	3 13 1	June and December	..	—
1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	..	..	—	—	6 7 10	Feb., May, Aug., Nov.	—	—
£158,100	100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	98	103	93	103	5 16 6	March & September	—	—
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	2⅜	3½	2⅜	3½	6 8 1	August	—	—
224,850	10/0	1¼d.	Consolidated Telephone Const. & Manufacturing	1/16	1/8	1/16	1/8	6 7 0	July	—	—
28,000	5	4/0	Monte Video Telephone 6 per Cent. Preference	..	—	—	—	7 5 6	October	—	—
484,597	5	3/0	National	5⅜	5⅝	5½	5⅝	5 4 4	February & August	5⅝	5⅝
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	12	14	12	14	4 5 9	" "	13⅜	—
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	12	14	12	14	4 5 9	" "	13⅜	—
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	5½	5⅝	5½	5⅝	4 10 11	" "	5⅝	5 1/16
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	100	103	100	103	3 6 8	June and December	102½	101
171,504	1	0/4	Oriental	⅜	½	⅜	½	6 13 4	April and October	—	—
58,000	5	6/0	United River Plate	4½	4⅝	4½	4⅝	6 6 5	July	4⅝	—
£151,753	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	106	103	106	4 14 4	June and December	106	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	2	1/2⅜	Brush Electrical Engineering	1⅜	2	1⅜	2	3 0 0	—	1⅜	—
90,000	2	1/2⅜	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	—	2 1/16	2⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	111	115	111	115	3 19 0	February & August	111½	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102	105	104	105	4 7 0	June and December	..	..
£20,000	5	5/0	Callender's Cable Construction	9½	10½	9½	10½	6 8 7	" "	..	—
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	110	113	111	114	4 0 4	November and May	..	..
300,000	1	9/8	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	—	1½	—
50,000	1	..	Chadburn's Ship Telegraph Ordinary	1⅛	1⅜	1⅛	1⅜	—	—	1 1/16	..
50,000	1	7½	Do. 6 per Cent. Cumulative Pref.	1	1⅛	1	1⅛	4 16 0	—	1 1/16	—
32,098	3	..	Crompton and Co. (Nos. 1 to 32,098)	1½	2	1½	2	..	..	—	—
£82,850	100	5%	* Do. 5% First Mort. Deb. (red.)	91	96	91	96	5 5 10	January and July	—	—
99,261	5	2/1½	Edison and Swan United ("A" Shares) (£3 paid)	2	2⅛	2	2½	7 4 0	February & August	..	—
17,139	5	3/1½	Do. (£5 paid)	4	5	4	5	6 0 0	" "	..	—
£194,023	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	99	101	99	101	4 0 5	June and December	..	—
17,400	5	5%	Edmundson's Electric Corporation Ord (fully paid)	5	5½	5	5½	4 10 11	Half-yearly	6 1/16	—
110,000	2	1/2⅜	Electric Construction Co. (Limited)	2⅛	2⅜	2⅛	2⅜	4 12 0	February & August	2⅜	2⅛
25,000	2	2/2⅜	Do. 7 per Cent. Cumulative Pref.	2⅜	3⅛	2⅜	3⅛	4 6 2	August	3 1/16	3
£111,100	Stock	4%	Do. 4% First Mortgage Deb. (red.)	105	107	105	107	3 16 2	—	—	—
91,196	1	..	Elmore's Patent Copper Depositing	⅛	⅜	⅛	⅜	..	..	—	—
12,500	10	8/0	Henley's Telegraph Works Ordinary	20	21	20	21	6 8 10	February & August	21⅜	20½
8,000	10	7/0	Do. 7 per Cent. Preference	18	19	18	19	3 13 8	" "	..	—
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 8	" "	..	—
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	22	23	21½	22½	4 8 11	" "	22	—
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	102	106	102	106	3 15 6	March & September	—	—
£7,350	12	1/0	Telegraph Construction and Maintenance	37	41	37	41	4 6 2	March and July	40	39½
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	104	107	104	107	4 14 9	January and July	—	—
£70,000	5	4/0	Willans and Robinson Ordinary	7⅜	8½	7⅜	8½	4 17 0	April and October	—	—
£30,000	5	8/0	Do. 6% Cumulative Preference	6⅜	7½	6⅜	7½	4 2 9	" "	7 1/16	7⅛
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	108	110	106	108	4 0 5	May and November	—	—
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	..	Blackpool and Fleetwood Tramways	16½	17½	17	18	..	—	18½	17½
25,000	10	6%	Bristol Tramways and Carriage	21⅛	22	21½	22	2 14 7	—	—	—
25,000	10	6%	Do. (£7. 10s. paid)	18⅜	18⅞	18⅜	18⅞	1 14 1	—	—	—
£90,410	Stock	4%	Do. 4% Debenture	121	123	121	123	3 5 1	—	—	—
80,000	10	..	British Electric Traction Ordinary	15½	16½	16	17	..	—	18½	16½
10,000	10	2/4 7/16	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm.pd.)	12½	13½	12½	13½	4 8 11	—	13⅜	13½
£35,250	10	5/0	Central London Ordinary	10	10½	9⅞	10½	2 18 6	June and December	10½	10
178,303	10	1/9⅜	Do. (£6 paid)	5⅜	6½	5⅜	6½	2 16 6	" "	6⅜	..
£630,000	Stock	2½%	City and South London Railway Con. Ordy.	63	70	65	68	2 19 4	January and July	67	66
22,500	10	..	Do. Ordinary (£4 paid)	3½	4	3½	4	..	..	—	—
9,251	10	5%	Do. 5% Perpetual Preference	14⅛	15½	14⅛	15½	3 4 6	January and July	—	—
£137,701	Stock	4%	Do. 4% Perpetual Debenture	134	136	134	133	2 18 10	May and November	—	—
20,000	10	6%	Imperial Tramways Ordinary (old £6 shares)	16⅛	16⅜	16⅛	16⅜	2 3 9	March & September	—	—
10,000	10	6%	Do. 6% Preference	15	15½	15	15½	3 18 8	" "	—	—
37,500	10	3%	Liverpool Overhead Railway Ordinary	10⅛	10½	9 1/16	10 1/16	3 4 9	February & August	—	—
10,000	10	5%	Do. % Preference	15½	16	15⅜	15⅝	3 3 0	" "	—	—
125 000	Stock	4%	Do. 4% Debenture	108	110	108	110	3 13 1	January and July	—	—
20,000	5	3/3½	New General Traction 6% Cumulative Pref	4⅜	5½	4⅜	5½	—	—	—	—
£540,000	Stock	3%	Waterloo and City Ordinary	107	112	109	114	2 13 3	June and December	111	—

* In calculatin the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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CONTENTS OF THE CURRENT NUMBER.

NOTES	213	Electrical Transmission of Power in Mining	225
Meetings of Scientific Societies.	215	Electricity Works Accounts	226
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe	216	THE ROTATORY CONVERTER	228
Carbons for Electric Lighting and Other Purposes. By F. Jehl. Illustrated. Continued	217	The Theory of the Rotary Transformer. By G. Kapp. Illustrated. Concluded	229
Polyphase Transmission of Power. By F. Wallis	219	Rotatory Converters.—*Discussion*	230
Some Large Induction Motors. Illustrated	222	Long-Distance Transmission of Electric Power. By Prof. G. Forbes, F.R.S., M.Inst.C.E. Illustrated	233
The Higgins Type-Printing Telegraph Apparatus. Illustrated	223	Correspondence	237
Some American Suggestions to European Electric Tramway Builders	225	Legal Intelligence	239
		Trade Notes and Notices	241
		Companies' Meetings & Reports	247
		City Notes	248
		Companies' Share List	250

NOTES.

UNDERTAKERS of electrical supply are liable to pay a penalty of £5 daily for a breach of the Board of Trade regulations for constant supply and constant pressure. Under these regulations the pressure may only vary 2 per cent. from the standard when the supply is at high pressure, and 3 per cent. in other cases, and interruptions of the constant supply are only permissible for testing purposes "or for any other purposes connected with the efficient working of the undertaking." No penalty is to be inflicted, however, if the default is caused by an unavoidable accident. In the hearing of the summons brought against the Dublin Corporation on Thursday, last week, a full account of which will be found in another column, it was contended that the Corporation was liable to a penalty for failing to supply electrical energy to two consumers. This was regarded as a test case, for, during the replacement of the faulty rubber cable in Dublin, similar interruptions have been of frequent occurrence. Undertakers in a like predicament will welcome Mr. SWIFTE's decision that the interruption might be considered an unavoidable accident.

DURING the last few weeks the supply stations at Edinburgh and Manchester have been so overloaded that the pressure at the hours of maximum load has been extremely low—at Manchester as low as 87 volts sometimes. In both cases the prime cause has been the failure of contractors to deliver plant which has long been overdue. The non-delivery of plant and machinery at the contract time has of late been of frequent occurrence in the electrical engineering industry—so much so, in fact, that it has ceased to be regarded as anything unusual. A point has been reached, however, when companies or local authorities who are ordering electrical plant, whether it be for new stations or for extensions, should protest in the way most likely to have an effect on the contractors, viz., by the rigid enforcement of penalty clauses. One of the machines which should have been running in Manchester by October, 1897, is not yet at work, and it is hardly conceivable that the engineering strike can be alone responsible for this delay. But even if the delay is pardonable on account of the long cessation of work in the engineering trade, what is not pardonable is the repeated promise of early delivery by the contractors which has induced the station engineers to add to their lamp connections during the early part of the year. The latter gentlemen have now had it brought home to them that the non-reliance on the contractors' assurances, and the refusal to connect new consumers until the new plant was in position and the date of its operation certain, would not have done them a hundredth part of the damage which they have incurred through the actual course of events. Incidentally it would be interesting to know whether the supply authorities are exempt (on account of the engineering strike) from the penalties cited above.

A DELAY is taking place in the erection of the new generating station at Port-Dundas, near Glasgow, and the Glasgow Corporation has not only ceased to connect new consumers but has, we believe, discontinued the supply to some 110 who were only connected on the understanding that they should be cut off if it were found necessary. Could not a few large consumers be found in Edinburgh and Manchester willing to make a similar sacrifice? Probably they are now obliged to resort to other illuminants than electric light during some hours of the day, for electric lamps burning at 10 per cent. or more below their normal voltage will give but a small fraction of their normal light, so that the sacrifice, as things are at present, would not be very great. Doubtless the central stations themselves are not illuminated by electricity during this crisis; the various corporation offices should also be employing gas, candles or oil lamps for the benefit of the community, and surely in Edinburgh temporary arrangements could be devised to diminish the street lighting somewhat

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Stratified Brush Discharge.—Let a spark gap and a large liquid resistance be inserted in the circuit of a 60-plate Toepler machine, and let the capacity of the conductors be small. Then, according to M. Toepler, the following phenomena are observed on increasing the current strength: While the current is feeble the discharge takes the form of the ordinary brush discharge; but when the current strength attains a certain minimum limit the brush discharge is displaced by a stream of sparks. Instead of the low humming, a rattling sound is heard, rising in pitch as the current increases. On reaching a certain higher limit a nearly continuous brush light arc takes the place of the spark discharge, characterised by a great evolution of heat and by a stratification resembling that already described by the author in the case of a large battery of Leyden jars. This brush light arc burns nearly noiselessly. A further increase in the current strength does not produce any further change. On gradually reducing the current the same phenomena are noticed in the reverse order. Experiments with various gaps show that the lower limit between brush and spark discharge is nearly independent of the size of the gap, but when the current falls below a certain small minimum value none but spark discharges can be produced, however large or small the gap. If the anode is pointed the brush light arc consists of bright, whitish-violet cathode light, a second layer of brick-red light, scarlet positive light, and anode glow light. This observation is another bridge across the gulf that divides the phenomena of electric discharge in the open air and in a vacuum respectively. The analogy between the two kinds of discharge is strengthened by the fact that the Wiedemann-Hittorf law for vacuum discharges, according to which the difference of potential at which discharge sets in is independent of the current strength, also holds for these open-air discharges.

[Toepler, *Wied. Ann.*, No. 12, 1898.]

Mechanical Reproduction of Magnetic Phenomena.—C. Weyher uses a wooden shaft with strong paper paddles along its whole length to represent a bar magnet. When maintained in rotation, the shaft with its paddles represents a kind of centrifugal pump which sucks in air or water at both ends and expels it from the central region. Its rotation produces vortices in the surrounding medium, possessing a right-handed screw motion on one side of the centre of the shaft, and a left-handed screw motion on the other side. Two such models are suspended side by side by means of a cardan link, which allows them to oscillate like a pendulum, while preserving their freedom of rotation. When unlike "poles" are placed in juxtaposition, the models attract each other. When the two rotations are in the same direction they repel each other. The body exposed to the action of the magnetic model is a mill wheel capable of turning on a fixed spindle, and also of travelling along it. When it does not turn it is neither attracted nor repelled, and thus represents a non-magnetic substance. When it turns it travels along the spindle towards the "magnet." Several such mill wheels can be mounted on the same spindle, and made to represent a chain of nails adhering to a magnet. No attraction is exerted by the central region of the model magnet. The behaviour is the same in water as in air, but the rotations can be slower in water.

[Weyher, *Comptes Rendus*, Nov. 21, 1898.]

Secular Variation of Magnetic Elements.—At the British Association meeting, A. Schmidt, of Gotha, suggested a new use for the various navies of the sea-faring Powers, which which would be of great benefit to magnetic science. These navies, particularly the British navy, visit annually a large number of out-of-the-way places, widely dispersed over the globe, where no magnetic observatories exist. The officers have already sometimes carried out valuable magnetic surveys, and the American naval men have done useful work in this direction. Dr. Schmidt suggests that some method should be introduced into the work, thereby forwarding magnetic exploration and increasing the usefulness of our "bloated armaments." If a certain number of selected "secular stations" were visited, say, every five years, that would suffice for the present. As it is, work is often wasted by choosing unimportant stations or stations which are too close together, and the values of the secular variation hitherto accepted are more often than not based upon a doubtful process of extrapolation. A proper investigation of secular variation is essential to a correct estimate of the distribution of terrestrial magnetic force both in time and space, and the author proposes that the International Committee take some steps to secure the co-operation suggested.

[Schmidt, *Terr. Magn.*, September, 1898.]

Earth's Magnetic Potential.—The methods which have been employed so far to represent the earth's magnetic potential in a series of spherical harmonics suffer from the serious defect that the different coefficients are not determined independently of each other. Thus, says Arthur Schuster, in the latest and most accurate computation of Adolf Schmidt, the value of the first and largest coefficient is found to be 1,872, 1,913 or 1,921, according as the expansion is supposed to end with terms of the third, fifth or seventh order respectively. If the value of the potential were known at all points of the earth's surface each coefficient might be separately determined by a direct integration over the surface of the sphere. But there are large tracts of the earth over which the magnetic forces have not been observed, and hence some form of interpolation is always necessary. On the other hand, a complete knowledge of the potential over any finite portion of the earth's surface is theoretically sufficient to fix it all over the globe, and the continuity of the potential and of its derivatives facilitates and justifies the process of interpolation. The author points out that the whole interest of the expansion in a series of spherical harmonics centres round the first few coefficients, and works out a simplified method based upon the above considerations.

[Schuster, *Terr. Magn.*, Sept., 1898.]

Strains due to Magnetisation.—C. G. Knott produced three series of nickel or iron tubes of increasing bore by boring out by successive stages an iron tube A, another iron tube B, half the length of A, and a nickel tube. Each tube was subjected to four distinct experiments, consisting in the measurement of the change of volume of the bore, the change of volume of the material of the tube, the apparent external change of volume of the plugged tube, and the change of length. From these measurements the principal coefficients of strain at the inner and outer walls could he completely determined. An element originally spherical became changed into an ellipsoid, whose principal axes were parallel to the axis of the tube and its radius respectively, and perpendicular to both. The corresponding coefficients of strain are distinguished as the longitudinal elongation λ, the radial elongation ν, and the tangential elongation μ. In nickel, λ is always negative, and μ and ν generally positive. In iron and steel, λ is positive in low and moderate fields, and negative in high fields. The cubical dilatation is always positive, whereas in cobalt it is always negative. The dilatation of the bore, $\lambda+2\ \mu$, is a differential effect. Hence its apparently capricious character.

[Knott, *Proc. R. S. Edinburgh*, Vol. XXII., No. 2.]

Earth Currents and Magnetic Disturbances.—S. Lemström describes the method employed by him for measuring the E.M.F. of the electric currents coming from the atmosphere, and quotes evidence showing that the variations of earth currents occur a short time (five minutes) before the magnetic perturbations, and that the former are more numerous than the latter. From the observations at Sodankyla it is, however, proved that not all magnetic perturbations are preceded by variations in the earth currents, but that these are most likely caused by earth-air electric currents. As a matter of fact, the magnetic perturbations in polar regions have a contrary direction to those in more southern countries, and at times of auroras the electric current from the atmosphere varies much, and must exert on magnetic instruments a

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marked influence depending on their position relative to the space within which the electric current is moving. The magnitude of the variations of earth currents increases with the latitude in a very high ratio. There is a maximum belt of earth currents and of earth-air currents as well as of auroras. Two international circumpolar stations should be established, and existing observatories should make arrangements for earth-air current observations. It suffices to take a wire to the top of the nearest hill, since the conductivity of the wire does not interfere with the very large resistance encountered by these currents.

[LEMSTRÖM, *Terr. Magn.*, September, 1898.]

Photography of Coherer Sparks.—If further proof were necessary that the change of resistance in coherers is due to sparks between the particles, the evidence adduced by R. Malagoli would be valuable. He laid a sensitive plate with the film upwards, and covered it along two opposite edges with tinfoil. Between the two sheets of tinfoil he strewed some metallic powder, thus producing a two-dimensional coherer mounted on a sensitive plate. Wires were attached to the tinfoil, and dipped into mercury cups. On exposing the coherer to the action of electromagnetic waves, and developing, a tracing was obtained, looking like nothing so much as a colony of bacteria seen under the microscope. The bacteria were the paths of the minute sparks postulated by Lodge's theory. A somewhat similar appearance is produced by a discharge from a Leyden jar sent through the powder. When the layer of powder is so thick as to conceal the sensitive surface, no photographic impression is obtained, probably because the discharges occur in the interior of the layer, and are hidden from the plate by the bottom stratum. When no tinfoil sheets are used, no action takes place, and, on the other hand, the action is materially increased by suitably choosing the length of the terminal wires. There is evidently here some phenomenon of resonance.

[MALAGOLI, *Nuovo Cimento*, August, 1898.]

Dielectrics under Mechanical Tension.—The study of the properties acquired by a dielectric subjected to strain, whether by mechanical or electrical means, is of considerable difficulty owing to the complexity of the reactions. Ugo Panichi endeavours to unravel a portion of these changes by the study of the variation of the specific inductive capacity of stretched ebonite. The method adopted is novel and ingenious. An ebonite tube is suspended by means of a brass cap, which holds a glass tube projecting from it and serving as a kind of capacity indicator, communicating, as it does, with the mercury with which the interior of the tube is filled. Another brass cap is attached to the bottom, and weights are attached to it by means of a fine wire. The first problem is to find whether the internal capacity of the tube is affected by the stretching, as that would influence the calculations of the dielectric capacity. An increase of the internal volume is actually observed. The dielectric capacity is then determined by inserting the ebonite tube in a glass tube filled with mercury, thus obtaining a long cylindrical condenser with mercury armatures. The final result of all the experiments showed an increase of the dielectric constant of ebonite with tension, and proportional to the tension within the limits of the experiments.

[PANICHI, *Nuovo Cimento*, August.]

Earth Currents.—Writing on "The Interpretation of Earth-Current Observations," A. Schuster says: If two metallic plates are inserted into the ground, an electric current is found to traverse the conductor, and this is generally called the "earth current." It is not, however, obvious at first sight what the connection is between this observed current and that which traverses the ground when the earth plates are removed. The statement sometimes made that the observation gives the difference of potential of the earth at the two points at which the plates are inserted would be true, provided the connecting wire has a sufficiently large resistance, if earth currents were only due to chemical or thermo-electric forces. But as there can be little doubt that earth currents are chiefly, if not entirely, effects of induction, a separate investigation is necessary as to the interpretation to be attached to the galvanometer indications. A simple process of reasoning points to the importance of measuring the conductivity of the ground wherever earth-current observations are made. Samples of the soil taken from different depths would probably give different results, and would then indicate how the current density varies with depth.

[SCHUSTER, *Terr. Magn.*, September, 1898.]

CARBONS FOR ELECTRIC LIGHTING AND OTHER PURPOSES.*

BY FRANCIS JEHL.

(*Continued from page 808, Vol. XLI.*)

VI.—GAS GENERATORS.

Modern carbonising furnaces in which carbons are baked are all worked with gas, which is generated in a sort of furnace called the gas generator. The advantages in employing gas are the following:—

1. The easy regulation of the relation of the fuel and the air necessary for its combustion.
2. The facility with which the air can be mixed with the gas, by which the chemical action that results through combustion is accelerated.
3. The possibility of first heating the air that is used and thereby obtaining a higher temperature, while at the same time effecting an economy in fuel.

It would be practically or commercially impossible to heat the modern carbonising furnaces without using gas.

Principle of the Gas Generator.—Before describing the furnace it will be necessary to investigate the principles of the gas generator, which is one of the most important factors. In order to be able to render the matter clear, the writer has, to some extent, taken advantage of the admirable works of Prof. A. Ledebur and H. Stegmann.

The gas generated for such heating purposes is not manufactured in the same manner as the gas used for illuminating purposes, for in such processes the fuel is distilled, that is, the volatile parts are driven off, while coke remains behind. In a gas generator, however, nothing remains behind but ashes. Nor can a gas generator be called a furnace in the common sense of the word, for in an ordinary furnace the product of combustion is carbonic acid gas, CO_2, while the object of the generator is to produce carbonic oxide gas, that is, CO.

In Fig. 32 we have the principle on which all gas generators are constructed, and it will be seen that in reality it resembles an ordinary furnace or stove, in which there is a high layer of fuel. In the figure, *g* represents the grate on which the fuel is piled up to nearly the orifice *c*, into which the gas issues. At *b* there is an opening, into which fuel is thrown when necessary. In a gas generator it is of vital importance to keep the fire at a high temperature, by means of which the chemical and physical actions that result in connection with the fuel and air are accelerated. Not a partial but a complete combustion is the principle by which gas generators work in converting fuel into gas.

In an ordinary furnace the heat generated is generally given off to surrounding bodies, or used in one way or the other, whereas in the gas generator the heat, with the product of the combustion (*i.e.*, carbonic acid gas), acts as follows: The heat is imparted to the fuel over it, which gets heated to a high temperature, which dissociates it, causing any gases or hydrocarbons which the fuel may possess to be liberated and pass upwards. The carbonic acid gas which was formed, in passing this heated mass of carbon or carbon vapour, takes up another atom of carbon, and is converted into carbonic oxide gas. The fact that a great heat is necessary when reducing carbonic acid gas into the oxide gas is shown from the following theoretical considerations: The combustion of 1 kilo of carbon, C, produces about 8,080 thermal units (1 thermal unit being the heat necessary to raise 1 kilo of water from 0°C. to 1°)

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when transformed into carbonic acid gas, or when reduced into carbonic oxide gas gives about 2,473 thermal units. Now, in the reduction of carbonic acid gas into the oxide one atom of carbon is taken up by the carbonic acid, and we have $C + CO_2 = 2CO$. As this one atom of carbon is fixed it cannot be liberated before it has received sufficient heat, which heat is supplied from the combustion that produced the carbonic acid. Now, when we have the conversion of one part by weight of the carbonic acid gas into two parts of the oxide we have $2 \times 2,473 = 4,946$ thermal units, which, when subtracted from the 8,080 that the carbonic acid gas produced, leaves us 3,134, which represents the work done in converting the carbonic acid gas into the carbonic oxide gas. This heat, which is necessary for the conversion, must thus be present in the generator.

This conversion is, however, only one part of the actions going on in a generator, as the fuel, when it is coal, wood or turf contains other hydro-carbons with water perhaps, all of which are distilled by the action of the heat, which shows us again where some of the heat is also expended and absorbed. The nitrogen that comes into the generator with the air passes upwards, and mixes with the other gases, so that the gas used in heating the oven, or rather for carbonising, really consists of a mixture of several gases, some of which, like the carbonic acid gas and the nitrogen, may be called dead gases, as they do not support the combustion.

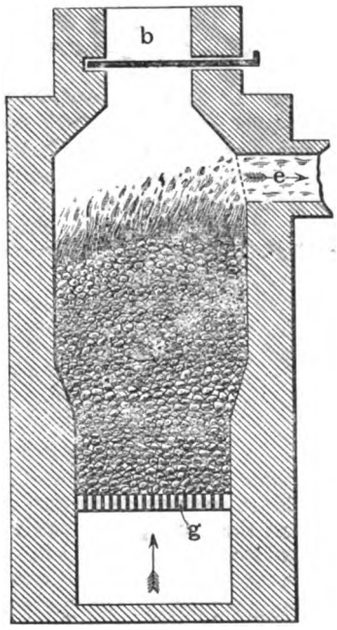

FIG. 32.—Principle of the Gas Generator.

If only coke is used as fuel in a gas generator we do not obtain such a mixture of gases as mentioned above, as the hydro-carbons have already been driven out of the coke, which is, in fact, pure carbon, containing also a little ash. In this case, if we suppose that no carbonic acid gas escapes, and that all is converted into the carbonic oxide gas, we obtain in weight or volume 34·3 parts of the carbonic oxide gas and 65·7 parts of nitrogen. 1 kilo of such a mixture when burned —that is, when its carbonic oxide is consumed by being converted into carbonic acid gas—gives about 824 Cal. or thermal units, while a cubic meter will weigh about 1·25 kilos. Of course, in reality these figures are lower, as there is always some carbonic acid gas that escapes and more air taken than is necessary. It must be remembered that air contains about 21 parts of oxygen and 79 of nitrogen, from which we see that an over-abundance of air, of which the oxygen is not all consumed, brings lots of nitrogen with it that dilutes and weakens our gas, so that it produces less thermal units per volume when burning. One of the main things in working a generator is to see that the fire is even throughout its whole cross-section, for if there is a spot where the fire is weak or where there is none at all the air will ascend without doing any work, and passes into the passage that leads to our oven. Not only does such air weaken the thermal qualities of the gas, it is also dangerous, as an explosion may follow by the formation of oxy-hydrogen.

It is well known and has been proved by experiment and practice that the conversion of the carbonic acid gas into carbonic oxide gas is accelerated by maintaining a high temperature in the generator, while at the same time the hot fuel should have a large surface with which the gas can come into contact.

The amount of fuel converted into gas in a given time, on which also the temperature depends, is proportional to the amount of air supplied, which depends on the draught and the resistance offered to the gases in their passage through the layers of fuel. The air is generally supplied to the generator by means of a blower, and in such a case can be regulated so as to force any amount of air that is necessary te overcome the resistance offered to the gases in their passage. Another advantage in using a blower is that the pressure of the gas is higher than it would be if only a chimney draught was used, and the chemical actions are performed better.

Another good way is to build the generator so that there are small channels around its sides through which the air first passes before it enters in at the grate. By this means the air gets warmed up, which means economy. The temperature with which the gases issue from the generator depends, of course, upon the nature of the fuel used and upon the care taken in handling. Fuel that has already been carbonised, as coke, charcoal, &c., produce hotter gases than those fuels which are composed of hydrocarbons that must be decomposed first by the generator, thereby absorbing large quantities of heat which could be otherwise taken up by the gases, while a good draught from the blower which generates large quantities of gases helps to attain a high temperature. Bunte found that by using coke, and having a draught of about −7mm. to −8mm. on a water manometer, the temperature of the gases issuing from the generator was about 1,000°C. Gas generators are generally built in different forms, as the form depends upon the nature of the fuel it is intended to use. In fuel we have a great variety: as coals of the anthracite and soft kinds, coke, charcoal, lignite, peat, turf, wood, sawdust, &c.

It may be mentioned that coke or charcoal give about the least trouble when running a generator, as they do not form much ash and do not cake or slag as many of the coals. When broken into small pieces we obtain an even mass that presents a large surface, and we get a gas that issues at a high temperature, while there is no danger of distilled matter condensing in the passages that lead to the oven. No doubt charcoal is too expensive; but there are many countries where coke is as cheap as coal, or cheaper, and in such places it would be advisable to use it. One of the main things in a fuel is the quantity of carbon it contains, and preference is to be given to that fuel whose unit weight of carbon costs the least. Most of the other fuels contain also hydrogen, oxygen, nitrogen, moisture and ash.

The following table shows approximately the volume and weight of gas that can be obtained from 1 kilogramme of fuel, supposing it to be free from ashes and moisture, and including also the carbonic acid gas and nitrogen:—

Coke or charcoal will	produce	about	6·5cbm.	= 8	kg. of gas.
Wood	,,	,,	,,	2·2	,,	= 2·8	,,
Turf and lignite	,,	,,	,,	2·8	,,	= 3·4	,,
Brown coal	,,	,,	,,	3·4	,,	= 4·0	,,
Mineral coal	,,	,,	,,	4·5	,,	= 5·4	,,

From the above table we see at a glance the advantage in using coke in the generator when it can be procured relatively as cheaply as other kinds of fuel. Coke, charcoal, wood, turf and coarse brown coal generally retain their form when in the generator, only shrinking more and more together, until they are at last reduced to powder, which falls either through the grate or gets mixed with the ash. Many other kinds of fuel, however, when heated, begin to split or crack, falling into small pieces, as lignite and some coals of the anthracitic class, and also some of the coals that are rich in gas and do not cake. When such kinds of fuel form high layers it may happen that this splinting and breaking of the material may clog up the passages that are necessary for the gases in ascending, hindering the conversion of the gases, and thus

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diminishing the quantity. Such fuel is used in generators with special grates.

Coals that get soft when heated, or cake together into lumps, also often render it difficult for the gas to ascend, as they clog up the passages, thus rendering it necessary to use a blower to overcome such obstacles; in fact, as has already been mentioned, the form of the generator depends upon the fuel used.

Prof. Ledebur, in pointing out the influence of moisture or water in the fuel on to the temperature obtainable, when the gases produced from various kinds of fuel are burned, arrives at the following figures, supposing that the temperature of the gases and air as they reach the oven are at 0°C.:—

From	fresh-cut wood	the	gases	can produce about...	1,412°C.
„	air-dried wood	„	„	„ ...	1,600°C.
„	well-dried wood	„	„	„ ...	1,704°C.
„	peat or lignite	„	„	„ ...	1,642°C.
„	dried peat	„	„	„ ...	1,774°C.
„	old brown coal	„	„	„ ...	1,737°C.
„	mineral coal	„	„	„ ...	1,896°C.

From this table we see that it is economy to use fuel containing as little moisture as possible. In the above calculated temperatures it was supposed that the gases and air entered the oven at 0°C., whereas in practice they generally enter the oven at a high temperature, so that the real temperatures are higher than the table gives. The fuel used in a generator should always be stored under a shed, and, if possible, dried before using, especially such porous fuel as coke. For further information concerning fuel, &c., *see* Mr. E. T. Carter's "Motive Power and Gearing." (*The Electrician* Series.)

(*To be continued.*)

POLYPHASE TRANSMISSION OF POWER.

BY F. WALLIS.

The transmission of energy by polyphase currents has made much greater progress abroad than it has in this country, and, in addition to our national conservatism in adopting new methods, there are two main reasons for our backwardness. In the first place, there are but few sources of water power in Great Britain, and recently steam power can be obtained comparatively cheaply all over the country. In Switzerland and in America, where long-distance transmission has made such strides, water power in large quantities is constantly to be met with, and is naturally taken advantage of; while, again, in the mining districts of both America and South Africa, fuel can often only be obtained at very great cost, and consequently it is cheaper to transmit power over a great distance from one large centre, where water power or fuel can be more easily obtained, than to have a number of isolated plants.

Nevertheless, there is a considerable field even in this country for the transmission of power in large quantities over long distances—say 20 to 40, or even 50, miles; for not only might great generating stations be erected near the coal pits, where fuel can be obtained delivered to the boilers at 2s. 6d. per ton, but, further, the enormous power that runs to waste in our blast furnaces might be in part utilised for the generation of electricity. It has been estimated that, for every 100 tons of metal cast, energy sufficient to generate 2,000 H.P. for one week is wasted in blast-furnace gas, and that throughout the country about 2,000,000 H.P. is thus wasted

But quite apart from such problematic schemes there are many cases in which polyphase transmission might be advantageously employed. For instance, at Dublin where the generating station is only seven miles from the furthest substation and the pressure employed is only 3,000 volts, polyphase transmission has been found to give admirable results. Indeed, wherever it is desirable to work at a pressure of 2,000 or 3,000 volts or more, polyphase transmission offers many advantages. Again, in many cases where the generating station is within a few hundred yards of the area of supply, the polyphase system may be profitably adopted, owing to its suitability for motor work. This particularly applies to the case of the transmission of power in works where motors form the chief part of the load. And it must be borne in mind that even though there may not be many openings for long-distance transmission at voltages of 10,000 or so in England, many such transmissions are required in the colonies and elsewhere abroad, and it is preferable that the necessary plant should be installed by English engineers.

The question thus arises, What is the greatest distance to which electrical energy can be economically transmitted, and how do the various systems of transmission compare with one another? The largest circuit yet employed has been the experimental one between Frankfort and Lauffen, a distance of 100 miles, over which 300 H.P. have been transmitted at 8,000 volts, three-phase currents being employed; 4,000 H.P. have also been transmitted on the three-phase system at 10,000 volts over 24 miles at Sacramento, and 1,400 H.P. at 11,000 volts over 35 miles at Fresno, Cal., not to mention the Niagara-Buffalo line, and many others. There are also several two-phase lines at work. Of single-phase alternating lines, that at Rome may be mentioned, where 2,000 H.P. are transmitted at 6,000 volts from the Falls of Tivoli, 18 miles distant from the city. M. Thury and others have also installed several long-distance continuous current plants, of which that at Geneva, where 400 H.P. at 6,600 volts are transmitted over 20 miles, is the longest; though the Brescia line, over which 700 H.P. are transmitted 12 miles, is worked at the highest voltage, namely, 1,500. In the case of many of these transmissions, where water power is employed, it must be remembered that the power available is greatly in excess of that required, and that consequently very considerable losses in the line and plant could be permitted.

Abroad, transmission of power is almost invariably carried out by bare, overhead wires. In England no such transmission on any large scale has yet been tried, and it is more than probable that the Board of Trade would insist on insulated cables being laid either underground or by the side of a railway, or in some such thoroughly safe and efficient manner, whenever a high voltage was employed. And in many ways this would be an advantage, for any long-distance transmission would necessarily be on a very large scale and any breakdown, which might easily occur with overhead wires, would cause great loss to the community. Further, overhead wires have great inductive effects, and in a crowded country like England would cause much trouble. The underground mains would, of course, be either concentric or laid very close together.

In other countries the conditions are, as a rule, entirely different. The chief consideration is generally small first cost, and, consequently, bare overhead conductors are almost universally employed. But, even with these, there are limits to the voltage which may be employed; not, indeed, in the apparatus at the ends of the line, for transformers can be made to safely stand almost any voltage but in the line itself. In a very dry climate 20,000 or 30,000 volts may be safely employed, but in a damp and foggy atmosphere, even 10,000 volts may be too high for satisfactory working, owing to moisture collecting on the insulators, and so causing short-circuits.

But, granted a long-distance transmission, the question still remains, How does the polyphase system compare with the direct-current and with the single-phase alternating? Now, though direct currents have been employed by M. Thury over considerable distances at very high pressure (*e.g.*, the 15,000 volts at Brescia), there are many disadvantages connected with such a system. In the first place, as M. Thury himself states, the maximum output of a high-pressure continuous-current dynamo is about 45 amperes at 3,000, or, at most, 4,000 volts; hence, for generation at 15,000 volts, four or five machines must be coupled in series; and likewise, wherever it is desired to tap the mains, another four or five machines in series must be run as motors, each either helping to drive a common shaft, from which a large generator may be driven to supply the lower potential current required for distribution, or driving its own smaller generator direct. In other words, large units with the corresponding gain in efficiency and in first cost cannot be employed with the continuous-current system. And, further, since commutators must be employed at the full

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potential of line, the risk of accident to the attendants or to the machines themselves is very great. On the other hand, the employment of the direct current admits of a saving in the weight of copper in the line as compared with any of the alternating systems, the relative figures for direct current, single-phase, two-phase, four-wire and three-phase circuits being 0·50 : 1·00 : 1·00 : 0·75, assuming the same maximum potential difference in each case. As a matter of fact the gain in copper is even greater, for in almost all alternating circuits the power factor is less than unity, and consequently a greater current has to be carried than corresponds to the power transmitted. On the other hand, in the above figures it is assumed that the maximum alternating E.M.F. is $\sqrt{2}$ times the effective E.M.F., and though this is approximately true it should be remembered that the disruptive discharge due to an alternating E.M.F. is sluggish; that is to say, does not at once follow the applied E.M.F., so that, to take an instance, an alternating E.M.F. of more than $\frac{15{,}000}{\sqrt{2}}$ effective volts is required to produce the same disruptive effect as a continuous-current E.M.F. of 15,000 volts. Further, there is no electrolytic effect with an alternating current, nor does the osmotic effect, whereby moisture creeps to the negative pole of a continuous-current circuit, exist. Of course, with underground cables these effects would not, under normal circumstances, be present; yet should by any chance a minute leak develop they would at once manifest themselves.

On the whole, in the majority of cases, it will be found that though there would be a considerable saving of copper in the line, the continuous-current system is placed out of court by the fact that the generators and motors have to be split up into comparatively speaking small units, and that a considerable element of danger is always present owing to the necessarily more or less exposed commutators being at high potentials above the earth.

The single-phase alternating system is well adapted for the transmission of power over long distances when it is simply a case of one receiving station where the one or two large motors convert all the energy at once into its mechanical equivalent. In the text-books it is shown that the system requires more copper in the line than the three-phase, the proportion being 100 to 75; but, as large single-phase motors, such as have just been referred to, are always synchronous and there is practically no lagging current in the line, whereas with a three-phase transmission the power factor will rarely exceed 80 per cent. and the line wires have to be increased proportionately in size, it follows that there will not in practice be much difference in the weights of copper employed. The real objections to the single-phase system are two in number—first, that the motors employed have to be of the synchronous type, and, secondly, that rotary converters designed to transform single-phase alternating currents into continuous current cannot be built for an output much above, say, 50 kilowatts, on account of the excessive sparking at the commutator, this sparking being due to the great fluctuations in the alternating current in the armature. A synchronous motor might, of course, be arranged to drive an entirely separate continuous-current dynamo and the sparking difficulty so got rid of, but the cost of the two machines would considerably exceed that of a polyphase rotary converter, and the efficiency of the conversion would be lower. But the chief objection to the single-phase system is undoubtedly that first mentioned, namely, that synchronous motors have to be employed which cannot be started without external aid, and further require separate field excitation. This does not matter so much in a large transmission, where power is simply sent from one end of a line to the other in large quantities, for in such a case the cost of the exciter, and of the battery of accumulators or the small non-synchronous motor required for starting purposes, does not bear a large proportion to the total cost of the installation, nor is the extra attendance required for these a serious item. But where only small motors are concerned such complications become prohibitive; and though many induction and other self-starting motors have been brought forward, none have yet proved themselves sufficiently satisfactory for general adoption, or at least, as a matter of fact, have not yet been generally adopted. It should be added that synchronous motors may be started not only by small subsidiary self-starting motors, or by driving their exciters as motors from a battery of accumulators, but also by supplying the exciters from the alternating current mains when, provided their field-magnets are laminated, they will run as alternate-current motors. But this method involves the use of the laminated fields and other complications, and does not seem to be often employed.

With the polyphase system the difficulty of self-starting is entirely done away with. Even synchronous polyphase motors will start themselves, owing to the reaction of the eddy currents induced in the solid pole-pieces—provided the pole-pieces are solid, and not laminated at the tips, as is often the case; but as the resulting torque is not very great, the motors have to be started light and the load only thrown on when they are running in synchronism. Synchronous motors have the great advantage of a power factor of nearly unity when properly excited, and hence, if three-phase synchronous motors are employed, there is a saving of 25 per cent. of the line copper over the single-phase system. But in spite of their lower power factor, induction motors are far more generally employed on polyphase circuits. With these there is no difficulty in starting, even under full load. Small motors up to 10 H.P. or so are generally made with squirrel-cage rotors, and these when starting under full load take for a short time a current of two or three times the normal full-load value. Larger machines are provided with a variable resistance in the rotor circuit, and will start under full load, taking only the normal current. For cranes and hoists the rotors are wound to have a considerable resistance, and a starting torque of even five times the normal can be obtained.

Further, the polyphase system has the advantage of being peculiarly well adapted for use with rotary converters. A three-phase current can thus be transformed into a single-phase, a two-phase, or a continuous current, though for conversion into single-phase or two-phase it is far simpler and more efficient to use static transformers. For conversion into continuous current, however, rotary transformers must be used, and since in polyphase systems the flow of power is constant there is no difficulty with sparking at the commutator. Indeed, the tendency to spark, and the demagnetising effect of the armature, is far less than with continuous current dynamos, since the armature reactions of the two circuits tend to neutralise one another. Thus we are told that the 600 kilowatt converters at Niagara will give 900 kilowatts without sparking.

It is rather a drawback to the use of the rotary converter that as a rule it requires a static transformer to reduce the polyphase voltage before it reaches the machine. The reason is that continuous currents are almost always required at low voltage and a rotary converter with only one armature winding has a fixed ratio between its polyphase and continuous current voltages, the former being lower than the latter. But even were any voltage ratio possible it would still be undesirable to introduce high potential currents into a revolving armature, and static transformers would have to be employed. From what has been said it must not be inferred that static transformers must necessarily be employed with motors, for such is not the case. The polyphase circuits can be, and in large sizes generally are, led into the stationary portion of the motor, where they can be as well and safely insulated as in a transformer itself. Small motors, however, cannot be wound for high pressure except at prohibitive cost—the limit for a 20 H.P. motor being about 1,000 volts—and with these static transformers must be employed.

Thus in a large transmission system large motors will take current direct from the high-pressure mains, while for smaller motors one or more distributing centres with large static transformers will be established. Lamps may also be run from the low-pressure polyphase circuits, being connected either between the three mains in a three-phase system, or, preferably, between each of the mains and a fourth balance wire running to the junction of the three circuits on the low-pressure side of the static transformer, in which case the

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latter must be star wound. In a balanced three-phase system the sum of the three currents is always zero, and so a fourth return wire is unnecessary, but where the load may be unevenly distributed, as is the case when lights are run from the mains, a fourth wire will take the unbalanced current and the voltage regulation is more satisfactory than if no return wire were used. As against the extra weight of the return wire this system has the advantage that the voltage between the mains is raised to $\sqrt{3}$ times that required by the lamps, and consequently the mains themselves take less copper. On the other hand, in many cases in practice there is no difficulty in obtaining a good balance even without the complication of a fourth wire. The motors on the circuits act as automatic regulators, for should the voltage between any pair of mains fall owing to extra lamps being switched on to that circuit, the current in the corresponding branch of the motor windings will fall. The back E.M.F. in these branches will rise and the current still further fall, while at the same time the currents in the other two branches on the motors will rise to make good the deficit, and the voltages will once again become approximately equal. Nevertheless, many engineers prefer the two phase system with four wires, where, as the two circuits are electrically independent of each other, they can be independently regulated. The lamps are then each on their own circuit, and only in the motors are the two phases brought into play. For this reason it has been suggested that it would be better to employ three-phase transmission in the line on account of the saving of copper (the weight for the same maximum potential difference as compared with the two-phase 4-wire system being in the proportion of 75 to 100) and at the receiving points to transform by static transformers to the two-phase system.

A third method is to transform from three-phase to continuous currents by the use of rotary converters, and much can be said in its favour. In the first place rotary converters can be made to act not only as transformers, but also as boosters, for the field winding may be compound, and sufficient series turns employed to actually make the full load voltage greater than at no load, the phase relations in the polyphase circuit being altered thereby. Again the periodicity of the polyphase circuits may be too low for the satisfactory working of lamps (neither arc nor incandescent lamps should be worked under 40 revolutions per second), and then the only thing to do is to distribute by continuous currents. Further, the regulation of a continuous current voltage is easy; and, of course, continuous current motors work satisfactorily. Such a combined system is particularly well adapted for traction purposes where on account of induction troubles and of three-phase currents requiring at least two trolley wires, it is as a rule impossible to use anything but continuous currents for the working of the cars. On the other hand, the use of the polyphase system throughout is in many cases more satisfactory. Where motors alone are to be driven the conversion to continuous current is quite unnecessary; for, as has been said, large motors can be supplied directly from the high pressure mains, and smaller ones only require static transformers in place of the more costly and less efficient rotary converters. Where, however, the distribution is mixed, that is to say, where motors and lights have to be run from the same circuits, the question is not so easy of solution even when the frequency is high enough for lighting purposes. Although in some cases, as has been mentioned, the regulation of voltage on polyphase circuits has been found to be a comparatively simple matter the experience obtained has perhaps not yet been sufficient for us to say that this will always be the case, and it may be taken as a maxim that wherever regulation will be a difficult matter requiring great care and attention it will be more economical in the end to install some simpler system, even at an increased first cost. Again, though accumulators may be charged by means of rectifiers or rotary transformers from alternating circuits their use is almost entirely confined to continuous current distribution.

So far as the motors are concerned the polyphase system more than holds its own. Not only will induction motors start under full load, but their regulation is an easy matter. Synchronous motors will run at absolutely constant speed, no matter what the load, and well-designed induction motors of from 2 H.P. to 100 H.P. drop only from 8 per cent. to 4 per cent. in speed at full load. They thus act like continuous-current shunt motors. Their efficiencies between these sizes vary from about 76 per cent. to 92 per cent., and could be designed to be greater still. As a rule, the regulation of speed is effected by a variable ohmic resistance in the rotor circuit, though in cases where large starting torque is not required, auto-transformers, which inductively reduce the voltage of supply, are often employed. Alteration in speed may also be effected by alteration of the number of stator poles, by changing the connections from star to mesh, and by coupling two motors together, so that the rotor current of the first machine supplies the stator of the second. As a rule, however, regulation is effected by altering the resistance of the rotor circuit, though this method has the disadvantage that when carried out to any large extent the efficiency is considerably reduced. The polyphase motor has, further, the great advantage over the continuous-current motor of requiring no commutator. It is also of very strong mechanical construction, and requires little or no attention. Likewise for equal power, its weight is less than that of the direct-current machine; while, at the same time, it can stand very considerable overloading for a short time. There is very little difference in efficiency, power factor, starting torque, and exciting current, between the three-phase and the two-phase motor, what slight difference there is being in favour of the three-phase.

A great deal has been said concerning the low power factor of polyphase systems. For transmissions in which the load consists chiefly of induction motors, the factor varies from about 0·65 to 0·85. As a rule it will be about 0·75 or 0·8. The motors and transformers, and not the line, are the chief sources of the lag of current behind the E.M.F., though the result of a low power factor is increased size of plant all round. The coil can, however, be compensated for to a considerable extent by the employment of a few large synchronous motors, which not only have no lag when properly excited, but when over-excited will still run as motors, with the current leading the E.M.F. They then, in fact, act as condensers. One American firm actually sends out condensers with its motors; but, generally speaking, the condenser cannot yet be regarded as a commercial article. In the matter of power factor the advantage of the three-phase over the two-phase motor is so small as to be practically negligible. It must be remembered that as the load decreases the power factor also decreases, so that when the motor is running light, and absorbing but little energy, the current it takes is still 20 to 30 per cent. of the full-load current.

With the introduction of polyphase motors frequencies have fallen considerably from those of 100 $\sim$ per second, and more employed some years ago, for electric lighting. The higher the frequency the cheaper are the transformers; but, on the other hand, if a motor is to run on a high-frequency circuit at a given speed, it must have an increased number of poles, and this, in small sizes at least, means increased size and cost. Further, the higher the frequency the greater the magnetic leakage and the magnetising current required. Also, the higher the frequency the greater is the skin effect in conductors, and consequently the more finely must they be subdivided. At Niagara a periodicity of 25 has been adopted, and this is but little lower than that of the majority of polyphase transmissions in America. In Europe a rather higher figure, of somewhere over 40, is more general, in order that the circuits may be employed for lighting as well as for motive purposes.

Lighting Concessions in Turkey.—It has been announced twice that an imperial iradé had been issued, granting to Sir Ellis Ashmead-Bartlett a concession and monopoly for the electric lighting of Smyrna and Salonica. The *Daily Mail's* Berlin correspondent is informed, however, that a similar iradé for the town of Smyrna had been granted to a German firm in 1889. Possibly the present of an Arab steed may prove the more useful of the two gifts from the Sultan.

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SOME LARGE INDUCTION MOTORS.

The accompanying Fig. 1 shows one of two motors built by Messrs. Brown-Boveri and Co. for the second locomotive of the Jungfrau electric railway. A full description of the line and equipment appeared in our issues of Sept 23 and 30. We may remind our readers that each locomotive carries two three-phase star-wound induction motors, designed to run in parallel at 760 revolutions per minute, and to develop each 125 to 150 B.H.P. when supplied with current at 500 volts and 38 revolutions per second frequency. The weight of each motor is 2·6 tons, and the locomotive complete weighs 13 tons. To this weight must be added that of two passenger carriages, containing each 40 passengers, which the locomotive must be capable of propelling up a 25 per cent. gradient. The rheostat, shown in course of construction in Fig. 3, is placed in series with the rotor of the motor, to avoid starting it on short-circuit.

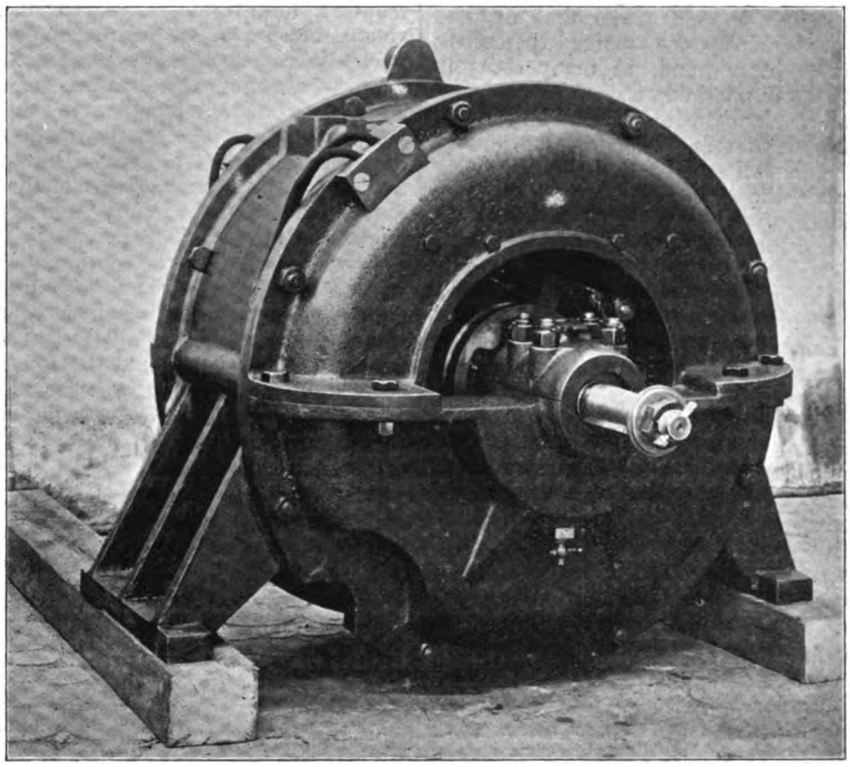

FIG. 1.—Motor for Jungfrau Locomotive.

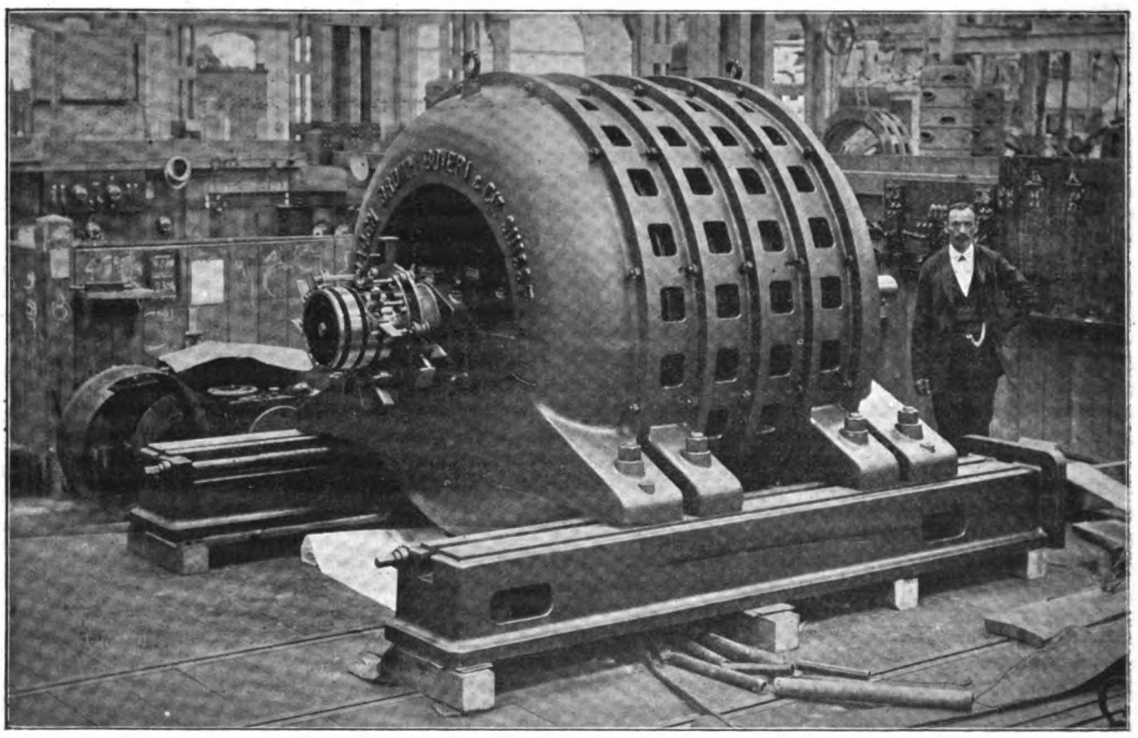

FIG. 2.—One Thousand Horse-Power Induction Motor.

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No resistance is placed in the stator circuit, the coils of the stator being connected directly to line through a switch and fuses. Fig. 2 is from a photograph of a two-phase motor where it will be coupled directly to a Sulzer centrifugal pump working against a head of 466ft. The motor is designed for an output of 1,000 B.H.P. at 544 revolutions. It is wound for

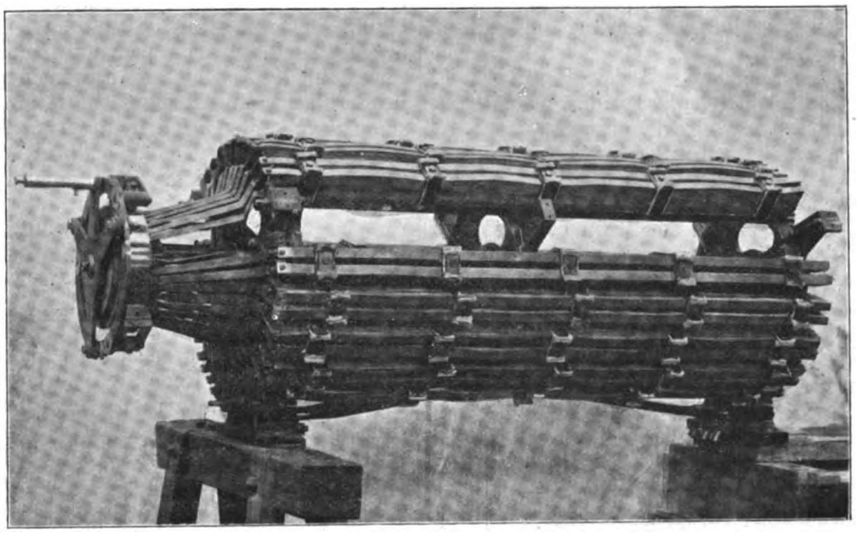

FIG. 3.—Regulating resistance.

built by the same firm, who claim that it is the largest induction motor in the world. It has been built for the city of Geneva, a pressure of 2,500 volts and a frequency of 46 ∿ per second. The weight of this motor complete is 27 tons.

THE HIGGINS TYPE-PRINTING TELEGRAPH APPARATUS.

The latest pattern of type-printing apparatus designed by Mr. F. Higgins, of the Exchange Telegraph Co., has many points of novelty. Although not constructed on any entirely new principle, the numerous improvements in detail make it a decided advance upon its predecessors, and render a detailed description of interest.

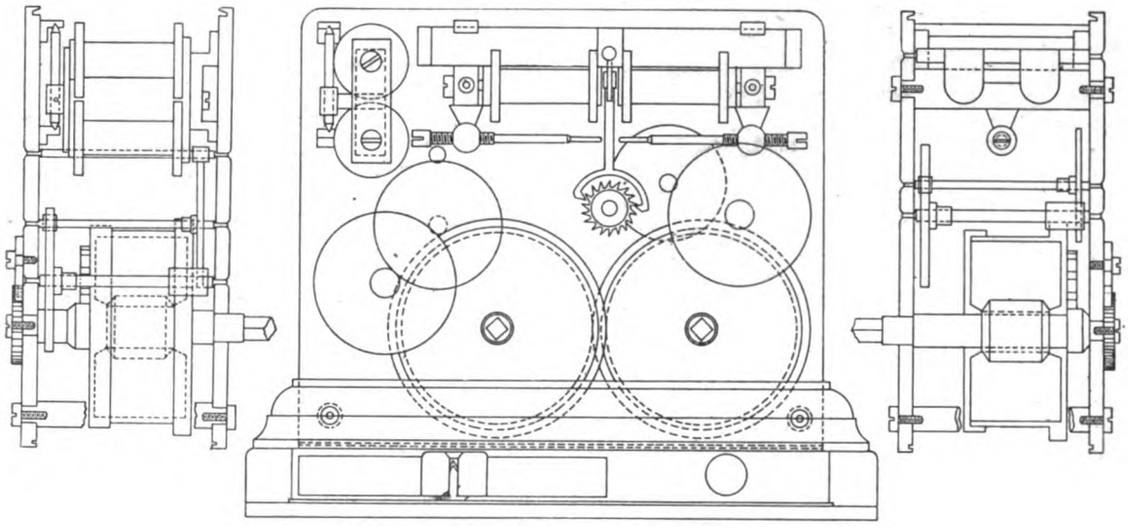

FIG. 1.—Receiver of the Higgins Type-Printing Telegraph Apparatus.

The transmitter is of the Wheatstone A.B.C. type having a horizontal circular keyboard with 36 keys, one for each letter of the alphabet, one for each numeral from 2 to 9, one for the negative sign, and a zero or blank key. The working current is generated by a magneto machine driven from a treadle by the operator, and the same movement drives through gearing a vertical spindle carrying a toothed wheel which normally engages with and carries a pawl round the circle formed by the keys, th gearing being so designed that the motion of the pawl from one key to the next corresponds exactly to a half revolution of the magneto armature and therefore to the duration of current in one direction. As there are 36 stops, there are 36 reversals of current to each complete revolution of the pawl round the key circle.

So long as all the keys are up, the toothed wheel on the spindle engages with the pawl (which is shaped like a bell crank), and the pawl in rotating holds by friction a lever against a contact button, and by so doing completes the line circuit through the magneto machine. On depressing any one key a small lever attached to it is pushed forward. As the spindle rotates one arm of the pawl strikes this lever and disengages the other arm from the toothed wheel, causing the pawl to stop at that point. At the same time it allows the contact to fall away from the contact button, disconnecting the current generator from the line. When a key has been depressed it remains down until the depression of another, the keys being restored by an arrangement of a thin chain and pulleys attached to them. Thus, supposing one key down, on

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depressing any other on the board the first one rises, allowing the pawl to engage with the revolving toothed wheel and to be again carried forward. The line circuit is then completed until the pawl strikes the lever of the newly-depressed key, when it again stops and the current to line is interrupted as before. A pointer is fixed to the pawl shewing the operator when and at what key it stops.

The receiver, shown in elevation and end-elevation in Fig. 1, consists of two trains of wheels driven by springs. One train works the type wheel, and is controlled by an escapement, A, attached to an armature, which is pivoted between two pairs of electromagnets, and so arranged as to oscillate in synchronism with the alternations of the line current. Each movement of the escapement allows the train of wheels to rotate the type wheel $\frac{1}{36}$th of its circumference. Thus 36 reversals of current cause the type wheel to make one complete revolution. As already stated, the pawl in the transmitter also makes one complete revolution with 36 reversals of

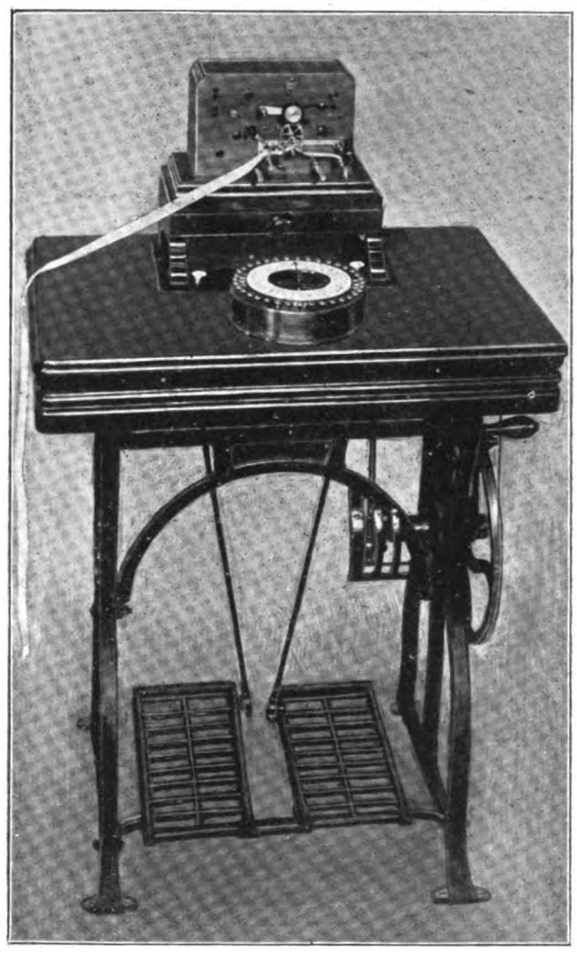

Fig. 2.—General View of the Higgins Type-Printing Telegraph Apparatus.

current, so that the pawl, pointer and type wheel move in synchronism, and, if arranged so that when the pointer is opposite any letter or figure on the keyboard of the transmitter, the same sign on the type wheel is undermost, then at whichever letter or figure the pointer is afterwards stopped the type wheel will be in a corresponding position, and the two will remain in synchronism as long as there is no external cause to upset the motions.

A synchronising mechanism is placed in the apparatus in case it should get out of step. In the receiver is a small lever, engaging by means of a pin a screw thread cut in the type-wheel spindle. This pin carries the lever against a stop, fixed to and rotating with the type-wheel spindle. After a certain number of revolutions of the type wheel spindle (if the printing mechanism is not in the meantime brought into play) this step holds it in position when the blank figure is undermost. Hence, if all the keys on the transmitter keyboard be lifted and the current allowed to flow to line for a few revolutions of the pointer, the type wheels in the receiver are turned a certain number of revolutions and then stop, with blank key ready for printing. If the blank key in the transmitter is now depressed, its pointer now stops at the blank. The pressing down of the key, as will be shown directly, actuates the printing mechanism, and the latter raises the lever, which is preventing the type-wheel spindle from rotating and releases the latter, the lever being at the same time pulled back by a spring to the commencement of the screw thread. The type wheel is now free to move, and rotates in synchronism with the pointer.

The second train of wheels in the receiving apparatus works the printing mechanism. It is controlled by the armature of an electromagnet so adjusted that when the alternating current is flowing the armature is held up and does not vibrate with the reversals of the current. When the current is interrupted this armature falls and releases an escapement which allows a sprocket wheel to rotate through a distance equal to the pitch of the sprockets. Each sprocket travels past a lever carrying the paper roller, and in passing lifts the lever at one end, causing the latter to press the paper against the type wheel. After lifting the lever end a certain height the sprocket slips past, and the lever drops back to its original position. At the same time it actuates the feed mechanism for the paper, which is moved forward by the proper distance in readiness to receive the impression of the next letter.

A detail, which, though a small one, makes a material difference to the possible speed of working, is that the type wheel is connected to its train of clockwork through the medium of a spring. Thus, both at starting and stopping, the spring helps to counterbalance the inertia of the mechanism.

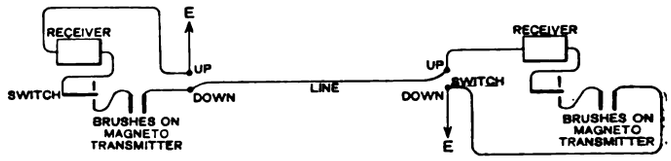

Fig. 3.—Connection Diagram.

The following is a summary of what occurs during the transmission of a signal: The operator presses down the key of the transmitter which corresponds to the letter or figure he wishes to signal; this stops the pawl, interrupts the line circuit, and leaves the type wheel of the receiver motionless, with the letter signalled undermost. At the same time the interruption of the line circuit causes the printing armature to fall back, releases the train of wheels which move the sprocket wheel, and forces the paper-carrying lever sharply up against the type wheel, prints the letter, and as the sprocket wheel continues to move forward the paper-carrying lever falls back, actuating the feed mechanism, and the paper is fed forward a certain distance. On depressing the key for signalling the next letter the first key rises, the pawl re-engages with the revolving toothed wheel, the current again flows and causes the type wheel to rotate, attracts the printing armature which it holds up until the current is again interrupted by the transmitter pawl striking the other lever of the second depressed key, and the same cycle of movements as before takes place. Fig. 3 will help to explain the action of the apparatus.

The main springs working the train of wheels are sufficient for the printing of about 1,000 words, and an indicator has been provided to show when re-winding is necessary.

One great advantage in this apparatus is that the working currents are generated by a very powerful magneto machine, which not only ensures the correct motion of the escapement but might in some cases enable the apparatus to be worked over a line so faulty as to cause a breakdown with other descriptions of instruments.

The apparatus is well constructed, compact, and any necessary adjustment is made with facility. Repairs will be seldom required but their execution should be easy. An experienced operator can work up to a speed of 25 to 30 words a minute with the instrument, and the manipulation is so easy that an unskilled person could learn it in a very short time.

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Instruments have been working between the Exchange Telegraph Co.'s office in Cornhill and their office in the Haymarket, with an added resistance of 1,500 ohms in circuit. Successful experiments have, we understand, been made between London and Folkestone, a distance of 60 miles. Trials were also made, with satisfactory results, at the Post Office before the Duke of Norfolk, Sir Spencer Walpole and Mr. Preece; and at the War Office before Lord Wolseley and members of his staff.

ELECTRICAL TRANSMISSION OF POWER IN MINING.

At the ordinary meeting of the Institution of Civil Engineers on Nov. 15th, Mr. W. B. Esson read a Paper with the above title.

The disadvantages attendant upon expensive transport of ore had been to a large extent neutralised by the electrical transmission of power. By using electrically-transmitted power the crushing mills could be placed at the mine, and the serious expense of transporting the ore to the site of the water-power could thus be saved. Generally, electricity furnished the only practicable means for transmitting power for mining operations, and the ease with which a copper wire could be carried over any kind of country, together with the plastic nature of the material, rendered the electrical conductor the simplest and most reliable of all vehicles for power transmission. Before deciding whether power transmission should be adopted, it was generally necessary to compare the cost of the alternative methods of (*a*) Bringing fuel to a mine to work the machinery by steam, and (*b*) Transmitting power electrically to a mine from a generating station situated at some convenient position for utilising existing water-power. The working expenses, added to the interest on the capital invested, made up in both cases the annual cost; but the question as to which alternative should be adopted depended largely upon the hours of working. For working 12 hours a day a result in favour of steam might be shown, while for a 24 hours' day the evidence might be largely in favour of water, depending upon the capital required to be expended in the hydraulic works.

The plant erected at the Sheba Gold Mining Company's mine for the electrical transmission of power to the crushing mills, five miles distant, was described, and the cost of milling was shown to be 1s. 8d. per ton of ore as against 6s. 1d. per ton when aerial ropeway transport was used, and £1. 12s. 6d. per ton during the time of ox-waggon transport. The water-power was obtained by a dam across the Queen's River, two miles above the generating station, to which the water was conveyed partly in open race and partly in tunnel. The maximum head derived was 32ft. The turbines were of the Victor horizontal type, driving a countershaft at 300 revolutions per minute by ropes, and were together capable of developing 396 H.P. They were provided with Snow governors, acting directly upon the turbine gate.

The generating-plant consisted of three alternating-current dynamos supplying current at 3,300 volts. Each generated two alternating currents having a phase difference of 90deg., and was capable of giving an output of 150 electrical H.P. The armature was stationary, and the field magnets rotated at a speed of 400 revolutions per minute. The stationary high-pressure coils were mounted on laminated iron sectors, which were laid close together in a strong cast-iron cylindrical shell made in halves to form the armature. This was 54in. in internal diameter by 12in. wide, and within it the field-magnet rotated. Each coil was wound on a former, and had 63 turns of double cotton-covered wire 0·12in. by 0·09in. in seven layers. The adjacent layers are carefully insulated by micanite cloth, while the complete coil was boiled in paraffin, and was afterwards heavily covered with impregnated tape to a thickness of $\frac{1}{16}$in. In addition, during the process of mounting, a trough of fibre was interposed between the coil and the iron core. There were 14 coils on the armature, the seven upper coils being for one phase and the seven lower coils for the other; each, therefore, contributed about 470 volts to the circuit. The coils were displaced to give the phase-difference by the interposition of idle laminated sectors.

The field-magnet was excited by a single coil and consisted of a steel wheel, from the rim of which projected two series of poles, N on one side of the coil and S on the other. The poles were expanded on the face, and were curved to form a circle of 16 alternate faces, which were presented to the armature core, with an air-gap of 0·33in. The exciting coil was wound on a cast-iron drum placed in the middle, between the projecting poles, and was positively driven by a couple of pins screwed into the steel casting. It terminated in a pair of gun-metal rings lying side by side upon, and insulated from, a substantial cast-iron bush, which in turn was keyed upon the shaft. The exciters were ordinary two-pole upright machines. For throwing the alternators into parallel the incoming alternator was plugged on to the synchronising bars, and when approximate synchronism was indicated by the hot-wire voltmeters it was thrown into the main circuit by closing, through a large choking-coil, a path between the synchronising bars and the main omnibus bars. The choking-coil prevented a large rush of current, due to difference of phase, between the alternators, though at the same time allowing sufficient current to pass to pull the new machine into step.

The current was transmitted by cables to the mine, and at the receiving-house the pressure was reduced to 100 volts for driving motors and lighting the workings. The frequency at which the plant worked was 53·3 per second. The conductors were laid underground, and consisted of concentric cables insulated with impregnated jute covered with lead and armoured. There was no fall of potential due to self-induction in the cables, nor had the current in one pair of conductors any inductive effect on the neighbouring pair. But when overhead wires were employed, the conductors, being of necessity some distance apart, there was not only a fall of potential due to self induction in the lines, but, unless precautions were taken, the mutual induction of the circuits carrying currents of a quarter-phase displacement tended to produce inductive dissymmetry throughout the system. Every length of cable was tested to a pressure of 10,000 volts before leaving the maker's works. Lightning-guards were fitted at each end of the line, to prevent accidents to the machinery from the effects of the induced charge.

At the receiving-house there were four transformers of 50 kilowatts capacity, two for each phase; these reduced the pressure from 3,000 volts to 100 volts. The use of oil for the transformers had been discarded after the experimental trials. The motors were of the induction type; their construction was fully described, and the author also explained their working under varying conditions, and gave a brief account of the laws which governed their action. The crushing mill at Sheba worked night and day; and in one year, of the possible 365 days of 24 hours each, the pressure had been cut off the conductors for only 4 days 8h. 22min., which had been chiefly occupied in inspecting the water-race, overhauling the belts, ropes, &c., and in executing general repairs to the machinery. The efficiency of the plant from the turbine shafts at the generating station to the motor shafts at the mine might be taken as 70 per cent.

SOME AMERICAN SUGGESTIONS TO EUROPEAN ELECTRIC TRAMWAY BUILDERS.*

If America may presume to make Europe certain suggestions regarding the building of electric tramways, a patient hearing may be hoped for, as it is generally recognised in all countries, we believe, that American experience in this particular branch of engineering is quite complete, though by no means wholly admirable. America has wasted—if we can call it wasting—so many millions in experiments that it observes, with something like a shudder, the danger that the same old weary course of trial and failure may be gone over again abroad.

First, as to roadbed. This is the foundation not only of a railway plant, but of its financial success as well. Nearly always by far the largest single item in the investment account, it is likewise almost the largest in the operating account if proper charges for repairs and depreciation are annually made. While by no means sure that the best present American practice is final or will be justified by results, we are confident that European practice in track building is in important respects less conservative and is inadequate for electric traction. European engineers do not appreciate, we believe, the tremendous pounding which the electric railway tracks have to stand from the motor cars, to say nothing of waggon traffic. It is true that there is no reciprocating motion in the motor, as in steam locomotives, to promote this pounding; but the slightest imperfection in the joint creates differences of level between the rails, which cause the car to fall upon the following rail and hit it a blow which greatly increases the trouble. With single-track roads both rails at an imperfect joint are hammered, and a hollow is thereby formed. Electric cars are always popular, are nearly always crowded with people, or are run at short intervals, and the blows thus being multiplied either in weight or in frequency, and their quickness of application being increased by high speed, the result, as we have found it in America, is that the best construction which we can make for joints and rails is hardly strong enough. It may be urged that the concrete foundations for track usual in Europe will cure this trouble; but this has not been American experience where tried, though there is undoubtedly some advantage in concrete foundations. The true remedy, as near as we can now judge, is, first, to use 60ft. rails, and so reduce the number of joints; second, to butt the joints together in paved streets; third, to increase the carbon in the rail, thereby giving it a hardness which will prevent the battering of the head; and, finally, to use a "square shouldered" section, so as to permit of accurate fitting of the joint plates and a strong vertical support—this whether the support be of iron cast around the joint or of wrought iron girder fish plates. Brittleness

* From the *Street Railway Journal*, of New York.

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in the rail due to hardness is not so much to be feared in tramway practice as softness, for a broken rail does not mean an accident, as on steam railroads, but merely the replacing of the rail. Hardness is advantageous not only at the joints but along the entire rail, since rails which have been in service longest show a wearing away of the rail head far greater than in horse railway practice, due, of course, to the self-propelling motive power employed.

Track special work—frogs, crossings, switches, &c.—ought, also, to be made of the best material, and with the greatest care. Some of the capitalists who are building electric tramways in foreign countries complain that they cannot get good special work from European makers, the latter still using cast iron largely, and following the old horse tramway methods, with results disastrous both to wheels and the special work itself. Transition curves should, of course, be made in all cases, and the greatest pains taken to provide for the easy movement of the car at all points on the road, curves as well as tangents. Great Britain is undoubtedly ahead of America in the care taken with track return circuits, and, in fact, has gone to an extreme in demanding low voltage drop in the earth. While a 7-volt drop generally means less electrolytic effect with pipes and wires, it does not always do so, since it is *current* which produces these troubles, and current can be obtained from low voltage in quite as great quantity as from high, providing only that the earth resistance be sufficiently low. In overhead construction, Europe has paid more attention, perhaps, to the ornamental than has America, and this is certainly right. With attractive poles and a simple and unobtrusive wire structure there can be no reasonable complaint on the part of municipalities with the overhead electric system, certainly in view of the great advantages of electric traction.

Power station equipment should be in the fewest possible units consistent with reliability of service. In early American practice we had stations with 20 and 30 small units. To-day these have nearly all been replaced, at heavy expense, by fewer and larger ones. Perhaps an ideal station for most conditions is one made up of five units, of which four are of the same size, and one but half that size. The small unit takes care of the night service, two of the larger should handle the every day traffic at its maximum, a third may be added on holidays and special occasions, and a fourth is always in reserve. A station arrangement of this character requires foresight in determining the probable maximum requirements of the future, as to load, but when this is once estimated it is better to determine the ultimate sizes of the units and purchase two (one for reserve), even in the beginning of the re-equipment than to buy smaller units to be replaced afterward by larger ones. It is needless to say that direct-connected units should always be employed, as belts are out of date for street railway work.

No fixed rules can be laid down for rolling stock except that all cars should be made as strong and durable as possible—far more so than for horse railway traffic. The tastes and habits of the people and local conditions otherwise must govern the seating arrangements and forms of cars chosen. Roof seats are popular almost everywhere, and though little used in America, it is not because people would not like them, but because, in the long run, it is believed that they would prefer speed of car and comparative immunity from accident. Americans have not been educated to climbing up and down a stairway to the car roof. It is impossible, of course, to speak within these limits in any but the most superficial and fragmentary way upon this general subject of adaptation of American experience to European conditions.

ELECTRICITY WORKS ACCOUNTS.

Bolton Municipal Electric Supply Works.

The Bolton undertaking commenced electricity supply on October 81, 1894; our analysis this week, therefore, covers the accounts of the third completed year of working.

The borrowed capital amounts to £60,000, out of which £57,038 has been expended, representing £76 per kilowatt of plant capacity. Exceedingly satisfactory is the rapid progress shown not only as regards increase in business, but also in the matter of economy of working; thus during 1897-98 the number of customers had risen from 237 to 390, and the equivalent 8-c.p. lamp connection from 19,477 to 32,000—an increase of 64·3 per cent. The output shows an increase on the 1896-97 figure of 55 per cent., being this year 341,888 units sold, while the average price obtained has dropped more than a penny to 4·7d. per unit.

A great reduction in the total costs per unit is noticeable which brings them down to 2·05d.—a figure well below the average of stations of similar output. Works costs contribute to this reduction by the amount of 0·5d., and management and property charges to the extent of 0·26d.

The net result of the working is a reduction in the ratio of costs to revenue of from 49 per cent. to 44 per cent. and a working profit of £3,771, which has been disposed of by an allocation of £918 to the depreciation fund, £1,410 to the sinking fund and the payment of £1,443 as interest on loans.

The detailed record below of the progress of the undertaking is interesting, and it may be stated that the lamp connection has been considerably increased since March last, being now the equivalent of 40,000 8-c.p. lamps with 500 consumers. We are also informed by the Corporation's electrical engineer that the capacity of the station has been increased from 750 kilowatts to 1,000 kilowatts, and that there are over 3,000 lamps awaiting connection to the mains and applied for.

Derby Municipal Electric Supply Works.

Electric supply at Derby was started a year before it was at Bolton, viz., on October 10, 1893; therefore, its fourth financial year was completed on March 31, 1898. Up to this date £60,784 had been borrowed at 3 per cent., and £65,909, representing £105 per kilowatt of plant, expended on capital account.

The output for 1897-8 was 340,783 units sold, being an increase of 15½ per cent. over the output of 1896-7. The average total revenue per unit comes out at 5·54d., as compared with 5·6d. for the year before.

Very substantial economies in working have been effected, as the total actual expenditure out of revenue has fallen in spite of the increased output, so that the costs show a reduction of nearly a penny per unit. It is chiefly through the items of works costs that the economy has been effected.

The working profit for the year was £3,221, representing 5·17 per cent. on the mean capital. £1,847 was set aside to the sinking fund, and £1,749 paid as interest on loans, resulting in a deficit of £374 to be met by the rates.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Ayr (Municipal)	Nov. 11	Kensington & Knightsbridge (Co.)	Sept. 30
Bedford (Municipal)	Mar. 4	Kingston-upon-Hull (Municipal)	Aug. 19
Belfast (Municipal)	Sept. 23	Kingston-upon-Thames (Mun.)	Mar. 25
Blackpool (Municipal)	Oct. 7	Lancaster (Municipal)	Oct. 21
Bournemouth (Company)	June 3	Leeds (Company)	April 8
Bradford (Municipal)	May 20	Leyton (Municipal)	Sept. 23
Brighton (Municipal)	May 6	Liverpool (Municipal)	Aug. 12
Bristol (Municipal)	July 29	Manchester (Municipal)	July 29
Burnley (Municipal)	Sept. 16	Newcastle and District (Co.)	Dec. 2
Burton-upon-Trent (Municipal)	April 15	Newcastle-upon-Tyne (Co.)	April 29
Bury (Municipal)	Nov. 25	Northampton (Company)	April 15
Cambridge (Company)	June 17	Norwich (Company)	Dec. 2
(Central) Kensington (House-to-House (Company)	Sept. 30	Notting Hill (Company)	Mar. 11
Charing Cross (Company)	April 22	Nottingham (Municipal)	Oct. 28
Chelsea (Company)	May 20	Oldham (Municipal)	Nov. 18
Cheltenham (Municipal)	Oct. 7	Oxford (Company)	April 1
Chester (Municipal)	Oct. 14	Portsmouth (Municipal)	Nov. 4
Clerkenwell (Company)	Mar. 18	Preston (Company)	Oct. 28
Dewsbury (Municipal)	Nov. 25	Reading (Company)	Sept. 16
Dover (Company)	Mar. 11	Richmond (Company)	Mar. 4
Dundee (Municipal)	Nov. 4	Scarborough (Company)	April 1
Eastbourne (Company)	July 22	St. James' & Pall Mall (Company)	July 1
Edinburgh (Municipal)	Oct. 14	St. Pancras (Vestry)	May 13
Exeter (Municipal)	Aug. 5	Shoreditch (Vestry)	May 27
Glasgow (Municipal)	Aug. 12	Southampton (Municipal)	June 3
Guildford (Company)	May 13	Stafford (Municipal)	Oct. 21
Halifax (Municipal)	Nov. 18	Sunderland (Municipal)	Aug. 19
Hammersmith (Vestry)	June 10	Taunton (Municipal)	Aug. 5
Hampstead (Municipal)	Sept. 9	Tunbridge Wells (Municipal)	July 22
Hanley (Municipal)	April 8	Walsall (Municipal)	Nov. 11
Harrow (Company)	Sept. 9	Wandsworth (Company)	Mar. 18
Hastings & St. Leonard's (Co.)	April 29	Westminster (Company)	April 22
Hove (Company)	May 6	Wolverhampton (Municipal)	July 15
Huddersfield (Municipal)	Mar. 25	Worcester (Municipal)	May 13
Islington (Vestry)	June 24	Yarmouth (Municipal)	June 17

Year.	No. of consumers.	Equiv. 8 c.p. lamp connection.	Capacity of plant. Kilowatts.	Max. supply demanded. Kilowatts.	Units generated.	Units sold.	Average revenue from supply per unit.	Working profit.	Sum carried to depreciation fund.	Carried to sinking fund.	Interest on loans.
Five months to—											
March 25, 1895	65	5,100	...	...	45,968	35,128	5·4d.	£945	...	£580	£957
Year ended—											
March 31, 1896	117	9,525	350	152	149,507	94,914	5·26d.	794	...	835	1,014
March 31, 1897	237	19,477	550	266	281,282	186,957	4·8d.	2,296	...	1,103	1,296
March 31, 1898	390	32,000	750	380	486,836	341,888	4·01d.	3,771	918	1,410	1,443

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	BOLTON.		DERBY.	
Undertaking Worked by	Bolton Corporation.		Derby Corporation.	
Date of Commencement of Supply	1894.		1893.	
System of Supply	Alternate-current transformer sub-stations, [also house transformers.		Alternate-current transformer sub-stations.	
Chief Engineer	Arthur Ellis.		J. E. Stewart (since resigned).	
YEAR ENDED	MAR. 31, **1897.**	MAR. 31, **1898.**	MAR. 31, **1897.**	MAR. 31, **1898.**
QUANTITIES—				
Units generated	231,104	486,836	318,245	383,601
„ **SOLD (TOTAL)**	186,957	341,888	295,084	340,783
„ sold to consumers	178,565	331,382	163,633	210,758
„ sold for public lighting, &c.	8,392	10,506	131,451	130,025
„ used on works	10,586	13,034	8,677	9,544
UNITS SOLD PER 8 C.P. LAMP CAPACITY	10·9	14.6	15·65	17·4
Maximum supply demanded	266	380	614 kilowatts	691 kilowatts
Number of public lamps	5 arc	5 arc	77	77
Number of consumers	237	390	—	317
Connections to mains in 8-c.p. lamps	19,477	32,000	17,000	21,600
CAPACITY OF PLANT IN 8-C.P. LAMPS	17,200	23,400	18,860	19,580
CAPACITY OF PLANT IN KILOWATTS	550	750	604	627
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£40,000 / £72·8	— / —	— / —	— / —
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	40,000 / 72·8	— / —	— / —	— / —
RECEIVED (TOTAL)	40,000 / 72·8	£60,000 / £80	£60,734 / £100·5	£60,734 / £96·8
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	40,000 / 72·8	60,000 / 80	60,734 / 100·5	60,734 / 96·8
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— / —	— / —	— / —	— / —
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	— / —	— / —	— / —	— / —
REPAID (TOTAL)	2,518 / 4·58	3,929 / 5·24	3,428 / 5·68	4,451 / 7·10
RESERVE OR SINKING FUND	— / —	— / —	873 / 1·45	1,772 / 2·83
DEPRECIATION FUND	— / —	— / —	— / —	— / —
EXPENDED (TOTAL)	46,901 / 85·2	57,038 / 76·1	58,651 / 97·1	65,909 / 105
Lands and buildings	33,774[a] / 61·4	40,094[e] / 53·5	11,916 / 19·73	11,941 / 28·3
Plant			25,313 / 41·9	28,096 / 44·8
Mains	13,127[b] / 23·9	16,943[f] / 22·6	20,871 / 34·6	25,361 / 40·4
Miscellaneous	— / —	— / —	550 / 0·910	555 / 0·877
BALANCE OF CAPITAL ACCOUNT	−6,901[c] / −12·54	+2,962 / +3·95	+2,083 / +3·45	−5,175[a] / −8·25
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£4,487 / 5·760d.	£6,694 / 4·695d.	£6,867 / 5·585d.	£7,877 / 5·543d.
Revenue from supply	3,737 / 4·798d.	5,720 / 4·015d.	4,073 / 3·313d.	4,955 / 3·488d.
„ meters, &c.	93 / 0·119d.	157 / 0·110d.	99 / 0·081d.	21 / 0·015d.
„ public lighting	— / —	— / —	2,429 / 1·976d.	2,408 / 1·695d.
„ sale of lamps, &c.	657 / 0·843d.	816 / 0·573d.	240 / 0·195d.	461 / 0·325d.
„ miscellaneous sources	— / —	— / —	26 / 0·021d.	33 / 0·023d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£2,190 / 2·811d.	£2,922 / 2·050d.	£5,167 / 4·200d.	£4,656 / 3·277d.
WORKS COSTS	1,544 / 1·982d.	2,110 / 1·481d.	4,140 / 3·369d.	3,541 / 2·493d.
Generation of electricity	*1,518 / 1·949d.*	*2,087 / 1·465d.*	*3,351[b] / 2·726d.*	*2,971 / 2·092d.*
Fuel (including cartage, &c.)	312 / 0·400d.	691 / 0·485d.	1,428 / 1·161d.	1,394 / 0·982d.
Oil, waste, water, stores	202 / 0·259d.	330 / 0·232d.	326 / 0·265d.	227 / 0·160d.
Wages at station	944 / 1·211d.	995 / 0·698d.	884 / 0·720d.	808 / 0·569d.
Repairs and maintenance at station	60 / 0·077d.	71 / 0·050d.	710 / 0·578d.	535 / 0·377d.
Distribution of electricity	*26 / 0·033d.*	*23 / 0·016d.*	*286 / 0·233d.*	*109 / 0·077d.*
Wages, &c.	1 / 0·001d.	4 / 0·003d.	22 / 0·018d.	42 / 0·030d.
Repairs, renewals of mains, &c.	25 / 0·032d.	19 / 0·013d.	264 / 0·215d.	67 / 0·047d.
Public lighting	— / —	— / —	*503 / 0·409d.*	*461 / 0·325d.*
Attendance	— / —	— / —	224 / 0·182d.	223 / 0·157d.
Renewals	— / —	— / —	279 / 0·227d.	238 / 0·168d.
MANAGEMENT AND PROPERTY CHARGES	647 / 0·830d.	813 / 0·571d.	1,027 / 0·836d.	1,115 / 0·786d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*227 / 0·291d.*	*224 / 0·157d.*	*180 / 0·146d.*	*217 / 0·153d.*
Management	*420 / 0·539d.*	*589 / 0·413d.*	*847 / 0·689d.*	*898 / 0·633d.*
Salaries	254 / 0·326d.	371 / 0·260d.		631 / 0·444d.
Stationery, &c.	63 / 0·081d.	57 / 0·040d.	747 / 0·608d.	56 / 0·039d.
Establishment charges	45 / 0·058d.	65 / 0·046d.		118 / 0·083d.
Law charges, &c.	58[d] / 0·074d.	96[h] / 0·067d.	100[c] / 0·080d.	93[c] / 0·066d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£2,296 / 5·52%	£3,771 / 7·26%	£1,699 / 3·01%	£3,221 / 5·17%
Sum carried to Depreciation Fund	— / —	918 / 1·77%	— / —	— / —
Sum carried to Reserve or Sinking Fund	1,103 / 2·65%	1,410 / 2·71%	1,867 / 3·31%	1,847 / 2·97%
Net interest on loans (incl. Debenture charges)	1,296 / 3·11%	1,443 / 2·78%	1,767 / 3·13%	1,749 / 2·81%
BALANCE FROM LAST ACCOUNT	— / —	— / —	— / —	— / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	— / —	— / —	— / —
Deficit	*103 / 0·248%*	— / —	*1,935 / 3·43%*	*374 / 0·601%*
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	48·8%	43·65%	75·3%	59·1%
Expenditure per kilowatt capacity	£3. 19s. 8d.	£3. 17s. 11d.	£8. 11s. 2d.	£7. 8s. 6d.
REVENUE PER KILOWATT CAPACITY	£8. 3s. 2d.	£8. 18s. 6d.	£11. 7s. 2d.	£12. 11s. 0d.
Expenditure per 8-c. lamp capacity	2s. 6½d.	2s. 6d.	5s. 5¾d.	4s. 9d.
REVENUE PER 8-C.P. LAMP CAPACITY	5s. 2⅓d.	5s. 8½d.	7s. 3½d.	8s. 0½d.
REVENUE PER 8-C.P. LAMP CONNECTED	4s. 7¼d.	4s. 2¼d.	8s. 1d.	7s. 3½d.
Price charged for lighting, per unit	6d.[g] to 3d.	6d.[g] to 3d.	6d.	6d. to 3d.[d]
Price charged for power, per unit			—	3d. to 1d.[e]
Price charged for public lighting			—	—

BOLTON.—REMARKS—*a* Inclusive of £2,532 to meters. *b* Inclusive of expenditure on transformers. *c* Over-expended. *d* Includes insurance, £27, and deputation expenses, £32. *e* Inclusive of £3,856 to meters. *f* Inclusive of expenditure on transformers. *g* By the maximum demand system, 6d. for first hour, 3d. after. *h* Includes insurance, £28, and "collection of accounts," £56.

DERBY.—REMARKS—*a* Over-expended. *b* Includes £3 to "miscellaneous." *c* Being insurance charges. *d* 6d. per unit for first 1½ hours, and 3d. after. *e* 3d. for first 18 hours per week, 2d. for next 18 hours, and 1d. afterwards.

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THE ROTATORY CONVERTER.

The session of the Institution of Electrical Engineers has opened auspiciously with a Paper by Dr. S. P. Thompson, which has the double merit of being topical and intrinsically valuable. Within the last year, the adoption on some of the more important electric railway works of alternating currents to transmit energy, to be eventually utilised in the form of continuous currents, has drawn the close attention of engineers to the processes and means of effecting this transformation. That such a means should be adopted at all seems on the one hand a triumph for the advocates of alternating currents, but from another point of view it might be taken as a declaration of the final bankruptcy of the alternating current motor for railway work. The validity of either of these views may be presently reconsidered. Contrary to what we might expect from Dr. Thompson, the historical information given is somewhat limited, and substantially the Paper confines itself to the consideration of one type of converter, viz., that having a single field with an armature having one winding, connected at one side to a commutator, and at points depending on the number of phases of the alternating current to slip rings receiving the alternating current. The Paper then deals with the questions arising out of such an arrangement, viz., the ratio between the continuous current and alternating current E.M.F.'s, the total load in the form of continuous current the machine will carry for any specified range of heating, whilst the effects of armature reaction, both on the brush-sparking question and on the regulation and parallel running are dealt with, but not in a conclusive manner. Dr. Thompson's Paper places the matter in a logically reasoned form, which helped by graphical means and novel diagrams, presents the general description admirably, whilst for the accurate working out of special cases tables arrived at by various

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investigators are given. In this and our two preceding issues, we have given our readers a *résumé* of one of these investigations, published by Mr. G. KAPP in the *Electrotechnische Zeitschrift*, opportunely accompanying the present Paper and discussion. The features, perhaps new to most engineers, disclosed by these Papers are, first, the superiority for use with such converters of four-phase currents derived from a two-phase supply over three-phase currents; second, the fact of the very unequal heating of the wires on different parts of the armature winding. As to the first of these points, the investigations, above referred to by Kapp, Steinmetz and others, show that the possible output increases with the number of phases, and even at six phases the limit is by no means reached, it then being double of that possible with single-phase currents; and it may be that this points to a line of evolution where the generator will have as many coils as a continuous-current machine, the line wires will be the connections between the armature coils and commutator, and the commutator rotated synchronously at the receiving end will deliver continuous current. In the discussion which ensued upon Dr. THOMPSON'S Paper, we find that divergence of views between men equally capable of forming an opinion to be expected in a subject in which so little comparatively has been done. Notwithstanding the use of these converters for electro-chemical purposes at Niagara, and for railway work in America and England, there seemed a strong tendency of opinion that the gain in efficiency and first cost over the motor generator was (except when exact regulation is not wanted) rather dearly bought, owing to the inherent difficulty of regulation, whilst Mr. E. K. SCOTT, impliedly supported by Dr. THOMPSON, suggested that in the case of the Central London Railway there was no reason whatever to effect the conversion at all, as polyphase motors might equally well have been used. To summarise the views of the various speakers, it seems generally admitted that the single-phase rotatory converter is not, except in small sizes, an advantageous machine to use, and the experience of Prof. MENGARINI at Rome may be taken as a typical instance. There the single-phase converters are being replaced by motor generators, on account of difficulties with sparking due to the periodic fluctuation of the armature field, and to the difficulty of hunting when running in parallel. It is, further, generally conceded that, where the continuous-current pressure has to be regulated over more than a few volts, the boosters, variable-ratio transformers, or equivalent devices absorb any advantage over the motor-generator. Then, again, except where the frequency is low, say 40 $\sim$ per second or lower, the large number of poles and brushes on the machines places them at a disadvantage. But where three, four, or more phases are used, with low frequency currents, and where no very extended range of regulation is necessary, the rotatory converter has given and will continue to give satisfaction.

No doubt the reading of the Paper and the discussion will be fruitful in directing further attention to the subject, both on its theoretical and experimental side. One suggestion may be incidentally offered here. Whereas in a continuous-current generator the only change in current is that occurring under the brush when the coil is not in circuit, in the case of a rotatory converter it occurs during every part of the revolution. This effect of self-induction should, it seems to us, receive attention, both as to the modification it produces in the ratio of E.M.F., and also in its effect as to pulsations in the continuous current delivered.

THE THEORY OF THE ROTARY TRANSFORMER.

BY GISBERT KAPP.

(COMMUNICATED BY LLEWELYN B. ATKINSON, A.M.I.C.E.)

(*Concluded from page 153.*)

Four-phase Rotary Transformer.—A two-phase system of currents can only be utilised in a rotary transformer by a system of connection to the armature analagous to that called the *mesh* coupling in the case of three-phase currents, with the result that the working is that of a four-phase system. In Fig. 5, a_1 a_2 are the points of connection of phase a, and b_1 b_2 those of phase b. The brushes are d and f. If we consider the direction of the continuous current as positive, in the quadrant $a_1 b_1$, both alternate currents are negative; in the quadrant $a_1 b_2$ the current of the a phase is negative, that of the b phase positive.

The resultant two-phase current in the quadrant $a_1 b_1$ is

$$i = -J(\cos\alpha + \sin\alpha),$$

where J is half the maximum value of the current in each phase.

This expression holds good for all positions, the angle α being reckoned from the line $o d$.

Bearing in mind the trigonometrical relation,

$$\cos\alpha + \sin\alpha = \sin\left(\alpha + \frac{\pi}{4}\right)\sqrt{2},$$

we have

$$i = -J\sqrt{2}\sin\left(\alpha + \frac{\pi}{4}\right),$$

and the maximum value of the resultant alternate currents is

$$J\sqrt{2},$$

the current and E.M.F. being considered in phase as before. The maximum value is reached for $\alpha = \frac{\pi}{4}$, that is, in the case

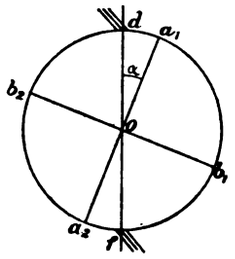

FIG. 5.

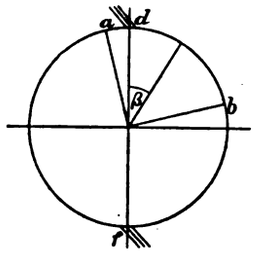

FIG. 6.

where the quadrant is exactly in front of the pole. In this case also is the E.M.F. of the $\frac{z}{4}$ wires contained in the quadrant a maximum, whilst it is zero when the quadrant is symmetrically disposed about a brush.

The effective value of the alternate E.M.F. is

$$e_a = \sim \mathrm{KN}\,\frac{z}{4}.$$

The coatinuous current E.M.F. is

$$e = \sim \mathrm{N}z,$$

so that

$$e_a = e\frac{k}{4}.$$

If the effective value of the current in a quadrant is J, the power of each phase of the alternate current in a quadrant is $Je\frac{k}{4}$, and for the whole armature JeK.

This is also (neglecting the losses) the power in the continuous current, so

$$2ec = JeK,$$

$$J = \frac{2}{K}c.$$

The maximum value of the resultant alternate currents in a quadrant is $\sqrt{2}$ this value, or

$$J_1 = \frac{2\sqrt{2}}{K}c,$$

$$J_1 = \eta c.$$

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The value of K depending on the proportion between the coil width and pole pitch, we have for $m=\frac{2}{3}$, $\eta=1{\cdot}32$, and for $m=\frac{1}{2}$, $\eta=1{\cdot}21$.

If there is a difference of phase, J_1 must be increased in the proportion $\cos\phi:1$, and the value of η must be divided by $\cos\phi$.

Next, the power lost in copper heat may be considered the assumption of no-phase displacement being made. To simplify the calculation, the angle β (*see* Fig. 6), which the centre line of the quadrant makes with $o\,d$, may be used, and

$$\beta=a+\frac{\pi}{4},$$

$$i=c\eta\sin\beta.$$

In order to arrive at the lost power in each quadrant, integrate the work between limits $\beta=o$, $\beta=\pi$, and divide by the semi-periodic time. The integration is taken at three stages, viz., $\beta=o$ to $\beta=\frac{\pi}{4}$, $\beta=\frac{\pi}{4}$ to $=\beta\frac{3\pi}{4}$, and, lastly, $\beta=\frac{3\pi}{4}$ to $\beta=\pi$. The last is numerically equal to the first. In the instantaneous position (shown in Fig. 6), the current in

$$ad=c+c\eta\sin\beta,$$

$$bd=c-c\eta\sin\beta.$$

Taking into consideration the length of the coil the differential of the lost power is

$$\left\{c^2(1+\eta\sin\beta)^2w\left(\frac{\pi}{4}-\beta\right)+c^2(1-\eta\sin\beta)^2w\left(\frac{\pi}{4}+\beta\right)\right\}dt,$$

and

$$dt=\frac{d\beta}{2\pi\sim}.$$

The first and last stages of the before-mentioned integral are given by the expression

$$A_1+A_3=\frac{c^2w}{2\sim}\int_0^{\frac{\pi}{4}}\left(1+\eta^2\sin^2\beta-\frac{8}{\pi}\eta\beta\sin\beta\right)d\beta,$$

which evaluated gives

$$A_1+A_3=\frac{c^2w}{4\sim}\left\{\frac{\pi}{2}+\eta^2\left(\frac{\pi}{4}-\frac{1}{2}\right)-\frac{8\sqrt{2}}{\pi}\eta\left(1-\frac{\pi}{4}\right)\right\}.$$

For the second stage the lost power is

$$A_2=\frac{c^2w}{4\sim}\int_0^{\frac{B\pi}{4}}\left(1+\eta^2\sin^2\beta-2\eta\sin\beta\right)d\beta.$$

Evaluated this gives

$$A_2=\frac{c^2w}{4\sim}\left(\frac{\pi}{2}+\eta^2\left(\frac{\pi}{4}+\frac{1}{2}\right)-2\eta\sqrt{2}\right).$$

The total power lost in one quadrant is

$$\frac{A_1+A_2+A_3}{\frac{1}{2}}=(A_1+A_2+A_3)2\sim,$$

and for the whole armature is four times this value, or,

$$P_v=8\sim(A_1+A_2+A_3).$$

Working this out with the above values gives the following result:—

$$m=\tfrac{2}{3},\quad K=2{\cdot}13,\quad \eta=1{\cdot}32,\quad P_v=2{\cdot}24c_2w,$$
$$m=\tfrac{1}{2},\quad K=2{\cdot}32,\quad \eta=1{\cdot}215,\quad P_v=2{\cdot}20c_2w.$$

If the same armature is driven by mechanical power developing continuous current $2c_1$, the loss would be

$$P_v=6{\cdot}28\,c_1^2w,$$

and substituting the values above, we find that for

$$m=\tfrac{2}{3},\quad c=1{\cdot}67c_1,$$
$$m=\tfrac{1}{2},\quad c=1{\cdot}69c_1.$$

In other words, as a rotary transformer, the machine will deliver from 67 per cent. to 69 per cent. more current than when mechanically driven. The figures also show that for a four-phase machine the ratio m is unimportant.

Three-phase Rotary Transformer.—Following a similar process, Mr. Kapp investigates the case of a three-phase transformer, with these results:

$$m=\tfrac{2}{3},\quad K=1{\cdot}94,\quad \eta=1{\cdot}45,\quad P_v=3{\cdot}28c^2w,\quad c=1{\cdot}38c_1,$$
$$m=\tfrac{1}{2},\quad K=2{\cdot}12,\quad \eta=1{\cdot}33,\quad P_v=3{\cdot}02c^2w,\quad c=1{\cdot}44c_1;$$

that is, the machine delivers from 38 per cent. to 44 per cent. more as a rotary transformer than as a mechanically-driven generator.

Six Phase Rotary Transformer.—By carrying the independent ends of the secondary coils of the three phases of a three-phase system, to slip-rings connected to opposite points of the armature, the system becomes a six-phase one, and a similar investigation may be carried through in this case.

Finally, all these results may usefully be summarised in a table, in which for comparison the values obtained in the limiting case proposed by Steinmetz, where the field is sinusoidal in value, are also set out.

Table showing the Output of Rotary Transformers as percentage of the Output of the same Machine used as a Mechanical Generator:—

Type of transformer and phase displacement.		Theoretical limiting case by Steinmetz.	Pole width.	
			$\frac{2}{3}$	$\frac{1}{2}$
Single-phase	$\cos\phi=1{\cdot}0$	85	88	95
	$\cos\phi=0{\cdot}9$	...	81	88
	$\cos\phi=0{\cdot}8$	...	73	80
	$\cos\phi=0{\cdot}7$	...	63	70
Three-phase	$\cos\phi=1{\cdot}0$	134	138	144
	$\cos\phi=0{\cdot}9$	...	128	137
	$\cos\phi=0{\cdot}8$	...	117	126
Two or four-phase	$\cos\phi=1{\cdot}0$	164	167	170
	$\cos\phi=0{\cdot}9$	...	160	167
	$\cos\phi=0{\cdot}8$	...	144	158
Six-phase	$\cos\phi=1{\cdot}0$	196	198	199
	$\cos\phi=0{\cdot}9$	...	192	196
	$\cos\phi=0{\cdot}8$	...	177	188

ROTATORY CONVERTERS.

The following is an abstract of the discussion which took place at the Institution of Electrical Engineers on November 10th and 24th, in connection with Prof. Silvanus P. Thompson's Paper on this subject. Speakers who have returned their proofs revised are denoted by an asterisk:—

DISCUSSION.

* Mr. M. B. FIELD said that the manner in which the author had dealt with the distribution of the currents flowing in the armature and the local heating of the different parts of the armature was very interesting, and particularly so because he had dealt with these matters without formulæ and without complicated diagrams, and, therefore, people like himself could readily understand his arguments. But he felt that particulars were missing of the way in which these rotatory converters worked in practice. Dr. Thompson had asked him to give some more particulars of the 30 kilowatt converter he referred to in his Paper. Fig. 14 showed the winding scheme, but there was a slight difference between that and the actual machine, viz., the slip rings were shown connected to the opposite side of the armature to what they actually were. In designing this machine he thought he gained a great advantage by choosing a number of conductors divisible by 16. The slip-ring connections divided the winding up into eight parts, and not only should all these subdivisions be exactly similar, but each should contain an even number of conductors; so that all the slip-ring connections might be brought out at the same end of the armature. The advantage of having such a number as this was again of value, because they got a number of commutator segments which was divisible by four, so that the brushes stood upon the commutator segments in exactly similar positions. When one brush was short-circuiting they were all short-circuiting, and this way they had perfectly symmetrical windings. The table immediately following Fig. 14 was taken when the converter was running as a continuous motor. The field was separately excited and the commutator voltage adjusted until the speed was exactly 1,200 revolutions per minute. He had the good fortune to be in the power station where this converter was supplying the excitation for the generators when there was a short-circuit on the mains. The converter was connected in parallel with a small turbine driven exciter, which was only about one-seventh the capacity of the converter. Of course, the voltage sank down to zero at once and the machinist wanted to switch everything out. But they let everything alone. The short-circuit lasted for about 15sec., a fuse blew, and the tension came up and nothing happened. Although the tension was reduced to zero, the converter was still in step and was delivering its proper share of the current. The heating of the poles of this converter was very considerable, but he attributed that principally to the proportion between the width of the slot and the air gap. He thought the question of pole heating a rather important point. One might imagine that the pole heating was very considerable in these converters, owing to the very peaky form of the resultant current in the armature conductors. Prof. Thompson had dealt very fully with the comparison of the heating of armature conductors in the rotatory converter and the corresponding continuous current machine, but he had not dealt with the pole heating. He noticed that

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the Central London Railway converter had laminated poles, but the Oerlikon converter had solid poles, and it would be very interesting if Dr. Thompson would tell them how many of the machines he had shown upon the screen at the previous meeting had solid poles, and how many had laminated poles. Dr. Thompson had exhibited one converter with two completely independent windings for working on a three-wire system. It was interesting to note that two converters working in parallel on the three-phase side could not be connected up to a three-wire distribution on the continuous current side. It was, however, possible to make use of the neutral point of the transformers on the three-phase side as a starting point for the neutral wire of the three-wire continuous current distribution. He had gone into this matter about six months ago, and found that if they got one side more loaded than the other they got a small current superimposed on the continuous side of three times the frequency. With regard to a variable ratio, this was of considerable importance when they wished to vary the voltage in a simple way. The auxiliary booster on the same shaft was expensive on account of the large size of the commutator needed. Something quite special had to be made. It was easy to see that if they insisted upon a variable conversion ratio they must get reaction in the machine. They could only obtain one at the expense of the other. There was one other way of making the continuous-current voltage depend upon the excitation, and that was by the use of transformers with much magnetic leakage. With such transformers, if the current lagged the voltage fell, if the current led the voltage rose. In a rotatory converter they had simply to either over or under-excite in order that the current might lag or lead. He had heard of a case where the transformer was specially leaky in order to obtain a large variable ratio. With regard to the hunting of converters, Dr. Thompson had thrown out the suggestion that the cure for the hunting effect or oscillating effect might be found in designing their rotatory converters with very stiff magnetic fields, which are not very easily disturbed by the reaction effect of the armature current. This might help them a great deal. Alternate current designers were all tending to work in the direction of small air-gaps and producing very stiff fields, but it did not necessarily follow that because a certain air-gap was necessary to keep down the self-induction of the armature winding the whole of it must be at the pole surfaces. Mr. Kapp in 1894 worked machines with small air-gaps. Between each segment of the armature he interposed an air-gap of ⅛in., and claimed that this was of special advantage in keeping down the self-induction. The main thing was to bring the windings as near as possible to the poles, so that the effects of the armature currents could not blow the field out sideways.

* Mr. JAMES SWINBURNE said that if they would start by thinking of the ordinary direct-current motor generator, they had a machine in which the power was poured in at one pair of wires and poured out with absolute uniformity at another pair, so that the only work the machine had to do was really to work its own commutators; but as soon as they came to working with alternate currents the machine had to do a little more. It had to be able to store up the energy by going slower or faster during a fraction of a period only. It must, of course, preserve its synchronism. If they could get over that difficulty or reduce the amount of energy to be stored up in each portion of the apparatus, they would get a machine very much smaller, for in the extreme case of two direct-current machines the armature was simply rotating to work the commutator. But there was another thing that came in at once, and that was that as soon as they had a current in the opposite direction on the armature they could do away with their air-space. In early days the air-space was very little understood. Now the chief application of the air-space was to get the excitation on the fields approximately right or properly proportionate to the excitation on the armature, to avoid cross induction and armature reaction generally. There was another matter which came in at the same time, and that was the lead of the brushes and sparking. Dr. Thompson had put this down as being first known in 1888, but it was known very early in the eighties. He did not think the question of "hunting" of parallel machines was confined to this particular converter. The hunting of machines was first discovered by Mr. Harrison, who made some experiments at Faraday House some years ago. His own explanation was that, suppose they had two alternators in parallel, let them imagine that one was doing a little more work than it ought to, and the field got altered by the armature reaction. Some years ago Lord Rayleigh pointed out in a lecture on electrical tuning forks that the fork would work only because the self-induction was so great that the pull both ways was not in synchronism with the contact in the mercury, and he also had explained the fact that the lag was the cause of the working. There was a simple application of the same idea to parallel machines. If the machine corrected itself instantly there would be no tendency to get out of step, but if a machine was doing too much work, then it altered its field, and even went on doing too much work when the field was right again, with the result that it got on the other side and did too little work. Then correction and over correction in the opposite direction took place. Mr. Field seemed to think they could get over this hunting effect by having non-laminated magnets. A "stiff bristly field," to quote Mr. Field, was a kind of nomenclature he objected to—simply because he did not know what it meant. He noticed that Prof. Thompson had altered the nomenclature from "rotary" to "rotatory." He would remind the Professor that the Institution was an electrical institution, and not a high school for girls. He (Mr. Swinburne) approved of the word dynamotor. As an English word it was indefensible, and that was why he had introduced it. There was not much to add to what Mr. Field had said as to the question of altering the E.M.F., but he did not think it was quite correct to take an armature uniformly all round and then find where the uneven losses and heat occurred. Some years ago he wanted to design one of these particular machines for transforming single alternating current into direct current, and, instead of working uniformly all round, he attempted to use wire of different sizes all round. But the calculations involved in this were so troublesome that he gave up the idea. Still, he thought such a thing would have to be worked out eventually with large machines, but the difficulty with it was that these machines were special machines for small air spaces, and if they had the wires embedded they then got into the difficulty of the holes not being uniform if they had the windings of different sizes.

* Mr. W. B. ESSON said that, if he remembered rightly, the rotary converter was first exhibited at the Frankfort Exhibition. Dr. Thompson had referred to the work of Lahmeyer. He did not remember very clearly about Lahmeyer, but he remembered very clearly the number of interesting machines exhibited there by Schuckert and Co. These machines fascinated most of the visitors from England. When he came home the first thing he did was to put slip rings on a dynamo and watch the results obtained in taking alternating or continuous-currents from the machine. The Table he exhibited showed the ratio between the alternate current and

150-Light Compound Dynamo; Speed, 1,180 revolutions per minute.

Amperes	0	12·5	20·5	36·0	65·8	74·7	90·0
Volts	95	99	102	102	102	102	102

Table I.

Direct.		Alternating.		Direct.		Alternating.	
Amps.	Volts.	Amps.	Volts.	Amps.	Volts.	Amps.	Volts.
0	95·0	0	68·2	77·0	99·0	30·0	74·0
0	85·0	30·0	58·0	86·5	100·0	30·0	75·0
16·0	92·0	30·0	65·2	92·5	100·5	30 0	75·0
27·0	93·0	30·0	67·5	38·0	94·0	58·5	63·0
36·0	94·0	30·0	69·0	49·0	101·0	32·4	72·0
42·5	96·0	30·0	70·5	54·0	96·5	52·4	68·0
49.0	97·0	30·0	70·5	60·0	99·0	36·5	72·0
71·0	98·5	30·0	74·0	79·0	100·0	31·0	74·5

Table II.

Direct.	Alternating No. 1.				Alternating No. 2.
Amps.	Volts.	Amps.	Volts.	Amps.	Volts.
0	70·3	32·0	51·5	32·0	50·5
16·0	86·0	32·0	64·5	32·0	63·0
29·0	89 0	32·0	66·5	32·0	66·0
43·0	91·0	32·0	69 0	32·0	70·0
57·0	94·0	32·0	72·0	32·0	71·5
63·0	95·0	32·0	71·5	32·0	72·0
70·0	95·0	32·0	71·5	32·0	71·5

direct current very clearly. The machine was bipolar, and was tested, having a direct and alternate current taken out of it at the same time. The alternate current was kept constant at 30 amperes while the direct was increased, and the table also showed the effect of the reaction in the field due to the alternating current. At no load the machine gave 95 volts; immediately the alternating current was put on, it gave only 85 volts. When tested as a compound machine, the volts very soon rose. Working with the ordinary two-phase arrangement, *i.e.*, taking two alternating currents out of the machine in addition to the direct current, the volts only reached 70. He thought these were the first experiments made in this country on a direct-current dynamo with slip rings. As a general principle, he supposed that the more tappings they had in the continuous current winding for the alternating current, the more energy they could convert with the apparatus. For instance, with a single-phase machine there were two tappings; with a three-phase, three tappings; and with a two-phase, four tappings. The result was that they got out of the two-phase the greatest amount of energy for a given size of machine, and, at any rate, with rotatory converters, two-phase distribution was very much superior to three-phase, because something like 25 per cent. more energy was got out of the machine. With regard to the see-sawing action which had been mentioned, it certainly did require more investigation, but he would like to ask the author whether it was not true that it was extremely necessary to have the form of wave given by the generator correspond exactly with the wave given by the alternate current part of the convertor. A good deal of the see-sawing action also, he thought, was due to the fact that the ratio altered with the excitation of the field magnets. It was rarely that the ratio was exactly the same in different convertors, and the consequence was that currents passed between the machines. This he had been told by American engineers of great experience. There was a great deal of difficulty in deciding whether they should use a rotatory converter or an induction motor with a dynamo attached to it. And these difficulties increased when it was known that in some stations where rotatory converters had been in use they were now installing alternate-current motors with dynamos attached instead, and in other cases *vice versâ*. He thought the rotatory converter had mostly been used in tramway work, in which the absolute regulation of the voltage was not of paramount importance. Again, a tramway generally worked across a two-wire system, whereas in lighting a three-wire system was necessary, and when they came to balance up the cost of, say, an induction motor with an ordinary dynamo coupled to each end against that of a rotatory converter constructed for a three-wire system, with all the complication of poles and brushes entailed, the balance would be little, if any, in favour of the latter. At the present moment he was connected with the laying down of the first two-phase central station in this country, and they would have to convert in several districts alternating into direct

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current. This was being done by induction motors with dynamos coupled at each end of the shaft, and working on the three-wire system. One of the reasons for not using rotatory converters he confessed was because they did not know so much about them as they did of the other type, and what information they had got was not wholly satisfactory. Another point was that rotatory converters were not suited for such frequencies as could be employed for lighting. When they got a converter suitable for a frequency of 50, it had just as many poles as the ordinary alternator with all the brushes added.

Mr. H. M. HOBART sent a communication in which he stated that to his mind the cure for all erratic tendencies of the kind mentioned in the Paper was to be found in using for the generating plant steam engines which had a more uniform angular velocity. This was also the very foremost of the difficulties which attended the paralleling of alternators. He considered that there was now no necessity for tolerating this phenomenon of "hunting." He had some cases in mind where considerable difficulty was at first encountered on this score. The rotaries were specially designed with laminated pole pieces for the purposes of eliminating eddy currents, and with perfect speed conditions this would have resulted in a higher commercial efficiency than with solid pole faces, since with the latter there was a higher eddy current loss than for the corresponding continuous current generator owing to the cyclic rise and fall of the alternating current component of the resultant current in the armature face conductors as they swept past the solid pole faces. But the elimination of this loss deprived the machine of the use of the induced currents in the pole face for tending to keep the armature rigidly in synchronism. It became necessary to resort to devices to correct the trouble, and these devices involved some sacrifice as regards efficiency, the amount being entirely dependent upon the closeness of the regulation of the engine. With first-class multiple crank engines with liberal flywheel capacity, the loss in efficiency would rarely, he thought, exceed 1 per cent. But unless a fair engine specification was rigidly adhered to, it might often run to 2 or 3 per cent. He also thought the triple concentric cables were troublesome in the balancing of the voltage. Symmetrically arranged, three-core cables were more satisfactory, but instead of employing one three-core cable to transmit the current, it could with advantage be divided up into two or three cables in multiple. He recalled cases with troublesome engine speed and no corrective devices, where attempts to run two rotaries in parallel had often resulted in failure when only one three-core cable was in service, although this was of ample capacity. The throwing in parallel of another similar cable permitted the parallel running of the rotaries. The main argument in favour of rotatory converters and static transformers, as compared with the motor generator method, was based upon the lower first cost and the higher combined efficiencies. As an example in the Blackrock sub-station of the Dublin electric tramways, where 30 periods 200 kilowatt rotatory converters were fed by oil circulation transformers, the combined efficiency being 92 per cent. at full load and 91 per cent. at half-load, the cost of the equivalent motor generator set would have exceeded that of the combined cost of rotary and transformers by 10 per cent., and its combined efficiency would have been 85 per cent. at full load and 82 per cent. at half-load. But the very high efficiency obtained in Dublin involved higher cost, (particularly as regards the static transformers) than in another case where air blast transformers were used. Here, at an efficiency of 90 per cent. at full load, the combined cost was only 80 as against 100 for the Dublin sets and 110 for the motor generator sets, However, the motor generator was much more flexible than the rotatory converter as regards independent control of the alternate-current phase relations and the continuous-current voltage and output conditions. The range of adjustment of the commutator voltage in the case of the rotary converter was only obtainable by virtue of lagging and leading currents, or else by reverting to auxiliary boosters or to variable-ratio transformers. All such additional appliances tended to cut down the margin of advantage. Long ago he had investigated the matter of the resultant C^2R values in the armature conductors of a three-phase rotary, following practically the same plan as that adopted by the author, but he had also deduced values for other power factors. The results were: for power-factor unity the resultant C^2R was 58 per cent. of that of the same armature in a continuous-current generator of the same output; for a power factor of 0·87, it was 85 per cent.; for 0·5, 37·5 per cent.; and for 0, 0 per cent. These results were on the assumption of 100 per cent. conversion efficiency. He did not think that sufficient emphasis had been laid upon the fact set forth by Steinmetz and Kapp, that in six-phase rotaries the alternating and continuous-currents in the armature cancel each other so much more effectually, and, while as regards armature heating the three-phase rotatory converter had an advantage of 34 per cent. over the same machine operating as a continuous-current generator, the corresponding advantage possessed by the six-phase rotary was no less than 95 per cent., *i.e.*, almost twice the output must be taken from it for equal armature heating. Nor did it introduce much complication. The high-potential circuits, both line and static transformers, remained exactly the same as for three-phase. The only difference was that all secondary terminals were carried in the sub-station from the secondary terminals of the three-phase transformers to collector ring on the rotary converter. In such a case one would arrange not to have any switches in the low-tension alternating-current circuits, thus avoiding complications at the switchboard. In rotary converters the current was incompletely commutated. In a certain plant once he interposed the 300-volt coil of an 80 kilowatt transformer between the negative 'bus bar and the rail, and had the current been really uniform there would have been but a trifling drop, say, 5 volts, through the ohmic resistance of the transformer coil. But there was a very considerable drop across it. The interposition of the resistance of this coil reduced the telephonic disturbances on a branch of the telephone system which used a ground return, hence before its interpolation the pulsation of the current was probably much more marked. When this rotary converter was subsequently got into thorough working order the telephonic disturbances on this grounded circuit became so slight as to cause no comment. He thought the 16-pole 600-kilowatt machine, running at 188 revolutions per minute, at the Schenectady works, must be a quarter-phase rotary and not a three-phaser. This showed the ratio conversion to have been in accordance with general practice.

* Mr. W. M. MORDEY mentioned that he had seen many converters working in America and on the Continent, and had observed an interesting fact with regard to the hunting. It was considerably lessened if not done away with altogether by putting a short-circuited coil of copper round the field. This was an old method for various purposes, but he thought it was interesting to mention it on account of what Mr. Field had said about the alternative difficulties of laminated poles which did not check see-sawing, and solid poles which checked see-sawing but wasted power. Obviously, if eddy currents were useful for steadying purposes, they should be applied to give the greatest effect with the least loss; they should surround the core, and should have copper circuits provided for them instead of iron. The right way would seem to be to use laminated poles with a closed copper circuit round them. The author, who was a master of exposition, had given an admirably simple and clear treatment of a very difficult subject.

* Mr. A. J. LAWSON referred to the see-sawing of rotatory converters, and said that two years ago he went over the Tivoli-Rome transmission installation, and Prof. Mengarini had told him that he had a great difficulty with any converter of over 60-kilowatt output, and he strongly recommended for tramway work the use of motor generators. Since then he believed these had been put in for the larger sizes. A few months ago he went over the Paderno-Milan installation, where three-phase generators were used at a distance of 21 miles from the station, and in the old Edison stations they were now putting in motor generators to transform both from the high-voltage three-phase to 220 volts for the Edison three-wire system for lighting, and also for the 500-volt tramway system. There the motor generators had been used exclusively, and they had a flexibility with motor generators that could not be obtained with rotary converters. At this latter installation the machines had been tested up to 20,800 volts, and for the last three months had been working at 13,500 volts without any step up transformers, and as these voltages could be taken out of the machines they could also be put into them and the continuous current machines kept quite independent. He would like to know if Prof. Thompson had got at his fingers' ends the relative costs and efficiencies of motor generators and rotary converters of sizes from 200 kilowatts and upwards.

* Prof. CARUS-WILSON said it was well-known that the load at which an alternate-current motor, running synchronously, fell out of step depended very largely upon the heating of the armature. Referring to Mr. Field's experience with a short circuit on a converter, he (Prof. Carus-Wilson) ventured to predict that if it had been a synchronising motor running a direct-current generator, the synchronous motor would have fallen out of step. He was inclined to think that the satisfactory result must have been due to the fact that, although the current output on the direct-current side was so enormous, yet the C^2R losses in the armature were reduced in virtue of what they had been hearing from the author. It appeared to him that the inertia of the rotating part of the converter must play a very important part in all the functions that such a machine was called upon to perform. It seemed to him important in the design to consider the effect of increasing the moment of inertia of the armature. Incidentally, it occurred to him that the hunting difficulty might be met by a similar remedy. In the matter of reaction, he thought the rotatory converter held an immense advantage over the dynamotor method. In the case of a rotatory transformer, fed from an alternate set and delivering direct current, the energy component which would be in step with the induced volts of the machine would tend only to distort and was unable to magnetise or to demagnetise. On the other hand, the wattless component of the current tended to magnetise or demagnetise. It followed, therefore, that since the distorting component was the only one that could give trouble from the sparking point of view, this was the only one they need discuss in considering the question of reaction. If they had an armature with two windings—a primary and a secondary—and if there was absolutely no torque loss in the armature, it followed that the distorting reaction due to the energy component must be equal and opposite in both sides of the armature. It followed, therefore, that whatever transformation they were having, that the distorting component of the current in the two sides of the armature must be absolutely equal and opposite—that was to say, there was no resultant distorting action in a rotatory converter which had absolutely no torque loss. If, however, there was a torque loss—as, of course, in practice there always would be—then the amount of that torque loss would be a measure of the tendency to distort the field, and, therefore, a measure of the tendency to spark. Mr. Steinmetz, in a Paper some two years ago, proved mathematically that in a rotatory transformer, in which there was absolutely no torque loss, the reaction components of the two sides were absolutely equal, and there was no reacting tendency whatever. His own reasoning also showed that the reaction in a rotatory transformer only depended upon the amount of current required to overcome the torque loss in the machine, and it appeared to him that, if on that account alone, the rotatory converter had a great advantage over the dynamotor method.

*Mr. E. KILBURN SCOTT expressed a doubt as to whether rotatory converters were really necessary for railway work. For instance, on the Gornergrat and Jungfrau railways three-phase motors were used on the locomotives. The inclines were 20 per cent. and 25 per cent.—a sufficient answer to the query, "Has the three-phase motor enough torque to work heavy gradients?" The question of control was another point which had been queried and upon this he had received a letter from Mr. C. E. L. Brown, confirming his (Mr. Scott's) opinion that the Central London Railway might very well have been worked by three-phase locomotives and the rotatory converters dispensed with altogether.

*Mr. EUSTACE THOMAS referred to Mr. Esson's remarks that in some cases converters had been taken out and replaced by motor generators. He

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thought that in some of these cases it would be found that they were single phase converters rather than three-phase or quarter-phase. This was partly due to the fact that the torque is quite uniform in the case of three or four-phase machines, but not with single-phase supply. Consequently, they had set up a varying torque which was likely to give trouble. Again there was a great deal of difference in the heating in the two cases. He quoted tests: a rotatory converter both as a three-phase and single-phase machine, and showed that as a single-phase converter the total amount of power got out of it for a given amount of heating was only 55 per cent. to 58 per cent. of the power that could be taken from it as a three-phase converter. It was an actual fact that it was easy to correct any trouble from hunting. The causes were fairly well understood. With regard to the question of reaction, he said there was no resultant reaction in a three-phase converter when it was adjusted for minimum input of current and when the losses were comparatively small—that was to say, the armature reaction of the three-phase part balanced exactly and overlay the armature reaction on the continuous-current side; but, as soon as the field was under or over-excited, then immediately lagging or leading currents came in and produced armature reaction. Unless there were in the circuit a sufficient amount of auxiliary reactance it was necessary to obtain voltage regulation to make the current lag or lead by a rather considerable amount, necessitating correspondingly heavy series compounding coils. In practice, this was no difficulty. For instance, after consideration it had been decided to work street railways in New York electrically, and to use rotary converters and three-phase transmission. There were to be six or more generators of 3,500 kilowatt capacity, and the distribution would take place through rotary converters. From practical experience it had been found—in the matter of regulation—that for a given load with rotaries and generators in circuit, the load might vary from nothing up to a considerable overload with the voltage on the continuous current side varying from 2 per cent. to 4 per cent. The question of the armature action of rotary converters was rather an interesting one in connection with sparking on the commutator side. The brushes were, as the author had said, almost always fixed dead at the neutral point; in some cases a slight lead might be given. On account of the balancing of the reactions on the two sides, the field was practically unaltered over the pole tips. The fact that at the same time one could get sparkless commutation made it very clear that we have to depend on something other than a reversing field. The rotary converter, and still more the railway generator, shewed clearly that sparkless commutation must be obtained from some quite different cause. Comparing two and three-phase converters, he said that although both types would give uniform turning moment on the armature of the rotary converter, yet there was a strong advantage in favour of three-phase in transmission lines. For an equal amount of energy transmitted they would only have to employ about three-quarters the amount of copper in three-phase that they would in two-phase, and more than that, only three conductors would have to be insulated instead of four. This meant that the total cost would be correspondingly diminished.

*Prof. SILVANUS P. THOMPSON, replying, thanked Mr. Thomas for the very valuable information he had given them. He was not disposed to question Mr. Scott's accuracy in thinking that it might have been an advantage in the Central London Railway to do without any converters, but that was not the point of the Paper. Prof. Carus-Wilson had drawn their attention to a very important point in saying that the limiting load of a synchronous motor would depend upon the heating of the armature, and at the same time had emphasised that the moment of inertia was of importance. It was of importance in the case of single-phase converters, but he doubted whether it came in very much in the case of two or three-phase, for the simple reason that their torques were so very uniform. The argument that Steinmetz put forward some years ago was all right. In Prof. Carus-Wilson's simple form it was this: if there was no heating loss in the armature the two torques must be equal, and, therefore, the distortions would wipe one another out. That was literally so, provided the ampere-turns of the two sides at every moment were equal. If there were no losses, both torques must be equal on the average. But, in the case of a single-phase machine, they were varying from moment to moment, and there certainly would be armature reactions from moment to moment. Mr. Lawson had referred to the Tivoli-Rome transmission installation, where motor generators were employed to feed the tramways. The alternate-current generator at Tivoli was single-phase, and single-phase converters were admittedly bad on account of the armature reactions and trouble from sparking. It was a curious fact that the firm who supplied these machines had altered their design several times since. Probably, if the whole of that station had to be designed over again, they would put in either two or three-phase at Tivoli and use converters at Rome. Mr. Mordey had referred to the advantage of using a short-circuited copper winding round the poles. Certainly that was a great advantage in some cases; and not for converters only, but for alternate-current machines of several types when running in parallel. He did not want to dispute at all the emphasis which Mr. Hobart placed upon the necessity of having the engine power regular if the machines were to keep in step, for they must remember that the engine power transformed itself through the generator and through the line and through the stationary transformer. Mr. Hobart had referred to the great advantage of using six-phase converters. As was pointed out by Mr. Kapp and Mr. Steinmetz, this certainly was an admirable thing, and could be used very easily in those cases where a stationary transformer was used to transform down the voltage from high voltage transmission. He objected to the misleading use of the adjective "static" for "stationary." In efficiency, a four-phase converter was better than a three, and a three better than a thing that had two slip rings, while a six-phase was better still. For a given power it gave less heating, or for a given limit of heating it might be used to transmit a larger amount of power. He thought Mr. Field's suggestion of using leakage transformers for regulating the voltage ratio was rather a lame solution. In reply to Mr. Swinburne's insinuation that he had changed the English language, he ventured to challenge him or anyone else to produce a standard English dictionary in which there was such a word as "rotary." There had been a syllable cut out of the word, which he did not think improved it, and it did not add dignity or literary (or should he say "litary") form to any communication that might be written in such abbreviated language.

LONG-DISTANCE TRANSMISSION OF ELECTRIC POWER.*

BY PROF. GEORGE FORBES, F.R.S., M.INST.C.E.

This subject has been much talked about, but little has been done, and even at this moment there are few people who realise what a vast field there is in this way for investment of capital on a sound commercial basis. Hitherto people have been appalled at the capital required for copper conductors. In the present Paper I bring forward nothing new. I use the methods which have been used for shorter distances; and I do not propose to suggest the use of electric pressures which have hitherto been considered unattainable. In all cases it is assumed that the power is generated by a waterfall driving a turbine which rotates a dynamo machine. The electric pressure may be raised by transformers. It is then carried by bare copper conductors to a point perhaps hundreds of miles distant; the pressures may there be lowered. The current is then passed through an electric motor which drives stamps, or mills, or pumps, or hoists, &c. During the progress of the electric works at Niagara Falls, attention was much given to the economic problems involved in the transmission of electric energy to a distance. But in that case clearly the following financial conclusion ruled the conditions:—It is always more profitable to bring the works requiring power to the electric source of power than to transmit the power to a distance *provided*—and in most schemes this is a large IF—you can find consumers to come to your locality. At Niagara this seemed likely, and, consequently, distance transmission beyond 25 miles was considered undesirable in the first instance.

Of all industries to which it is applicable, gold mining is the one which has come mostly to my notice as wanting a continuous supply of power day and night, and often without any economical means of getting it except by electric transmission. In these cases it will often be profitable to the gold miner to pay a high price for his power. The distances which I have had to deal with go up to 250 miles in India, New Zealand, and Egypt, and if the Rhodesia mines show generally such returns as the Geelong and Selukive mines have done, I have shown that the power of the Victoria Falls may be economically transmitted in some cases to 500 miles, and pay well.

In 1893, I sat on a committee appointed by the Indian Government to see whether the water power, incidentally created by the Periyar irrigation works, could be used for making aluminium electrically out of the corundum found in the neighbourhood, and for other purposes. We found that power could be generated very cheaply, but that the corundum was not suitable, and no other important demands for power were brought to our notice. Years afterwards, I found that the Mysore, Kolar, and other gold mines could easily be reached by the power, and save great cost in coal. Here we have a transmission of 250 miles which will pay well if the mines are likely to continue producing gold as they have done.

Another specially favourable case of gold mines is in New Zealand, in the North Island. The Waihi mines already work their mills by electrical and water power, but there is no adequate supply of water in summer. At many of the other mines there are no roads, and power cannot be obtained. In 1896, I was asked to explore the Waikato River, in order to find the best site for developing power to be transmitted to all the gold mines on the Coromandel Peninsula, near Auckland. I finally settled on the Haka Falls, near the centre of the island, with a transmission line of from 180 to 250 miles, 20,000 H.P. being generated to supply not only all the gold mines but every freezing works and factory on the North Island. I spent six weeks on the survey of sites for the works, and furnished plans which would already be executed, except for what I must call the dog-in-the-manger policy of the Government. The site was peculiarly favourable. To take another case of gold-mining. I was engaged in 1895-96 on a project without water power and a transmission of 300 miles as a maximum. The Coolgardie gold fields are so far from a port that coal is very expensive, and water for the boilers could hardly be obtained. I found that it was actually more economical to generate power by steam engines at the coast, where coal and water were available, and to transmit power all the distance electrically, rather than to transport coal which was otherwise a necessity in all cases as well as water in many cases. In this case the miners were prepared to pay as much as £180 per annum for the horse-power.

* Abstract of a Paper read before the Society of Arts, November 23, 1898.

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In 1894, before I had completed the first electric works at Niagara, I was asked by letter from Johannesburg whether it would be possible to transmit power from the Victoria Falls, on the Zambesi, to all the gold mines in Rhodesia, varying from 350 to 500 miles distance. I had been supplied with maps and costs of fuel, &c., and in a short time I found, to my astonishment, that if the facts were as stated, the scheme was financially and electrically a sound one. I was assured that at least 10,000 H.P. would be required at the mines, and that from £70 to £100 per annum would readily be paid for the horse-power. Upon this I was asked to go to South Africa to negotiate with Mr. Cecil Rhodes and Dr. Jameson for a concession. They both appreciated the value of the enterprise to the country, and prepared a draft of the concession, which was only awaiting the sanction of the Chartered Company's Board when the Jameson raid and the Matabele rising closed negotiations. Here is a case where, if there be really good gold mines, it will pay handsomely to transmit electric energy a distance of 500 miles, provided the surveys of the Falls prove as satisfactory as the photographs do, and provided the fever is not an insurmountable obstacle.

At this stage let me point out to those unacquainted with the difficulty of obtaining power at some gold mines that £100 per annum for each horse-power continuously delivered would readily be paid in many cases. Broadly speaking, the power required for rock breakers, stamps, &c., may be taken as being such that 1 H.P. mills 1 ton of ore per day; the value of the gold is, say, £3 or more per ton in a rich mine. I am not speaking of soft conglomerate like the Rand ore, where 1 H.P. mills 2 or 3 tons per day, but hard quartz. Now, when I speak of £100 per annum for a horse-power; this, at the rate of 1 ton a day, means 5s. 5d. per ton of ore for milling expenses. There are plenty of places where they would pay double this.

But while I expect that gold mining is the principal industry to be benefited, there are many others, the chief requisite being a continuous demand for power day and night. This is met by electro-metallurgical processes, but these can generally be brought to the power. It also includes irrigation, which in some countries wants power day and night, and, to a certain extent, throughout the year. The quantity of water pumped does not need to be perfectly constant, and this enables intermittent demands for lighting, railways and factories, to be met by slight variations in the pumping. Thus the plant is always fully at work and earning its dividend. In speaking these words I am naturally thinking of the utilisation of the Nile cataracts, upon which I have been engaged during the years 1897-8. My report on this subject is in the hands of the Egyptian Government, and is their property; but I am not divulging secrets when I tell you that the electric lighting of Cairo could be done cheaper by power generated at the First Cataract than by steam engines at Cairo. The distance is 400 miles as the crow flies. Do not imagine that I propose lighting Cairo immediately in this way. The Government has far more important uses for the power, not only in the irrigation of the country as it is, but still more for the perennial irrigation which will be so much extended when the great reservoir designed by Mr. Willcocks, Sir William Garstin and Sir Benjamin Baker shall be completed by Mr. John Aird. You may take it as certain that before long the cataracts will be harnessed and forced to assist in developing not only Egypt proper, but the Sudan, and specially the Dongola province up to the Fourth Cataract, which, with efficient irrigation, may become the most fertile country in the world.

Higher up the Nile, I have not travelled or made surveys, but I notice that Sir William Garstin is undertaking a journey to Khartum and the Blue and White Niles to determine the value of the country there. A time will doubtless come when the Murchison and Ripon Falls will also be turned to account.

In 1882, at Munich, Marcel Desprez earned great credit for transmitting electric power 35 miles and getting a return of 25 per cent. But, in 1891, 70 per cent. efficiency was obtained between Lanffen and Frankfort, the distance being 108 miles. Only one difference between short transmissions and the 108 miles from Lanffen to Frankfort was found to exist and it had been anticipated by me in preparing the Niagara works. In 1892, I laid it down as essential for the works at Niagara, in order to be prepared for long distance work and for other reasons, that the frequency of the alternations should be as low as the construction of a good dynamo would warrant. In 1894, the tests at Lanffen-Frankfort were published, showing that without this low frequency no good efficiency could be got from the long distance power transmission owing to the great self-induction of the line.

All engineers will agree as to what is the principal item of expenditure, viz., the cost of copper under the conditions of existing practice. Improvements may reduce this cost, but cannot increase it; hence the financier may be very sure of the data of expense, and if he can be equally well assured of the data of revenue, he has before him everything required for forming a sound judgment. Let us take three cases.

1. Suppose a water-power is utilised for distant transmission of 200 miles to a gold mine where transport is difficult and the ore rich. Suppose that the miners are ready to pay £100 per annum for each horse-power delivered continuously to the stamps, &c.—I am taking what may be looked upon by some as an extreme case, but there are many such places in the world—suppose that it is a gold field employing only 1,000 horse-power continuously, the gross income is then £100,000 per annum. This is a large sum, and will warrant a very large capital expenditure. Now if it is a case in which 20,000 volts electric pressure may be used, less than 900 tons of copper is required, after 50 per cent. has been added for self-induction, giving an inefficiency (inverse of efficiency) of only 1·4. Thus, 1,400 H.P. will have to be generated at the waterfall end of the transmission line for 1,000 H.P. delivered at the other end—the gold mine. The hydraulic and electric machinery are not likely in a favourable case, even with costly transport, to exceed £14,000. The working expenses are small, and clearly the great thing to be considered is the cost of copper. If transport is costly, this might amount to £80 per ton of copper laid, or £72,000. Very likely the whole cost would be under £100,000, which, with a maximum possible annual expenditure of £20,000, would produce a revenue of £80,000 per annum or 80 per cent. I am sure that actual cases exist where this might be done.

2. If the distance were 400 miles, all other things remaining the same, the only serious difference is in the cost of copper, which rises to £288,000; and taking £32,000 for the other expenses, the capital expenditure is £320,000. If the annual expenses were £20,000, which seems impossible, the net income is £80,000, or 25 per cent.

3. Suppose the distance still 400 miles, and all other things remaining the same, but only £50 being paid per annum for the horse-power; here we have still £320,000 of capital expenditure, and a net income of £30,000 for 1,000 H.P. delivered, or 9 per cent.

Of course, it understood that while cases can occur where these figures apply, each case must be examined on its own merits. Looking at the last case quoted, the delivery of 1,000 H.P. at 400 miles, using 20,000 volts (or 200 miles with 10,000 volts), the financier would say 9 per cent. was not good enough for such a venture. I will now show how he may get 40 per cent., using the same machinery, the same copper, and the same annual expenses.

I have now the pleasure to lay before you a simple financial transaction which copper merchants or others would willingly make, and which may avoid the huge capital hitherto required by those who transmit the power, and will increase the dividends on money spent on the transmission. What I propose is to divide the capital account into two parts—ordinary stock, which may be looked upon as speculative; and bonds on the copper, which would be as sound an investment as could be desired. Taking the last case mentioned, the capital charges are—

3,600 tons of copper at the extreme value of £75 a ton	£270,000	
Putting it in place at £5 a ton	18,000	
		£288,000
Hydraulic and electric machinery, &c.		32,000
Total capital required		£320,000

Most of this capital is required for copper, which may be taken away if the company fails, and is an absolutely safe security.

The value of the copper is	£270,000
Cost of removal (uncalled capital)	18,000

On the £270,000 a mortgage may be raised, and 4 per cent. ought to cover the chances of a change of market value. Thus we have—

Annual payment on mortgage	£10,800

All we have done is to raise a mortgage on the best possible security. This might be done by the copper companies, who often have too much material in stock not paying interest, or the money could easily be obtained from independent capitalists. Let us now see what difference this has made upon the balance-sheet. The capital charges are—

Putting copper in place		£18,000
Hydraulic and electric machinery		32,000
		£50,000
Annual gross receipts—1,000 H.P. at £50		£50,000
Less annual expenses	£20,000	
Mortgage on copper	10,800	
		30,800
Annual net receipts		£19,200

or almost 40 per cent.

By this simple transaction we reduce the total capital required by the transmitters of power from £320,000 to £50,000 for 1,000 H.P. delivered, and we have increased the rate of interest from 9 per cent. to 40 per cent., which ought to satisfy most people. This scheme I have laid before the manager of one of our largest copper companies, and he entirely approved of the general lines.

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Before leaving this part of the subject, I wish to make it quite clear that none of the figures which I have given up to the present must be taken as applicable to every case that may arise. The costs used in the above calculation are over the mark for the most favourable cases, and the cost of copper is also too high. All that I have tried to make clear is that if there be a large and continuous demand for the power, and if the value of the mechanical power to the gold miner or others is great, the distance to which it can be transmitted with financial success is not limited to a few hundred miles.

I feel some diffidence in laying before you the following methods because there is nothing new in the results, and all the results can be obtained by the ordinary methods. They have, however, been invaluable to myself. These methods are particularly useful for getting out preliminary estimates quickly. Here let me say that in all preliminary work on the cost of long conductor lines, I never take notice of the resistance of the conductor, nor of the value of the current. I deal only with the current density, and loss of volts. It is the same thing under a different name. But it is what you want. Again, I never use, in calculations for my own use, the efficiency of the conductor system. It is far more convenient to use the inefficiency, or the reciprocal of the efficiency, which is also the horse-power put into the generating end of the line to deliver one horse-power at the other end. I give you these suggestions for what they may be worth as the result of long experience.

I suppose everyone present is aware of the fact that if you had a case where the power cost absolutely nothing, you would use the least copper and have the cheapest arrangement, with an inefficiency of 2, *i.e.*, an efficiency of 50 per cent., or 2 H.P. generated for each horse-power delivered. If you make the current density either greater or less than what is required to produce this inefficiency then you have to use more copper to deliver the same quantity of power. Fig. 1 shows this very well, and a study of it is interesting. This figure shows the weight of copper required per horse-power delivered at a distance of 100 miles at 10,000 volts, or 150 miles with 15,000 volts, or 200 miles with 20,000 volts. It is drawn for the simplest case of continuous current, to which corrections only for temperature and sag have to be made. It is equally applicable to a single-phase or two-phase alternating transmission to 100 miles at 10,000 effective volts; or at 5,000 effective volts from any wire to the middle of the electric system, or to three-phase transmission to 100 miles at 5,000 effective volts from any wire to the middle of the electric system. But with alternating current corrections must be made for self-induction and capacity.

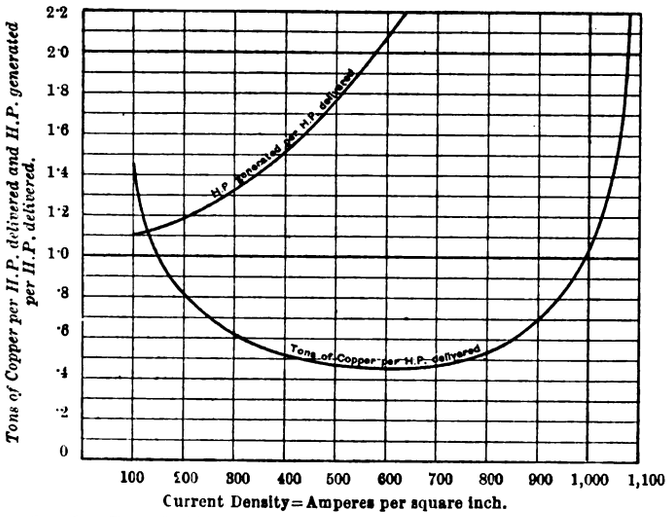

FIG. 1.—Electric Transmission Curve for 100 miles at 10,000 volts Continuous Current.

The same remarks apply to the meaning of the voltage of the line in all the curves and tables referred to. They are worked out for continuous current, and for any other system the engineer must add the usual corrections.

Another curve may be drawn showing the inefficiency at each current density. This curve constantly rises, *i.e.*, the greater the current density, the greater is the inefficiency. Now from these two curves we can deduce a third curve, which is the one which I find gives one in a few minutes all the main facts one wants for any horse-power to be delivered to any distance at any initial volts. This curve gives the tons of copper per horse-power delivered at 100 miles with 10,000 volts, continuous current, in terms of the horse-power generated per horse-power delivered. Measuring along a horizontal line, you get the inefficiency, *i.e.*, the horse-power generated for each horse-power delivered; and measuring vertically you get the corresponding tons of copper required for each horse-power delivered at a distance of 100 miles. The curve is also marked with figures to show the current density, in amperes per square inch section of copper. I never travel a day without this curve in my pocket.

This curve is correct for 100 miles and 10,000 volts, or for any other case where the volts = 100 times the miles. The curve shows you, for example, that for an inefficiency of 1½ you require a current density of 387 amperes per square inch, and 0·55 tons of copper. And thus current density and weight of copper per horse-power is the same, whether you use 10,000 volts at 100 miles or 100 volts at 1 mile. For any other volts and distance in miles, V and M, you divide the volts by the miles and get $\frac{V}{M}$; then $\frac{V}{100M} = D$, the multiplier for the current density, and $\left(\frac{V}{100M}\right)^2 = T$ the divisor, for the tons of copper per horse-power.

As an example, 15,000 volts and 300 miles. Here $D = \frac{15{,}000}{100 \times 300} = \frac{1}{2}$. Hence for an inefficiency as above of 1½, the current density will be ½ × 387 = 198. The tons of copper per horse-power will be $\frac{0{\cdot}55}{(\frac{1}{2})^2}$ = 2·20 tons.

Now let me show another use of the curve. Suppose we capitalise the cost of running the generating station, and add to it the cost of the generating works, and divide by the horse-power, we have then the capitalised value of 1 H.P. generated. I will call it for short the value of 1 H.P. generated. We also know the cost of one ton of copper. Divide the value of the horse-power by the value of the ton of copper, and draw a line across the axes so that it cuts the axes in that ratio. Draw a line parallel to this and touching the curve. This gives you, according to Lord Kelvin's law (as modified by Ayrton and Perry), the point of maximum economy giving directly the inefficiency, the tons of copper per horse-power and the current density. Thus on the curve two examples are shown, one where the value of 1 H.P. is four times that of a ton of copper. In this case the greatest economy is got by an inefficiency of 1·18, a current density of 180 amperes per square inch, and 0·91 tons of copper per horse-power delivered at 100 miles distance, the initial pressure being 10,000 volts.

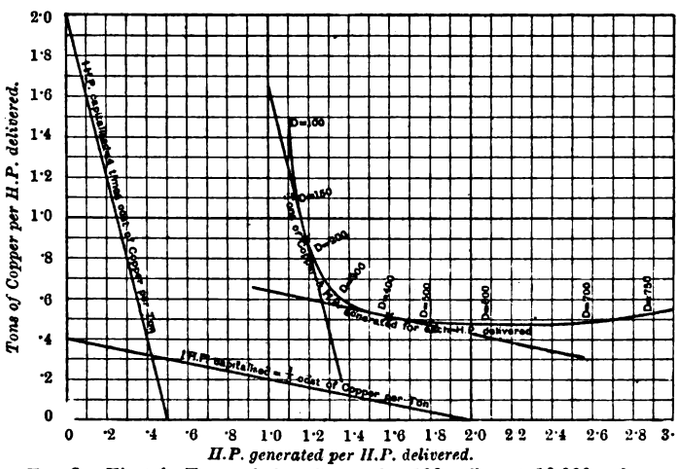

FIG. 2.—Electric Transmission Curve for 100 miles at 10,000 volts Continuous Current.
D = Current Density = Amperes per square inch.
For V volts and M miles multiply the weight of copper by $\frac{M^2}{10{,}000\ V^2}$.

Another example is shown on the curve where the horse-power is one-fifth of the cost of a ton of copper. The resulting values are seen directly to be: inefficiency = 1·58; current density = 420; copper = 0·51 tons.

To do this for other values of T, $\left[T = \left(\frac{100\,M}{V}\right)^2\right]$, you must divide the value of the horse-power by T. Measure this distance vertically by the unit on the vertical scale or by fractions of these units, and measure the cost of a ton of copper horizontally by the unit on the horizontal scale or by the same fraction as before of that unit. Join the two points by a line and draw a parallel line touching the curve at the point of maximum economy.

But we can do more than this. Divide the tons of copper per horse-power by 18 times the distance in miles, and you get the sectional area in square inches of the conductors (go and return) per horse-power. Multiply this by the total horse-power to be delivered, and you get the size of your conductors.

N.B.—Remember that this is all worked out for continuous current, and must be corrected for other systems as well as for temperature and sag.

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Some people prefer to work by tables instead of by curves, so I will put down the readings of the curve which we have just been discussing. For ordinary work the following is sufficient :—

Inefficiency.	Tons copper per H.P.	Current density.	Inefficiency.	Tons copper per H.P.	Current density.
1·10	0·86	190	1·70	0·49	475
1·30	0·66	266	1·80	0·48	510
1·40	0·58	330	1·90	0·472	545
1·50	0·55	387	2·00	0·470	574
1·60	0·51	432			

In most practical cases, however, the economical inefficiency for long distance transmission lies between 1·20 and 150. The following table gives closer values over this range :—

Inefficiency.	Tons.	Density.	Inefficiency.	Tons.	Density.
1·20	0·86	190	1·36	0·60	306
1·22	0·80	207	1·38	0·59	319
1·24	0·76	221	1·40	0·58	330
1·26	0·72	236	1·42	0·57	342
1·28	0·69	250	1·44	0·56	354
1·30	0·66	266	1·46	0·55	365
1·32	0·64	279	1·48	0·54	376
1·34	0·62	292	1·50	0·53	387

From either of these tables, having given the efficiency, to get the density for any volts and distance, multiply the above value by $\frac{V}{100M}$, and to get the tons of copper, divide the above value by $\left(\frac{V}{100M}\right)^2$.

In actual practice I find it far more useful to have the table extended in such a way that an approximate result may be arrived at without any calculation. Three tables are here given. The first gives a reference letter for any volts and distance. In the second and third tables the results we want are found under that reference letter. The second table gives the tons of copper per horse-power delivered, and the third gives the current density for any inefficiency that we may select.

Table I.—*Distance of Volts.*

	Virtual volts between wires.					
1 or two phase	5,000	10,000	15,000	20,000	25,000	30,000
3 phase	4,325	8,650	12,975	17,300	21,625	25,950
	Distance in miles.					
A	12·5	25	37·5	50	65·5	75
B	25	50	75	100	125	150
C	37·5	75	112·5	150	187·5	225
D	50	100	150	200	250	300
E	62·5	125	187·5	250	312	375
F	75	150	225	300	375	450
G	87·5	175	262·5	350	437·5	525
H	100	200	300	400	500	600
K	150	300	450	600	750	900

Table II.—*Tons of Copper per Horse-Power Delivered.*

Inefficiency.	1·2	1·3	1·4	1·5	1·6	1·7	1·8	1·9	2·0
A	0·0537	0·0412	0·0382	0·0344	0·0319	0·0306	0·0300	0·0295	0·0294
B	0·2150	0·1650	0·1450	0·1375	0·1275	0·1225	0·1200	0·1180	0·1175
C	0·4837	0·3725	0·3262	0·3094	0·2869	0·2756	0·2700	0·2655	0·2644
D	0·8600	0·6600	0·5800	0·5500	0·5100	0·4900	0·4800	0·4720	0·4700
E	1·344	1·031	0·9062	0·8594	0·7969	0·7656	0·7500	0·7375	0·7344
F	1·935	1·499	1·305	1·237	1·148	1·102	1·080	1·062	1·058
G	2·634	2·020	1·776	1·684	1·562	1·504	1·470	1·446	1·439
H	3·440	2·640	2·320	2·200	2·040	1·960	1·920	1·888	1·880
K	7·740	5·740	5·220	4·950	4·590	4·410	4·320	4·248	4·230

Table III.—*Current Density.*

Amperes per square inch.

Inefficiency.	1·2	1·3	1·4	1·5	1·6	1·7	1·8	1·9	2·0
A	760	904	1,320	1,448	1,728	1,900	2,040	2,180	2,296
B	380	452	660	724	864	950	1,020	1,090	1,148
C	253	301	440	515	576	633	680	727	765
D	190	226	330	387	432	475	510	545	574
E	152	181	264	310	346	380	408	437	459
F	127	151	220	258	288	317	340	363	383
G	108	129	188	221	246	271	292	311	327
H	95	113	165	193	216	237	255	272	287
K	63	75	110	129	144	158	170	182	191

Rules for Using the Tables.

Rule I. *To Find the Reference Letter.*—In Table I., in the column referring to the volts generated, find the approximate distance of transmission in miles. The capital letter at the beginning of the line in which this is found is the reference letter.

Rule II. *To Find the Tons of Copper per Horse-Power Delivered.*—Look along the row in Table II., referring to the reference number, and tons of copper are there given for each inefficiency. The inefficiency being the horse-power generated to deliver the horse-power at the distant point.

Rule III. *To Find the Current Density.*—Table III. gives this in amperes per square inch in the row corresponding to the reference number, and in the column corresponding to the inefficiency chosen.

Rule IV. *To Find the Economical Conditions of Working (Kelvin's Law).*—Divide the capitalised value of 1 H.P. by the cost of 1 ton of copper. Divide this by 10, and call it q. In Table II. look along the row corresponding to the reference letter until the difference between successive numbers is approximately q. The number at the head of that column is the economical inefficiency, the tons are also then given, and the current density is obtained directly in Table III.

Rule V.—*To Find the Total Section (go and return) of all the Transmission Conductors.*—Multiply the tons per horse-power by the total horse-power, and divide by 18 times the distance in miles. This is the result in square inches. Dividing this by the number of conductors gives the sectional area of each.

The only point affecting the cost which has been left to the choice of the engineer is the electric pressure to be used, and every engineer in reporting on a scheme generally gives his reasons for selecting the pressure. In old days the highest pressure for which we could get a guarantee from contractors was used. But the expense of insulation increased so much with increase of pressure that now, as at Rheinfelden, we work to that pressure which is the most economical. Manufacturers will now guarantee any pressure if you will pay for it.

It has been my object to-night to put before engineers some useful rapid methods for arriving, on the ordinary lines of working, at the data for any special case of long distance transmission of power. It has also been my object to show that those who carry out such schemes do not require to be handicapped by the enormous capital which has hitherto been generally considered necessary. Incidentally it would appear that whenever gold mines exist which can afford to pay 5s. or 6s. per ton of ore milled, and if there be good water-power within 400 miles of the mines, it is most probable that it will pay well to transmit the power electrically.

The following is an abstract of the discussion which took place in connection with Prof. Forbes' Paper :—

The CHAIRMAN (Sir John Wolfe Barry) said that Prof. Forbes had brought before them a most suggestive and valuable Paper. One of the great matters which was pressing upon the engineering mind was the conservation of energy, and this might take the form of capturing the power which exists in the clouds and comes from them in the form of rain, or it might be harnessing the winds and making them serve for the "use and convenience of man." Another proposal had been to capture the force which ran to waste in the waves, and before all was the seductive subject of capturing the electricity in the air. The fact of having to pay £100 per horse-power was rather startling to them, but then Prof. Forbes had given figures which showed that the gold-mining industry could afford to pay this amount. We looked to realise a horse-power at something like £5 or £6. A mortgage on a mass of copper in the centre of Africa at 4 per cent. seemed to him somewhat hypothetical. No doubt the value of the copper would be there, but he doubted whether capitalists in London would advance 4 per cent. under these circumstances.

Colonel GOURAUD said that just after the great boom of the Crystal Palace electrical exhibition he, along with others, formed a company with a capital of £1,000,000 sterling with the object of lending money to people who had central station schemes on hand ; but at the end of a year they had been obliged to call a meeting of the shareholders and confess that they had not succeeded in finding a profitable employment for their money, for, said he, as chairman of the company, "We are 10 years ahead of time." With respect to Prof. Forbes' copper proposition, he thought that as there was not a copper market in Central Africa, he should add the cost of copper transportation out and back again in case the project was not successful. Even then, on the figures given in the Paper, the speculation should still be a profitable investment.

Mr. G. L. ADDENBROOKE had been on the Continent and had seen machines in course of manufacture at Messrs. Brown-Boveri and Co.'s works which were going to generate at 13,000 volts without transforming up. In the course of his travels, nothing had struck him so much as the confidence with which foreign capitalists had put large sums of money into water-power transmission schemes. There was a great difference between steam and water-power transmission. With steam, they need only start on a small scale—1,000 H.P., for instance—and in many cases they could wait and see whether they were going to have any return, but in the case of water-power transmission they had to put down their fundamental works on somewhat the same scale as they were going to work. At Rheinfelden, they had put down plant for 25,000 H.P., although only about one quarter of this was at present utilised. They had thus a large amount

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of capital locked up which certainly was not remunerative at present, but the capitalists had sufficient confidence in the concern to wait until it was so.

Mr. LÉON GASTER mentioned that in Switzerland they were generating by water power at 5,000 volts, and getting 77 per cent. at the end of a line 12½ miles long. He thought the only way to make water power schemes a success was by having very large central stations, from which they could meter out current to small consumers, who would otherwise have to erect small plants of their own.

Mr. W. M. MORDEY thought the question was a commercial one, and not a technical one. He did not mean to say that there were not many interesting technical considerations in the Paper itself, but the great value of it was that it did not contain any reference to technical difficulties, and this, he thought, was a significant thing. By offering 40 per cent profit Prof. Forbes should be able to make the mouths of capitalists water to such an extent as to get a water power of great dimensions.

CORRESPONDENCE.

ELECTRIC CANAL HAULAGE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of October 21st you published a Paper by Mr. Allen, and in that of November 4th a letter of criticism by Monsieur F. Galliot, and a reply thereto from Mr. Allen in your issue of November 18th. A perusal of the latter would lead many readers to suppose that the gentlemen named in the Paper and letter had quite solved the problem of electric canal haulage in this country. Will you please permit me to point out that the system of procedure I have devised, in conjunction with Mr. W. E. Kenway and his invention of overhead conductors, has some claim to the attention of those interested in the improvement of our canal haulage?

We dispense with the use of hauling ropes entirely, tow-path motors or aërial railways. Our conductors are mounted on Norway poles along the present tow-paths, and there is no interference with the fair way of the canal. Craft with masts or sails can proceed along the waterways as usual. We place our propelling device (in which the electric current is the source of power) on a light framework on any canal boat, and the whole contrivance may be unshipped when necessary.

Our joint invention has resulted from a study of the requirements of the complex Midland canal system.—Yours, &c.,

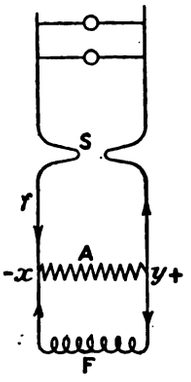
Birmingham, Nov. 30. T. VAUGHAN HUGHES.

THE BRIGHTON BREAKDOWN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Quin's interesting letter in *The Electrician* of last week draws attention once again to the Brighton breakdown, and to the experience, apparently not very rare, that severe external short circuits may demagnetise or even reversely magnetise the fields of shunt dynamos supplying that circuit. It seems to be of some interest to look at the possible causes of this effect a little more closely. The following is a suggestion which may or may not have been made before. Let A be the armature of a shunt machine supplying a feeder F, and S, a place where a sudden short circuit occurs which causes a momentary very heavy current to be taken from the machine. The circuit A F S is a circuit of very low resistance, but one having considerable inductance and not altogether negligible capacity. Hence the establishment or rupture of a sudden heavy "short" at S will set up in this circuit electrical oscillations. Accordingly, at the shunt-field terminals x y rapid alternations of potential are established super-imposed on the normal potential difference due to armature E.M.F.

The effect of the heavy current taken out of the machine is to enormously increase for the moment armature the reaction, and this alone tends to demagnetise the fields, whilst at the same time the drop in armature E.M.F. will reduce the normal shunt current. Hence the rapid decadent oscillations of potential at x y will send oscillatory currents through the shunt which may overpower the normal magnetising current, and are exactly of the character required to demagnetise the iron. The reverse magnetisation sometimes finally left may be due to the final rupture of the short-circuit creating a momentary increased rush of current through the armature (due to inductance), causing the potential at x to rise above that at y, and sending, therefore, a wave of current in the reverse direction to the normal one through the shunt. These current changes are so rapid that no maximum or minimum cut-out which depends on the magnetisation of iron has time to act. One remedy which might be effective would be the separate excitation of the fields, not from the main omnibus bars, but from a separate exciter plant, preferably including a storage battery. Conditions of economical working may, however, prevent the adoption of this drastic remedy. It is easy to see in the above theory why compounding the fields is at least a partial

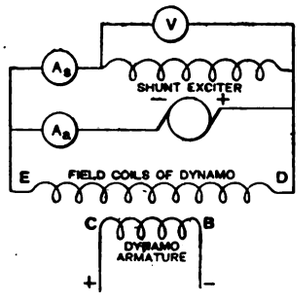


remedy for the mischief, but it is not easy to see any effective remedy other than that of separating entirely the shunt field circuits from the omnibus bars and separately exciting the fields.—Yours, &c., J. A. FLEMING.

University College, London, Dec. 5.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The very interesting account given in your last issue by Mr. Quin of his experience of the action of a short-circuit across the terminals of a separately-excited dynamo shows that the "transformer" effect, to which I called attention in my note on shunt dynamos in parallel, is of such magnitude, that as I suggested might be the case, it can, not only reduce the current in the shunt circuit in parallel, but may actually reverse it. The diagram, which I gave of the connections



made in my experiment, and which I repeat with slight modification here, gives precisely the connections which would exist in a dynamo separately excited by a shunt machine. The action is as follows:—

1. The sudden increase of current from B to C in the armature of the short-circuited dynamo suddenly removes lines of magnetic force from its field coils (due to the lead on the dynamo brushes), and, therefore, sets up an E.M.F. in these coils such as to drive the current in them from D to E—that is, increases the original exciting current momentarily.

2. But as the field coil is now a *source* of E.M.F., owing to the lines removed from it, it must be remembered that the point of highest potential due to this E.M.F. will be at the end E.

3. If the short-circuit current has been sufficiently large in the dynamo, the E.M.F. set up, as described in 2, will (*a*) increase the current through the exciter armature, and (*b*) decrease its field current or even reverse it.

4. The reversed current in the exciter shunt reverses the polarity of the exciter which (as the "transformer" E.M.F.

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in the field coils of the dynamo is only momentary), in its turn, reverses the field of the dynamo and therefore its polarity.

There are evidently at least two methods of avoiding this trouble, viz. :—To use separately excited machines, the armatures in parallel and protected by maximum, and reverse current cut-outs and the fields excited either :—

1. By secondary batteries ; or
2. By a series-wound dynamo.

In each case, of course, a regulating rheostat would be placed in the dynamo field coils.

I do not know whether any stations are run with machines in parallel and separately excited in this manner, but, if so, it would be of interest to know whether they have ever experienced the trouble described by Mr. Quin or have had any breakdown of the character which occurred at Brighton.

Mr. Quin does not state whether the case he describes, of an earth on an armature setting up a pulsating current has been actually observed in practice : it is certainly possible, and, as he points out, no system of cut-outs would appear to satisfactorily guard an armature so earthed from the possibility of burning out. If, however, it were worth the extra cost to insure against this accident it might be prevented by insulating the dynamo itself from earth, but connecting again to earth through a small current cut-out, which, by the fact of its acting, would indicate a fault on the armature to the frame.

Will you permit me a further trespass on your space, to add that the object of my note on the "transformer" effect in shunt-wound dynamos in parallel was—(1) to call attention to the fact that *any* short-circuit in the armature coils (not to earth) of such a machine, even when disconnected from the bars, *must* produce through its shunt-circuit, if this is connected to the bars, a *drop* of voltage across them, and that it is conceivable that even a reversal of polarity may be caused ; and (2) to show that, due to the same causes, a short on the bars, if all the machines are not working at precisely the same portion of the B and H curve, may cause some to motor, thus throwing a doubly heavy load on the remaining dynamos.

I have heard it stated that a *sudden* increase of load on the 'bus-bars fed by shunt-wound dynamos in parallel, even when they are direct-coupled to engines governed for constant speed, has been known to cause the machines to drop their volts and cease to excite ; whilst if the same load were gradually put on it would be taken up by the machines quite satisfactorily. Is any well authenticated case of this nature known ? I do not see how (if it exists) it can be explained except upon the supposition that the "transformer" effect in No. 1 machine has been greater than in the other, and has thus reduced the field of No. 2, causing it to motor, and has had all the outside load and the motoring load thrown upon itself, thus actuating its maximum cut-out.—Yours, &c.,

Bristol, Dec. 3. ARNOLD PHILIP.

PROF. WILSON'S "ELECTRIC TRACTION."

TO THE EDITOR OF THE ELECTRICIAN.

SIR : Your review on the above book hardly seems to me to be fair, and seems to be more of a personal attack on Prof. Wilson than a criticism of his book.

To begin with, the statement that "it bears throughout the evidence of the hand that has had little or no practical experience of its subject matter" is totally untrue. It is well known that Prof. Wilson is one of the professors who *has* had practical experience both here and abroad, who has been through the shops, and was responsible, when in Messrs. Siemens' works, for the design of some of the largest dynamo-electric machines both for traction and lighting.

Then take your reviewer's remarks on the tests of storage cells. It seems to me that Prof. Wilson took probably the two best known types as representative of what one might expect from cells with heavy rates of discharge ; and, considering the important part storage cells are likely to play in the propulsion of vehicles by electricity, these tests, coming from an impartial person, are, I think, most useful and welcome, and I should have thought the curves were quite sufficient summing up of the results.

If your reviewer will refer to the article by Prof. Wilson in your issue of Oct. 11, 1895, on the "Heating of Dynamos," he will see that Prof. Wilson was quite aware that the losses due to eddy currents and hysteresis are *not* constant, and he does not say they are : he even goes so far as to print the word "*assume*" in italics, thereby calling attention to the fact that the assumption is not correct, but suffices for the purpose he had in view.

Then, with regard to your remarks as to why the second shoe is required, I maintain that Prof. Wilson is perfectly correct. The series or main circuit coils, as Prof. Wilson states, would only be called upon to give a small augmentation of the induction ; and if the shunt circuit were not broken at all, I fail to see how the magnets can lose their magnetism.

Regarding the next so-called "error." On p. 188, Prof. Wilson certainly states that the generators at Dublin, "at 600 revolutions per minute give from 2,300 to 2,500 volts," but he does not state (as you say) that they give *only* this voltage ; and when discussing the efficiency of the system of conductors he does so on the maximum P.D. which the Board of Trade allow them to use, *i.e.*, 3,000 volts ; and this is surely the fairest way of treating it.

Then as to whom the book was written for. It certainly seems to me to fill the gap between the elementary treatises dealing with the principles of the sciences and the special advanced technological works ; and this was the object of the book (see publishers' advertisement of their "Science Manuals").

The concluding paragraph is hardly worth commenting upon ; the expressions referred to may not be strictly correct, but are perfectly intelligible. I wonder if your reviewer "shudders" at his own English in the review (see last paragraph but one).—Yours, &c., J. R. SALTER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : I trust that but few of your readers will so misinterpret the review of Prof. Wilson's book as to consider it rather a personal attack on the author than a criticism of the work itself. Certainly nothing was further from my intention than the introduction of anything of a personal nature : the review was simply the result of a careful and unbiassed perusal of the work in question, and should the author in the future bring forth a more worthy production no one will give it a more kindly reception than myself.

In answer to the criticisms of your correspondent, I may say that when I wrote the review I was not ignorant of Prof. Wilson's career and status ; but I must point out that the fact of having designed dynamos, even at Messrs. Siemens, does not necessarily qualify one to write on the design and equipment of complete traction systems.

Secondly, with regard to the tests of storage cells, I think I am justified in still adhering to my opinion that in a comparatively small work it shows a lack of the sense of proportion to give several pages of tabulated figures of two single types of cell. Even granting that the tables are of interest, they should have been published elsewhere than in the book in question. Nor, if the figures must be given, can the tables and bare curves be considered sufficient without anything to indicate the bearing of the results obtained.

Again, it is but cold comfort for the reader to afterwards learn that the author has elsewhere shown that he understands the variations of eddy-current and hysteresis losses ; he would much prefer that this knowledge should be displayed in the work before him. In this case but few words would have sufficed for this.

An author may, of course, use the word "assume," even in italics, but before doing so he should first make quite sure that the assumption involved *is* sufficiently accurate for the purpose he has in hand.

Regarding the breaking of the circuit, the author's language would lead one to suppose that in some way the shunt circuit itself was actually broken, which, of course, is not the case.

Lastly, people when speaking of dynamos of 2,300 or 2,500 volts do not *say* that they only give that voltage ; but they mean it, and expect others to so understand them. A dynamo may be run to give only 10 volts, but if it is generally employed at 3,000 volts we say that it gives 3,000 volts, and leave it to be inferred that it can also give lower pressures.—Yours, &c.,

THE REVIEWER.

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LEGAL INTELLIGENCE.

Savory v. Edward Lloyd (Limited).

An action was commenced on Wednesday before Mr. Justice Day and a special jury, in the High Court, in which Sir Joseph Savory sued Messrs. Edward Lloyd (Limited) and Mr. W. J. Richardson for damages for libel. The defendants are the proprietors and the printer of *London*, and the plaintiff complained that on June 30 last defendants falsely and maliciously printed and published a libellous statement concerning him. In commenting upon a statement made at a meeting of the Common Council of the City of London, by Mr. Brooke-Hitching (also of Marylebone), relating to the circumstances under which the City of London Electric Lighting Co. was established, *London* referred to that transaction as a very discreditable one, combining the characteristics of Hooleyism and Tammanyism, asserting at the same time that certain members of the Corporation were interested in the Pioneer Company, which promoted the present Company, and that the plaintiff, Sir Joseph Savory, the then Lord Mayor of London, was beneficially interested in the promotion. "It is one (continued the journal) of the worst jobs which have tarnished the municipal history of the City of London." After reviewing the history of electric lighting matters generally so far as they relate to the City, the plaintiff and his family connections are charged with having a considerable monetary interest in the City of London Pioneer Electric Lighting Co. (Limited), which, in its turn, promoted the present City of London Electric Lighting Co. (Limited). The journal continued :—"The Lord Mayor for the time being, Sir Joseph Savory, was chairman of the promoting company. He was also a member of the Streets committee, who executed the electric lighting contracts for the Commission of Sewers. Lord Mayor Savory was interested in the company which financed the promoting company—started solely for the purpose of making money out of the interest which the Commissioners of Sewers created and of the contracts which it had granted, presumably in the public interest. What would be thought of members of the County Council were they to degrade themselves to such sordid financial scheming for their own enrichment and the public loss? What would be said if the members of the Highways committee of the County Council promoted a little syndicate to acquire a valuable tramway concession, which in a public capacity they had granted, and then sold to another company, pocketing handsome premiums for their services? The worst feature of the whole business is that one of the chief persons concerned was the Lord Mayor (Sir Joseph Savory), whose official position is fully described in the share lists of the companies. What do the citizens, who all suffer now from the transactions, by excessive electric lighting charges, think of these doings? The Corporation is committed to protect the company against competition, while that company is able to enter the field of rivals in Southwark from its protected centre in the City. Were purchase proposed, the stock of the company would immediately rise in value." Plaintiff alleged that the defendants meant thereby that plaintiff had abused his official position, and had sacrificed the public interests for the purpose of making private gain, and had been guilty of discreditable, corrupt and dishonest conduct unfitting him for any official position in the City of London.

Defendants pleaded that the words did not mean what was alleged by plaintiff, and that they were incapable of any defamatory meaning. They further pleaded that, in so far as the words consisted of allegations of fact, they were true in substance and in fact; in so far as they consisted of expressions of opinion, that they were fair comments made in good faith and without malice upon the said facts, which were matters of public interest.

Sir E. CLARKE, Q.C., for the plaintiff, said that his client was an alderman, and had long been connected with the City. Prior to becoming Lord Mayor in 1890 he was not a member of the Common Council, nor was he, prior to that time, connected with the Commissioners of Sewers. The justification pleaded by defendants was founded upon mis-statements of facts relating to the plaintiff's position. From 1878 to 1890 the Commissioners of Sewers were the lighting body in the City. The plaintiff had nothing to do with the electric lighting in the City. The contracts for that purpose were made in 1890 before the plaintiff was appointed Lord Mayor. When elected Lord Mayor plaintiff made a statement as to the companies with which he was connected. In consequence of representations made to the plaintiff and under great pressure, the plaintiff joined the City of London Pioneer Electric Lighting Co. This was done publicly and under public pressure. He took shares in the company, as a matter of duty, to the extent of £1,250. The Pioneer Company, having fulfilled its duty, was wound up, and the plaintiff made a profit on his shares to the extent of £625. This was all that plaintiff had to do with electric lighting. All that plaintiff did was in the public interest and to promote electric lighting.

Sir J. SAVORY said he had nothing whatever to do with the contracts entered into with the Brush Co. or the Laing, Wharton and Down Co. In 1891 he was approached by a deputation, and he was asked whether he would join a company to carry out the electric lighting work. He at first declined, but ultimately on great pressure agreed to become chairman of the Pioneer Co., which was to carry out the work. He thought it his duty to do so as Lord Mayor. One of the objects of the company was to tide over the period until a larger company could be formed. The City of London Electric Lighting Co. was formed, and as the Pioneer Co. had performed its duty it was voluntarily wound up. He did not become chairman of the new company, though he was asked to. The Commissioners of Sewers entered into a contract with the Brush Co. and Laing, Wharton and Down. The Electric and General Investment Co. promoted the City of London Electric Lighting Pioneer Co. He did not know that every one of the companies made a profit. At one time he had shares in the Brush Company. The chairman of the company, Mr. J. B. Braithwaite, was his cousin. When he became chairman of the Pioneer Company he did not investigate the contracts. As to the Electric and General Investment Co., he got one Founders' share and 100 Ordinary. He held them for about a year. He got £129 for the Founders' share, and for the Ordinary shares £198. 14s. 6d. The reason of the promotion of the Pioneer Company was that during the Baring crisis the Brush and the L.W. and D. Companies had a great difficulty in finding the necessary capital by Feb. 7, 1891, and if they failed in this the contracts with the Commissioners would have lapsed. The Pioneer Company was not really the Electric and General Investment Co. in another form. The total capital of the Pioneer Company was £100,000, £50,000 only being called up. The secretary of the Electric and General Co. was also the secretary of the Pioneer Company. Every shareholder in the Pioneer Company got 50 per cent. profit for the few months it was in existence. It was an advantageous thing for the City that a virtual monopoly should be granted to one company. He did not know that it was in the teeth of the Electric Lighting Act, 1880. He did not know that before the prospectus of the City of London Electric Lighting Co. was brought out the Pioneer Company had entered into contracts with the Brush and L. W. and D. Companies to give them the work in their districts for £300,000 and £200,000 respectively. There was an agreement between the Pioneer Company and the Brush Co., but he could not say how the figures in that contract were fixed. He denied that a considerable sum of money was given to the Brush and L. W. and D. Companies to transfer the monopolies created by the Commissioners of Sewers. If he had known it, he should, as Lord Mayor, have thought it a discreditable thing. He did not believe a penny was given. He did not know that the L. W. and D. Co. paid the Electric and General Investment Co. £10,000. He could not say why the L. W. and D. Co. was to pay the Investment Co. £9,000. He did not know why the Brush Co. was to pay to the Investment Co. the sums of £1,000, £9,000 and £5,000. He did not know that the capital of £1,200,000 of the City of London Electric Light Co. was now worth £2,400,000 on the Stock Exchange. He had 200 Ordinary shares and 1,000 Preference. He made £200 or £300 profit on them. It was untrue that the Pioneer Company was a promoting company to buy up the two competing companies and create a monopoly. The Pioneer Company never carried on the business of an electric lighting company. It wound-up directly its mission was accomplished. He never inquired if the Electrical and General Investment Co. paid 30 per cent. He did not know that there was a division amongst the Commissioners of Sewers as to whether the Pioneer Company should be allowed to go on. He did not know that the Commission of Sewers required an undertaking that nothing should be paid to the contractors for the transfer of the monopoly. Instead of £150,000, the City of London Electric Lighting Co. paid the Pioneer Company £75,000. He was not aware that the Council had been advised that they would be bound to oppose any other provisional order for electric lighting. All the companies were publicly advertised. He was not personally aware that his family were shareholders. He believed that the contracts were absolutely beneficial to the City of London. If the contracts had lapsed, electric lighting in the City would have been indefinitely postponed. He believed that the contract with the Brush Company provided most carefully and scrupulously for the work being properly carried out.

Major-General WEBBER, C.B., said he was formerly consulting engineer to the Brush Company, and frequently consulted with the Commissioners of Sewers. Ultimately, in May, 1890, a contract was entered into for public lighting. The Pioneer Company entered into a contract with the Brush Company to do certain works at a certain price. The specification of works was prepared under his instructions. In 1890 he thought it would be better if municipalities did the work themselves, but he knew no municipality would do the work. It was considered a great risk financially and no municipality would saddle the ratepayers with such a rate. The cost of providing London with electric light would be far greater than that of any other city. He had been consulting engineer to the Brush, Pioneer, and City of London Electric Lighting Companies. The Brush Company could not expediently raise capital for the purpose of its contract. The figures of £300,000 and £200,000 were fixed after consulting with him, but he could not refer to any document showing how they were made up. Capital cost regulated the price charged for electric light, and the extra capital cost in London explained the difference in charges between London and other places.

Mr. W. H. PREECE stated that he had been connected with the Post Office since 1870. He had been permitted to advise local bodies with regard to electrical matters, and especially the City. He was originally consulted with respect to electric lighting in the City as early as 1882. From 1882 to 1890, when contracts were entered into, he was in constant communication with the representatives of the City. He made various reports to the Commissioners of Sewers, who consistently acted on the advice of Col. Haywood and himself. The Streets Committee of the Commissioners of Sewers took a great deal of trouble and spent considerable sums of money in their endeavour to secure contracts for the electric lighting of the City. In 1885, the expenditure of the Corporation in this way had amounted to many thousands. In 1889 the City was mapped out into three districts—east, west and central—with a view of securing the best arrangements for lighting the City, and he prepared specifications. Several companies, including the Brush and Laing, Wharton and Down, sent in tenders, which were submitted to him and to Col. Haywood, and they made a report upon them, and in consequence the tender of the Brush Company was accepted for two of the districts, and that of Messrs. Laing, Wharton and Down for the third. A provisional order was then applied for, and the circumstances of the case were considered by the Board of Trade. He believed the Corporation acted wisely in entering into the contracts. The contracts were made in May, 1890, but it was not until February

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1891, the contractors began their work. Sir J. Savory never had anything to do with him in this matter to his recollection, nor did any member of the Corporation or of the Streets committee attempt to influence him. The City of London was a most difficult district to supply with the electric light, and, consequently, the cost of supplying it was more expensive than that of northern towns. He had nothing to do with the financial parts of the contracts. In 1889 he made a report to the Corporation that he was in favour of potential competition, instead of having one company. He thought there would be an advantage in having three companies, as such an arrangement would encourage a spirit of emulation. He thought the financial position of both companies was good. He never contemplated that a contract would be given to a company not then in existence. In his opinion the transference of the contracts to a large and wealthy company would enable the undertakings to be more economically managed.

Mr. H. MONTAGUE BATES (clerk to the Public Health Department of the Corporation) said he was clerk to the late Commissioners of Sewers, and remembered the discussions with reference to the lighting of the City by electricity, but the plaintiff took no part in them. The second contract with the Brush Company was signed on Feb. 5, 1891, the day on which the Pioneer Company came out. The City authorities were not consulted at the transfer of the contract until after it had taken place. The late law officer of the Corporation had been asked to report as to the power of the Corporation to establish a competitive supply; but he could not say that he had reported to the effect that the Corporation had no power to enter into competition with the existing company. The transfer to the new company was permitted on the understanding that the rights of the Commissioners and of the ratepayers were not prejudiced. Plaintiff had nothing whatever to do with the discussion on the question of electric lighting, and certainly made no attempt to influence the decision of the Commisioners of Sewers.

Mr. J. B. BRAITHWAITE, jun., said he was a cousin of the plaintiff, who had a brother in his firm. Plaintiff had nothing to do with the subscriptions to the different companies by the members of his family. They acted as other customers did, on the recommendation of his (witness's) firm. He was one of the directors of the Brush Company. In 1890 it was extremely difficult for money to be raised for the purpose of lighting the City by electricity. In consequence of the Baring crisis it was quite impossible to obtain capital. The Brush Company received money for work it had done, but nothing in the way of a bonus. The promotion of the Pioneer Company was a necessity in consequence of the Baring crisis. It was estimated that the works under the Corporation contract would cost £1,200,000.

Mr. CARSON, Q.C. (for defendants): Why could not the Electric and Investment Company finance the work?—Because it was impossible to raise £1,200,000 at that time. Why could not the Electric and Investment Company do what the Pioneer did?—The risk was too great. The money subscribed by the Pioneer Company would have been hopelessly lost if this company had not been floated.

Was the Duke of Marlborough a director of the Brush Company, the Electric and General Investment Co., and of the Pioneer Company?—Yes.

The further hearing was adjourned till to-day (Friday).

Christoffer and Others v. the National Telephone Co. (Limited).

This case came before Mr. Justice Lawrence and a Special Jury on the 2nd inst.

Mr. MOYSES, for Messrs. J. C. and G. J. Christoffer, said they were the trustees under the will of the late Mr. Christoffer, owner of the property in respect of which the action was brought, Mr. Wm. Barrett being the occupier of the property. The action was brought to recover damages for trespass committed by the defendant company extending over 14 years, and which had existed unknown to the plaintiffs, as they were under the impression that the company, being termed "National," had something to do with the State, and had a right to do what they had done. It was only at the beginning of the present year that the plaintiffs became aware of their rights, and the writ in the action was issued on April 13. The facts were that no less than 546 wires on strands or cables passed over the plaintiffs' house in Assam-street, Whitechapel. At the back of the house there were two large poles, which were put into the ground to the depth of over 6ft., one pole being put there 14 years ago and one seven years ago. One pole was only about 12in. from the back wall of the house in question, and the other about 40in. These poles were subject to oscillation during the wintry weather, and had a pernicious effect on the adjoining property. Three years after the first pole was put there, there appeared a rent in the wall. That rent had been stopped up two or three times, but it had reappeared again and other mischief had been done. One of the plaintiffs caused a letter to be written to the defendants asking for compensation for the wires passing over the property, but the defendants replied denying liability. Hence the present action.

Plaintiffs gave evidence as to the damage done, and the annoyance to the occupiers by the noise of the wires.

Mrs. BARRETT, who had lived in the house 11 years, said the crack in the walls appeared after the poles were put there. She had then complained to the landlord as to the nuisance caused by the wires. The wall had given way and a ceiling had come down; also some of the doors would not close.

Mr. FARTHING, architect and surveyor, said he estimated the damage done at £45. It was caused by the oscillation of the poles.

Mr. HITCHCOCK, surveyor and engineer to the Vestry of St. George's, Southwark, gave similar evidence.

Mr. ROSKILL, for defendants, said that he would call evidence to show that the cracks were in the wall 14 years ago, and were much the same now as they then were.

Mr. L. H. ISAACS, surveyor to the Holborn District Board of Works, gave evidence that the poles had nothing to do with the cracks in the wall and that the difficulty as to the doors not closing was due to subsidence.

Mr. W. R. DEANE, architect, said that his opinion was that the cracks were caused by settlement or subsidence.

The jury awarded the owners of the property £45 and the occupier £5 damages. Judgment accordingly.

Holliday v. National Telephone Co. (Limited).

On Monday, in the Court of Appeal, Lords Justices A. L. Smith, Rigby and Collins heard an appeal from the order of Mr. Justice Wills and Mr. Justice Lawrence, reversing the decision of the Deputy Judge of the City of London Court, who found for the plaintiff for £25. The previous proceedings were fully reported in our last issue, p. 202. The present application was granted.

Alwyn and Craven v. G. Straus and Co. (Limited).

In the City of London Court last week, before Mr. Registrar Wild, plaintiffs sued defendants to recover the price of a number of incandescent electric lamps which they had supplied, and which were alleged to give a bad light. A member of plaintiff firm said the lamps supplied were used in an electric light installation at Parr's Bank, Kensington. In consequence of complaints, the lamps had to be taken down, and fresh lamps substituted. Defendants had been asked to return the price of the lamps, or to exchange them. They refused, because of the delay in making complaint. One parcel of lamps was purchased in May, and were used with others that were ordered in August. They were not fitted until September, and complaint was made in October. The lamps were of the high-voltage type, and could not be tested on an ordinary circuit. Defendants urged that the reason for refusing to exchange the lamps was that there had been a delay of five months before complaint was made. The Registrar was of opinion, from the evidence before him, that the lamps would not give a proper light, and he considered they were absolutely useless. He thought, under the particular circumstances, that complaints were made in a reasonable time, and plaintiffs were entitled to recover. Judgment for plaintiffs for £1. 3s. 3d., and costs, the lamps to be returned to the defendants.

Sun Insurance Co. and Another v. the Corporation of Dublin.

At Dublin, before Mr. Swifte, magistrate of the Southern Police Court, the Sun Fire and Life Insurance Co. summoned the Corporation of Dublin for that they "on Nov. 21, 1898, and on the two following days, at 17, St. Andrew-street, made default, and have continued to make default, in supplying energy to the complainants, being the occupiers of premises at 17, St. Andrew-street, to whom they were required to supply such energy under the provisions of the Dublin Electric Lighting Order, 1892, and thereby rendered themselves liable to a penalty not exceeding £2 in respect of every such default for each day on which such default occurred." The Corporation were also summoned by Wilfred Fitzgerald, of the same place, for similar default.

Mr. O'SHAUGHNESSY, for the Corporation, said that under the Act no penalty was incurred by the Corporation where the default to supply the energy was due to unavoidable circumstances. This case was not one of two or three 40s. penalties, but it meant a tremendous liability, for these were pioneer cases. A cable was laid down which was defective, with the result that the electric service broke down. That cable at the time it was laid was the best then known, and it was believed that it would be good for 25 years. Electrical science was yet only in its infancy [!], and this breakdown could not be foreseen. The Corporation were now engaged putting down a new cable at a cost of £100,000. The default was admitted, but they denied wilful or negligent default and he would prove that the breakdown was unavoidable and could not have been foreseen.

Mr. RUDDLE, electrical engineer to the Corporation, deposed that he had supervised the laying down of the original cable, under the consulting engineer, in 1891. That cable, the upper cable, was then known as the best on the market. It gave satisfaction for four years. They then discovered that, by some unaccountable chemical or other action, the rubber insulation was destroyed, with the result that the current leaked and was lost, and sometimes the supply was stopped. They had to open the streets to discover the cause. The Corporation in July began laying down a new cable which was guaranteed to last 10 years. The men were still at work on the laying of the cable, which was being put down as rapidly as was consistent with safety. In November there was a breakdown in the rubber of the cable, which it was impossible to guard against. There was no valid explanation yet given of this. The Board of Trade regulatious obliged them to test the cables once a week, but they tested them twice daily. On Nov. 21, when the cable in St. Andrew-street was tested, it was all right, but in the evening the test showed that it had broken down. The transformer on these premises was spoiled by the rain getting into the transformer chamber. The transformer could not be repaired in wet weather without danger to the life of the operator. The transformer could be repaired when the current was cut off. They would not repair it until the cable was first set right.

Mr. SHIEL, for the prosecution, said that the failure to supply current which left these premises in darkness was due to the breakdown of the defendants' plant, which they should have guarded against.

Mr. O'SHAUGHNESSY contended that the Corporation were not liable when every precaution had been taken that was possible.

The MAGISTRATE said that the engineer's evidence showed that this was an unavoidable accident. Electricity was yet more or less in a tentative position, and at the time the cable was laid down the Corporation took every possible precaution to get the best they could. It might be a fair case for investigation, but he should dismiss the summons, giving, however no costs

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Stegmann v. Williams.

This case came before Mr. Justice Grantham on Wednesday, on an application by plaintiff, an electrical engineer, to recover the price of electrical appliances and electric light fittings supplied—£18. 17s. 6d., £2. 17s. 6d., and £8. 10s. for an electric sign for the Savoy Palace Hotel. There was no defence, and judgment was entered for plaintiff for the amount (£80. 5s.) and costs.

Cambridge Electric Supply Co. (Ltd.) v. Cambridge Union.

At Cambridge on Friday, the Deputy Recorder delivered judgment in the appeal of the Cambridge Electric Supply Co. against the assessment of the overseers of Cambridge. Particulars of this case appeared in our issues of 8th Oct. and 4th Nov. The Deputy Recorder now said he had been deputed by the Recorder to deliver his judgment, which was for the respondents, and he dismissed the appeal with costs.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

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"The Bibliography of X-Ray Literature and Research, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. Prospectus on application.

"Electrical Engineering Formulæ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. A fine large paper edition with wide margins for notes can also be supplied. Price 12s. 6d.; post free, 13s.; abroad, 13s. 6d. *New Edition in the press.*

"The Alternate Current Transformer," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *New Edition.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"Electromagnetic Theory."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"The Electrician" Primers.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth 2s. 9d. Single Primers, 3d. each, post free.

"Armature Windings of Electric Machines."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"The Electrician" Electrical Trades' Directory and Handbook.—An important announcement in connection with the 1899 issue of the "Big Blue Book" will be found in an advertisement on another page of the present issue, to which our readers will please refer.

TENDERS INVITED.

The Corporation of *Barnsley* invite tenders for the supply and erection of: (1) Lancashire boilers and Green's economiser; (2) engines, dynamos, switchboard, condensers, feed-water pumps, balancing transformers, boosters, piping, tanks, crane, wiring of works, and engine, &c., foundations; (3) secondary batteries and accessories; (4) feeder and distributing mains (solid system); (5) potential leads, network and service boxes and service connections. Further particulars in our advertisement columns, and specifications, &c., can be obtained on application to the consulting engineer (Mr. Thos. L. Miller), 7, Tower-buildings, N., Water-street, Liverpool. The Corporation also invite tenders for the erection of a chimney and engine, dynamo and boiler house, storage rooms and offices. Specification, &c., from Mr. J. Henry Taylor, borough surveyor, to whom tenders should be sent by noon of Monday, Dec. 12th.

As will be seen from an advertisement, the Corporation of *Sunderland* require tenders for the supply of three 125 kilowatt, direct current, high speed, steam dynamos. Specifications, &c., may be obtained from the borough electrical engineer (Mr. J. F. C. Snell), Dunning-street, Sunderland. Tenders, addressed to chairman of Lighting committee, Town Hall, Sunderland, to the office of the town clerk (Mr. Fras. M. Bowey), by noon of Friday, 30th inst.

The *Leeds* City Council require tenders for the supply of underground conductors, switchboards, &c., in connection with the extension of their electric tramways. Additional particulars are given in an advertisement elsewhere. Plans and specifications may be obtained from the city engineer, Municipal Buildings, Leeds, or from Messrs. Hopkinson and Talbot, 26, Victoria-street, Westminster, S.W. Tenders, addressed to the town clerk, must be in by 10 a.m. of the 29th inst.

The Commissioners of the Burgh of *Stirling* invite tenders for the following:—(1) Lancashire boilers, with mechanical stokers; (2) engines, dynamos, pumps, steam pipes, &c., Green's economiser and tools; (3) storage batteries; (4) switchboard and boosters; and (5) arc lamps. Further particulars are set out in our advertisement columns, and copies of specification, &c., can be obtained from the clerk to the Commissioners (Mr. Thomas L. Galbraith), Town Clerk's Office, Stirling. Specifications and drawings may be seen at, but not obtained from, the office of Prof. Alex. B. W. Kennedy, 17, Victoria-street, S.W. Tenders to the Town Clerk's Office by Jan. 2 next.

Extension of Time.—The *Salford* Electric Lighting committee invite tenders for the supply and erection of the following: (1) boilers, (2) engines, (3) dynamos, (4) boiler feed-pumps, (5) mechanical stokers, (6) superheaters, (7) economisers, (8) condensers, &c., (9) steam and water pipes, (10) cranes and weighing machines, (11) tanks, &c., (12) switchboards, and (13) booster. Tenders to Town Hall, Salford, *by Dec. 15.*

The *Shanghai* Council invite tenders for a concession, for a period of thirty years, for the exclusive right of establishing and working a telephone system in Shanghai. Further particulars are set out in an advertisement on another page, and plans may be seen and particulars obtained on application to Messrs. John Pook and Co., 8, Jeffrey's-square, St. Mary Axe, London, E.C. Further information may be obtained on application to Mr. Charles Mayne, municipal engineer, Shanghai, whose telegraphic address is

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"Dynamo Shanghai." Tenders must be sent to the secretary (Mr. J. O. P. Bland), Shanghai, by noon of Friday, March 31.

The *Shanghai* Council also invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system. Particulars from Messrs. John Pook and Co., 8, Jeffrey's-square, London, E.C. Tenders to Mr. J. O. P. Bland, secretary, by noon of Wednesday, March 15, 1899.

The *Beckenham* District Council invite tenders for the supply of electric lighting plant. (For particulars see our issue of Dec. 2.) Tenders to Mr. F. Stevens by noon of Dec. 17.

The *Shoreditch* (London) Vestry invite tenders for the supply of six direct-current rotary transformers, with switch gear complete, three of 66 kilowatt and three of 33 kilowatt capacity. Tenders by noon, Dec. 13, to Mr. C. Newton Russell, Coronet-street, Shoreditch.

Particulars can be obtained at the Commercial Department of the Foreign Office of the tenders which are invited by the *Egyptian* State Administration of Lighthouses for the supply of two steam boilers. Tenders have to be in to the Controller General, Alexandria, by noon of the 31st inst.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been received by the *Southampton* Corporation for the supply of two engines and dynamos (each equal to an output of 24,000 watts), with accessories, for the electric lighting of Knowle County Asylum :—

F. Shalders (*accepted*)..	£4,300	0	0	Ernest Scott and Mountain	£4,865	0 0
Sax, Slatter and Co....	9,500	0	0	Bow, McLachlin & Co.	4,700	0 0
Prestwich and Burt ...	5,804	2	6	Joel and Potter	4,700	0 0
Thomas and Taylor ...	5,700	0	0	Calvert and Co.....	4,650	0 0
Crompton and Co.....	5,650	0	0	Brush Co.	4,630	0 0
Heath, Snoxell and Co.	5,540	0	0	Scott Anderson & Beit	3,856	10 0
Matthews and Yates...	5,385	0	0	Frank Suter and Co....	3,351	10 0
Laing, Wharton & Down	4,998	0	0			

The *Liverpool* Corporation have accepted the tender of the British Thomson-Houston Co. for the supply of 12 motor cars complete for the tramways department, at £6,752. The tender of Messrs. Robert W. Blackwell and Co. has also been accepted for the overhead equipment of the Aigburth-road electric line at £1,780. 12s. 1d.

APPOINTMENTS VACANT AND FILLED.

The Electricity Supply committee of Hull Corporation require a mains superintendent. Further particulars are given in our advertisement columns. Commencing salary £120 per annum, increasing by three annual increments to £150. Applications to the city electrical engineer (Mr. A. S. Barnard), Dagger-lane, Hull, by Wednesday, Dec. 21.

The Leith Town Council require three switchboard attendants. Applications to the town clerk (Mr. T. B. Laing) by 14th inst. See advertisement.

The Torquay Corporation require an arc lamp trimmer and an engine driver (for Willans' engines). Applications to the borough electrical engineer, Mr. P. Storey, by Tuesday, Dec. 13. See advertisement.

An experienced engineer is required to take charge of a large beam engine. Applications to Messrs. J. and J. Cash (Limited), Coventry. See advertisement.

An assistant lecturer in physics and mechanics is required at the Royal Naval Engineering College, Devonport. Salary £200 per annum. Applications to head master.

Mr. A. V. Anderson, assistant superintendent of mains at Edinburgh, has been appointed superintendent of mains in succession to Mr. S. E. Fedden.

Mr. W. C. Ullmann, of the British Thomson-Houston Co., has been appointed electrical engineer to the East Ham Town Council. Mr. Ullman is at present engaged on the Sheffield electric tramway contract.

Mr. Love has been appointed an assistant engineer at the Bath electricity works in place of Mr. Parsons, appointed to Halifax.

BUSINESS NOTICES.

Reference is made on p. 214 to correspondence which has passed between the Glasgow Corporation and a contracting firm with regard to the supply of telephonic apparatus. In connection with this subject, the following is of interest :—

"29, Waterloo-street, Glasgow, Dec. 7, 1898.

"Sir,—As you have published our letter of Nov. 25, 1893, to Sir James Marwick, Town Clerk, Glasgow, withdrawing our quotations of Sept. 23, 1897, for multiple switchboards, telephones, &c., we wish you to make it generally known that the contract made by Messrs. L. M. Ericsson and Co. (Limited), at Stockholm with the National Telephone Co. (Limited), London, was signed on Oct. 3, 1898, at Stockholm, without our knowledge or consent. The agreement made is not to sell telephone apparatus to or for any municipal corporation, or any licensee of Her Majesty's Postmaster-General, in connection with exchange lines, within the British Isles, except through the National Telephone Co. (Limited) at London.—We are, &c.,

"THE ERICSSON-BELL TELEPHONE CO.,
"Per Charles Bell, Sole Partner."

The business of the Waverley Electric Co., 117, George-street, Edinburgh, and at Portobello, has been transferred to Mr. J. G. Macandrew, 117, George street, Edinburgh, as from Nov. 28. Debts to date will be discharged by Mr. Mathew Buchan, 3, Victoria-terrace, Portobello.

Messrs. P. Jolin and Co. have removed from Narrow Wine-street to 25, Temple-street, Bristol.

BANKRUPTCIES, LIQUIDATIONS, &c.

A receiving order has been made against Edward B. Pym, electrical engineer, 29, Bramham-gardens, London, S.W., late of Bar Chambers, Scarborough.

At a meeting of the Mannesmann Tube Co. (Limited and Reduced) on Dec. 1 it was resolved that the company be wound up voluntarily, and Mr. E. Waterhouse, 44, Gresham-street, London, E.C., was appointed liquidator. A petition presented by George Senior and Sons (Limited) for the winding up of the company will be heard in the High Court on the 14th inst. A petition for the winding up of this company has also been presented by Messrs. C. G. R. Charubin, Arnold Wilhelm von Siemens and Georg Wilhelm von Siemens, and will be heard in the High Court on the 14th inst.

Claims against the Globe Electrical Advertising Syndicate (Limited) must be sent to the liquidator (Mr. T. C. Leman), St. Peter's Church-walk, Nottingham.

Claims against the London Provincial Electrical Co. (Limited) must be sent in to the liquidator (Mr. S. Wheeler, O.R.), 33, Carey-street, W.C., by Dec. 16.

Plant for Sale.—The plant, machinery and stock of electroplating and electric lighting works, in Blackburn, are for sale. See advertisement on another page.

Jandus Arc Lamp Patents.—The Jandus Arc Lamp and Electric Co. notify in our advertisement columns that they are prepared to negotiate for the sole right to manufacture the Pioneer arc lamp for use in England. Applications should be made to the sole agents, Messrs. Drake and Gorham, 66, Victoria-street, London, S.W.

Switch and Controller.—The General Electric Co. are placing on the market a lift controller and reversing switch with magnet control, for which special advantages are claimed. The form of resistance used with this controller is of tubular radiator type, with enclosed coils. In the construction of the reversing switch the arrangement consists of opening the circuit at 24 different points simultaneously, thereby dividing the sparking into many small arcs. The reversal of the current is accomplished by a half turn of the sprocket wheel.

Electric Fans.—The Kulm Hotel, St. Moritz, in the Engadine, is being fitted with an electric ventilating plant, current being taken from the private lighting plant at 200 volts. Mr. Ernest Hutton, Northallerton, Yorks., is the contractor.

Patent Amendment.—Notice is given in an advertisement in another column that Mr. G. W. C. Adams, of the Royal Naval College, Greenwich, Kent, has applied for leave to amend the specification of letters patent, No. 713 of 1888, for an improvement in voltaic or galvanic batteries granted to Theophilus Coad. Particulars of the proposed amendment are set out in the *Illustrated Official Journal* (*Patents*) of Nov. 30, and notice of opposition must be given within one month from that date.

Storage Battery Tests.—Following tests of a "Hart" cell have been made by the Electrical Standardising, Testing and Training Institution, and are of interest. The cell was charged and discharged four times at a current of 25 amperes, the discharges being considered complete when the open-circuit E.M.F. had fallen to 1·80 volts. The results of the measurements of the final charge and discharge are given in the following table :—

	Charge.	Discharge.
Mean current, amperes	25·0	25·0
Hours run	11·75	10·7
Ampere-hours	293	268
E.M.F. initial, volts	1·95	2·18
" final "	2·29	1·80
P.D. initial "	2·01	2·13
" final "	2·59	1·59
Mean P.D. "	2·26	19·2
Total watt-hours	662	514
Total weight of cell, kilos	47·5	47·5
Ampere-hour efficiency.....	91·5%	
Watt-hour "	77·7%	

The "Engineering Magazine."—The contents of the December issue of this magazine include, "Chinese Railway Development, Past, Present and Future," by Chas. Denby and E. P. Allen; "Equipment, Management, and Economic Influence of the Ship Canal," by W. Henry Hunter; "Old and New Forms of the

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Suspension Bridge," by Gustav Lindenthal; "The Steel Foundation of the Ship Building Industry," by James Riley; "A Simple and Effective System of Shop Cost-keeping," by H. M. Norris; "The Buildings of Oxford from an Engineer's Point of View," by J. W. Parry; "Extensions of Submarine Telegraphy in a Quarter-Century," by Charles Bright; "The Application of Electric Power to Pumping Machinery," by Sterling H. Bunnell; "The Timber Wealth of Pacific North America," by Frank Haines Lamb; "Mining, Smelting, and Refining of Nickel," by Titus Ulke. The usual review of the World's Engineering Press is also included. Copies can be obtained at 1, 2 and 3, Salisbury-court, Fleet-street, London.

"Cassier's Magazine."—The contents of the December issue include: "Luxury in American Railway Travel," "Transportation and Lifting of Heavy Bodies by the Ancients," "High Explosives in Naval Warfare," "The Evolution of the Machine Tool," "British Four-Cylinder Locomotives," "The Vesuvius Cable Railway," and "Early Marine Engine Construction and Steam Navigation in the United States."

"Engineering Times."—We have received No. 1 of "The Engineering Times," published by Ward, Lock and Co. The magazine is well got up, somewhat on the lines of "The Engineering Magazine" and "Cassier's," though not on so ambitious a scale as these well-known magazines.

"Hazell's Annual."—We are pleased to receive the 1899 edition of "Hazell's Annual." This is the 14th issue of a useful record of men and topics of the day, and so far as a cursory glance at its contents shows, much additional matter of a useful and instructive character has been added to the new edition. Under several headings information is given relating to electrical and industrial schemes, and a brief review is included of electrical work during the past twelve months. Under the heading "Telephones" we are informed that the yearly subscription in London is from £10 to £17. The maximum figure is too low.

Electric Motor Cars and Carriages.—An excellent sheet of illustrations of the latest designs of electric motor cars and carriages, for which, it is stated, arrangements have been completed to manufacture in England on a large scale, reaches us from Messrs. Shippey Bros. (Limited).

"Trigonometry at a Glance."—Messrs. G. Phillip and Son have sent us a cardboard sheet, bearing the above title. The meanings and relations of the various trigonometrical functions are explained with the assistance of a travelling arm; and a comparison of the functions of an angle and its complement is facilitated by a rotating triangle of mica. Teachers may find this card useful when demonstrating the first principles of trigonometry.

Calendars Received.—"Pictorial Calendar for 1899" of the Peninsular and Oriental Steam Navigation Co., showing time of sailings and ports of call of the company's steamers.

The Gloucester Railway Carriage and Wagon Co. send us the "Gloucester Diary," which, although mainly published to advertise the manufactures of the company, yet contains a quantity of useful matter.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Nov. 30 to Dec. 6, with the ports of destination:—

Argentina—Buenos Ayres, £1,427. *Australasia*—Adelaide, £55; Hobart, £20; Sydney, £1,189 (including £56 telegraph material); Wellington, £1,466 (including £1,287 telegraph material). *Belgium*—Ghent, £33. *China*—Shanghai, £285. *France*—Boulogne, £109. *Germany*—Hamburg, £110. *Gibraltar*—£774 (including £750 telegraph material). *Holland*—Amsterdam, £25. *India*—Bombay, £152; Calcutta, £1,775. *Japan*—Yokohama, £1,255. *North Atlantic*—£1,000 (telegraph cable). *Norway*—Christiana, £54. *Russia*—St. Petersburg, £57 (including £24 telegraph material). *South Africa*—Cape Town, £309; Durban, £348 (including £72 telegraph material); East London, £254; Port Elizabeth, £330. *Spain*—Barcelona, £115. *Straits Settlements*—Singapore, £9,192 (telegraph cable). *Sweden*—Stockholm, £40 (telegraph material). *United States*—Cienfuegos £397 (telegraph cable). *West Indies*—Trinidad, £36. Total, £20,807, against £33,449 in the corresponding week last year (Dec. 1 to Dec. 7).

Presentation.—On Friday last Mr. A. T. Cummins was the recipient of a handsome present on the occasion of his resigning the position of chief assistant engineer at Leyton electricity works. The presentation was made by Mr. H. C. Bishop on behalf of the engineering staff of the works.

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Alleged Perjury.—At Bow-street (London) Police Court on Tuesday, before Mr. Lushington, John Limbrey Higgs, solicitor, Delahay-street, Westminster, again appeared to an adjourned summons charging him with having committed wilful and corrupt perjury in his examination in connection with the liquidation of the I. E. S. Accumulator Co. It was announced that Mr. Walton, an important witness, would not be able to give evidence for 10 days or a fortnight. For the defence it was pointed out that defendant, so far from having received any monetary benefit from his connection with the I. E. S. and other companies, was actually the poorer by a sum estimated at £12,000. He had interested himself in various electrical appliances, and, like most pioneers, had lost heavily. Mr. Higgs, it was urged, was not guilty of any intentional perversion of the truth, and that no case had been made out against him. Mr. Lushington left the matter to be decided by a jury, and committed defendant for trial, bail being fixed at two sureties in £100 each.

Anglo-Chinese Trade Enterprise.—The *Statist* is a journal likely to be exceptionally well-informed on matters telephonic in China and Japan. In a leading article in the last issue of that journal attention is called to the case against the municipal authorities of Shanghai in their treatment of the China and Japan Telephone Co. The object of the article is to show the treatment received by English trading firms in the Far East, and especially as a commentary upon the claim made in political circles for an extension of British enterprise in those regions. The following extract contains the pith of our contemporary's charge:—

Shanghai, as our readers are aware, is a town founded as a consequence of our wars with China. There is a British settlement and a French settlement, the British settlement being far the larger and containing considerable numbers of Americans, Germans and, in short, Europeans of all nationalities. The French settlement is almost exclusively French. Each settlement is administered by a municipality, and it is the action of the British municipality—which the French in this case follows blindly—in regard to the Telephone Company working in Shanghai which we would bring to the notice of our readers and commend to the consideration of Lord Salisbury. The fortunes of the China and Japan Telephone Co. have very little interest for the public, and we certainly should not intrude their affairs upon our readers were it not that the attitude assumed by the municipality is an object-lesson which, we venture to think, supplies a useful comment upon Lord Salisbury's policy in China. The Telephone Company has been working since 1883 or 1884 without any privilege of any kind, or, according to the municipality, any agreement even with the municipal authority. And it has gradually built up a business which, to put it briefly and clearly, the municipality now proposes to set up to auction, inviting capitalists all over the United States, all over the Continent, and here at home to bid eagerly for. The municipality has issued a little pamphlet, inviting tenders for the working of the telephone system in Shanghai, with an offer of a concession for 30 years, the municipality, however, to have the right of purchase at the end of 15 years. And in this pamphlet it gives such information as may guide intending tenderers. It is from this little pamphlet that we take the information we now propose to lay before our readers. The pamphlet tells us that at the time it was made up the company had 338 subscribers, and that these subscribers and such others as may be added before the concession is granted will be handed over to whomsoever is successful. Of course, we are aware that the municipality cannot compel these subscribers to join a new system. What the municipality means, no doubt, is to hold out an inducement to capitalists in Europe and America by telling them that there are already 338 subscribers to the existing company, and that no doubt these find the telephone of so much use that they will continue their subscriptions whoever may supply the service. Is not this a very plain expression of opinion that British enterprise in China needs neither encouragement nor protection; that British traders are very well able to take care of themselves; and that any of them who are fools enough not to take security for the safe enjoyment of whatever enterprise they may build up deserve to suffer? And remember that the expression of opinion is from the trading community of Shanghai. Again, it will be noted that the trading community of Shanghai invites Americans and the people of the Continent, without exception, to send in tenders. . . . It would be wearisome and serve no useful purpose to go into the various conditions imposed upon those who tender. But there is one point which throws so much light upon the allegation that encouragement and protection are required by merchants in China that we cannot refrain from noticing it. Those who send in tenders are obliged to state the charges they intend to make to subscribers. But the municipality reserves to itself the right to revise the terms if those who carry on the telephone business extend that business anywhere in China beyond the British and French settlements. It is hardly credible that any capitalist in his senses will agree to this. And therefore we do not expect that very many will tender. But as defining the very little importance attached by the British residents in Shanghai to either encouragement or protection the proposal is exceedingly instructive. The tenderer must first state what he intends to charge. And the charge, one would suppose, is the main point in the business, for nobody will carry on the telephone system except for the purpose of making a profit. Yet the tenderer, having stated what he requires, is told in the same breath that if he extends his business the municipality may change the terms altogether. Now, it is obvious that if China is about to be opened up and to advance economically, it may be of the very greatest importance to those who in future will carry on the telephone business in Shanghai to establish themselves in other great centres. But if they do so the threat is held over their heads that the municipality of Shanghai reserves to itself the right to alter the terms of the contract. Whether this is law we do not pretend to say. But, at all events, it is a very eloquent comment upon the alleged necessity that is felt for encouragement and protection.

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Argentina Electrical Imports.—The imports of electrical plant and apparatus during the first nine months of 1898 were :—

	Value.
Galvanised iron wire (15,627 tons)	$984,227 gold.
Dynamos (44 tons)	30,740
Electric light mains (2,626 tons)	672,187
Fittings—gas and electric light (67 tons)	97,011
Electric light carbons (65 tons)	9,747
Incandescent lamps (12,104 dozen)	36,312
Electric light material (6,622 cases)	274,499
Telephone material (247 cases)	8,543
Telegraph material (635 cases)	18,953

Belfast.—The extensive premises of Messrs. J. Robb and Co., Castle-place, are now lighted electrically. The installation, which includes 40 Jandus arcs, has been provided by a local firm (Messrs. Coats and Co.) to the specification of Mr. J. H. Greenhill.

Owing to the great demand for current it has been decided to connect all applications already granted on the understanding, that if necessary the pressure of supply may be lowered to meet the extra demand pending erection of additional plant, delivery of which has been delayed.

Blackburn.—A sub-committee has been appointed to arrange terms with the consulting engineers (Messrs. Lacey, Clirehugh and Silliar) for the preparation (in co-operation with the borough electrical engineer) of a scheme for the extension of electric tramways in the district.

Buxton.—The District Council have obtained powers for borrowing £25,000 for electric lighting purposes.

Bromley (Kent).—The Bromley Electric Lighting Co. have notified the District Council that they propose laying electric lighting mains in several of the streets of the district.

Buluwayo.—In their annual report the Directors of Willoughby's Consolidated Co. (Limited) state that the contract for the installation of the electric light at Buluwayo had been completed and the electricity supply works taken over as a going concern by the Buluwayo Waterworks and Electric Light Co.

Carlisle.—The electric lighting installation at the Citadel Railway Station is now practically complete. The work has been carried out under the direction of the chief of the electrical department of the London and North Western Railway Co., Mr. J. W. Fletcher. In addition to 63 arc lamps for lighting the station proper and approaches, about 600 incandescents will be employed for lighting the interiors.

Chelsea (London).—At a special meeting of the Vestry last week it was decided, by a majority of one, not to proceed with the application for a provisional order for Kensal Town.

Chester.—A Local Government Board inquiry will be held on the 16th inst. into the application of the Town Council to borrow £20,000 for electric light extension purposes.

City of London.—The Common Council have informed the Smithfield Markets Electric Supply Co. (Limited) and the Charing Cross and Strand Electric Supply Corporation (Limited) that they cannot consent to the intended applications for provisional orders for the supply of electricity within the City which it was intended to make on behalf of those companies. A similar application by the Metropolitan Electric Supply Co. was refused a short time ago.

Copper.—The *Statist* for Dec. 3 contains an exhaustive article on "Copper Production," reviewing the position from 1879 to date. The figures given show that the world's production of copper in 1879 was 152,000 tons, against 396,000 in 1897—the largest output on record. The average price for the year 1879 was £57. 11s., against £48. 18s. 9d. in 1897—the highest price since 1891. In 1888 the price was £76 per ton. The United States contributed 212,000 tons to the 1897 total, Spain 54,000, other countries 130,000, the States output thus being far in excess of all other parts of the world. The diagram accompanying the review shows that the production in the States has been continuously increasing from 1879 to 1897, with exceptions only in 1886 and 1893. Having regard to the extent of the world's consumption of this metal the available stocks and supplies are smaller than ever previously in the history of the trade, at the present time amounting to only 26,879 tons, or approximately less than six weeks' consumption. Owing to the financial depression in the United States during 1895 and 1897, very large shipments of copper to Europe have been made from that country, but with the present indication of an expansion of business the outlook is (says the *Statist*) for an increase in the home consumption and for smaller supplies available for European and British requirements. The price of copper has improved 10 per cent. during the past four months, and our contemporary anticipates that the higher price will be maintained, if not increased.

Dewsbury.—The charge for current for motive power purposes has been reduced to 1¼d. per unit.

Dudley.—The Town Council have decided to oppose the application of the Midland Electric Corporation for Power Distribution for a provisional order. An agreement is to be entered into with the British Electric Traction Co. for relaying and electrically equipping the tramway from the railway station to the borough boundary.

Edinburgh.—The fine Library Hall of the Edinburgh University, which has been undergoing redecoration, is now lighted electrically.

Electrical Trades Union.—We are asked to state that the electrical workers of Glasgow are invited to attend a meeting on Monday evening next, at 79, Anderson-Cross, Glasgow.

Electric Pumping in South Staffordshire.—The Commissioners of the South Staffordshire Mines District have authorised the borrowing of £10,000 for providing electric pumps on the surface when a supply of electricity is available.

Electric Traction in West London.—The proposals of the London United Tramways for the extension of their system in West London, more particularly the suggested line between Hanwell and Acton, is exciting considerable attention. If the company are successful in their application there will be a continuous electric tramway from Uxbridge to the Central London Electric Railway at Shepherd's Bush. An illustrated pamphlet has been distributed by the Ealing Ratepayers' committee, setting forth the advantages of the projected Hanwell-Acton line.

Exeter.—At present there is an equivalent of 14,000 8 c.p. lamps connected to the electric light mains. The City Council have resolved to oppose the application for a tramway Provisional Order by the Exeter Tramways Syndicate, and have decided to municipalise the tramways and introduce electric traction.

Gold Coast Telegraphs.—During 1897 the permanent telegraph line to Kumassi was completed. The wires are mainly supported on trees, very few poles being used. Owing to increase of traffic, a duplicate land line has been established between Accra and Cape Coast Castle. There are 26 Government telegraph stations in the colony, which dealt with 84,580 messages in 1897. The responsibility for the maintenance of the line rests with the native chief through whose district it passes. It was found necessary to adopt this rule, owing to the thefts of telegraph wire and the destruction of telegraph property which had for some time prevailed.

Hammersmith (London).—The Vestry has invited other metropolitan Vestries and municipalities to assist in opposing the recommendations of the joint Parliamentary committee on the supply of electrical energy in the event of legislation being introduced to give effect to those recommendations. The Vestry contend that the local authority within the area of supply should have the power of deciding the route along which the mains are to be laid, and the right of breaking up and reinstating the roads, and also should retain its power of veto both in regard to overhead wires for traction and applications for provisional orders.

Hastings.—The Local Government Board have sanctioned the Town Council's application for a loan for the purchase of the undertaking of the Hastings and St. Leonard's-on-Sea Electric Light Co. (Limited).

Heckmondwike (Yorks).—There is a probability that the District Council will take electric current from the Dewsbury Town Council for street lighting purposes. A conference on the subject has been arranged.

Infirmary Lighting.—The proposal to put down an independent plant for the electric lighting of the new Islington Workhouse Infirmary at Highgate Hill provoked a heated discussion at the meeting of the Guardians last week. A report on the matter is to be prepared by an independent engineer, but it is probable that the Vestry will eventually obtain the contract for the supply of current.

Islington (London).—The work of laying electric light mains along Essex-road will be commenced in about a fortnight's time. The amount borrowed in connection with the Vestry's electric supply undertaking is now £191,300. There are at present 216 arc lamps in the parish, costing annually £6,822. 13s. 4d. The number of gas lamps displaced by these arcs was 440.

A number of letters from local subscribers and a memorial from the National Telephone Co. has been received by the Vestry against its proposal to compel the National Company to take down the telephone wires, the spans of which are longer than is allowed by the regulations. The memorial and letters asked that the company should be allowed to place its case before the Vestry. This matter is referred to in our report of the London County Council's meeting on Tuesday.

Kandy (Ceylon).—The agreement between the Municipal Council and the Colombo Gas and Water Co. for the electric lighting of this town has been signed. The contract for the plant will be placed in England.

Leeds.—The City Council on Wednesday decided to create Leeds Corporation Irredeemable Five per Cent. stock to the amount of £217,420. 10s. 4d., to produce by the dividends thereon the annuity referred to in Section 59 of the Leeds Provisional Order (1891). The Parliamentary committee has also been authorised to raise

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and pay all additional moneys which may be or become due and payable by the Corporation to the Yorkshire House-to-House Electricity Co. (Limited) under the agreement for the purchase of the company's undertaking.

The salary of the tramway electrical engineer (Mr. John Burbridge) has been increased from £300 to £400 per annum.

Light Railways.—The Board of Trade have confirmed the order of the Light Railway Commissioners for the construction of a light (electric) railway from Summerhill-road, Bristol, to Hanham.

At a meeting of Preference shareholders of the Great Eastern Railway Co., Lord Claud Hamilton said that when the Light Railways Act was brought forward it was on the distinct understanding that light railways should be free from any liability to the restrictions such as the Board of Trade imposed with respect to main line and express trains, but it now appeared that the Board was desirous of imposing the same restrictions on light railways as were imposed on main lines. The Directors of the Great Eastern Company had arrived at the conclusion that if the Board persisted in imposing these restrictions it would be utterly impossible to consider the construction of light railways, because they could not be carried on without great inconvenience to the public and at a loss to those who had constructed them.

The Colne Town Council are taking steps to obtain an order under the Light Railways Act to construct and work a light (electric) railway within the limits of the borough.

The Board of Trade have sanctioned the order of the Light Railway Commissioners authorising the British Electric Traction Co. to construct a light (electric) railway between Middleton, Rochdale and Oldham. The Middleton Corporation appealed to the Board of Trade against the order on the ground that the procedure should have been taken under the Tramways Act, which offers a purchase clause more favourable to local authorities. This point has been overruled, and it is expected the tramway will be at once proceeded with. Application is being made to take the tramway within the boundaries of Oldham, Rochdale and Manchester.

Lincoln.—The Corporation have been approached on the question of purchasing the undertaking of the local tramways. The tramways company is considering the advisability of adopting electric traction.

Liverpool.—The City Council have authorised the Tramways committee to spend in the course of the ensuing year £127,400 in laying down on various routes rails suitable for electric traction—£54,839 for rails, laying and bonding, and the balance for paving.

Liversedge.—The District Council have decided to support the application of the British Electric Traction Co. for the construction of an electric tramway from Dewsbury to Cleckheaton.

Llanelly.—Now that the Town Council have been threatened by the Board of Trade with the revocation of their provisional order (1891) the advisability of complying with its terms is being considered by the Property and Estate Committee. Mr. J. C. Howell's offer to carry out the work has been again before the committee, and the Council are to be asked whether negotiations with Mr. Howell shall be reopened.

London County Council.—At Tuesday's meeting it was reported by the Fire Brigade committee that the installation of the electric light at the chief station of the brigade had been completed, and is in working order. The contract with the National Electric Free Wiring Co. provided for the fixing of a secondary battery, but the chief officer suggested that in place thereof a duplicate dynamo should be provided. The company had offered to provide and fix the dynamo, and to execute the work therewith for £274, and they recommended that a fresh contract be, therefore, entered into. This was carried.

The Council have postponed the consideration of a report of the Highways committee recommending that certain overhead telephone wires erected by the National Company in Islington (which exceed the span allowed by the regulations of the Vestry) be permitted to remain.

Lourenço Marques.—The General Electricity Co. of Lourenço Marques has secured the contract to light the streets of this town by six 1,000 c.-p. arcs and 300 16 c.-p. incandescents for £1,000 per annum.

Malvern.—The Board of Trade having notified the District Council that the provisional order granted in 1890 has not yet been put into force, it has been decided to ask the Board to grant a further extension of time for complying with the terms of the order.

Manchester.—A deputation of the Corporation paid a visit to Glasgow on Friday for the purpose of inspecting the New Springburn-Mitchell-street electric tramway. The deputation report that (1) the overhead trolley system is the only possible one for Manchester; (2) no nusiance or danger from it is experienced in Glasgow; (3) electric traction has proved so successful there that gradually it will supersede horse traction; and (4) half-penny fares for short distances are possible and profitable.

Oldham.—A town's meeting has declared almost unanimously in favour of the Council's tramway proposals, which comprise the taking over of the present lines and the construction of 12 additional miles of track at an estimated cost of £78,000. The Corporation have practically decided upon adopting electric traction throughout the entire system.

Penzance.—The application of Edmundson's Electricity Corporation for a provisional order is to be opposed, and the Town Council will itself apply for an order.

Personal.—Mr. C. H. Wordingham, Assoc. M. Inst. C.E., M.I.E.E., has been elected a member of the American Institute of Electrical Engineers.

Proposed Electric Ferry Across the Thames.—In the list of electric traction notices published in our last issue was mentioned a bill deposited by the Thames Ferry Co. for the purpose of incorporating a company to construct a ferry on submerged rails across the Thames, between Greenwich and Milwall, the ferry to be propelled electrically. The ferry would run from a point at or near the site of Brewhouse-lane, one chain or thereabouts to the west of the Ship Hotel, terminating in the parish of All Saints, Poplar, at or near the western boundary of the Island Gardens. It is proposed to take power to sell or lease the undertaking or any part of it to the Corporation or the London County Council or any corporate body, or to make agreements with such authorities with respect to the construction, management and maintenance of the undertaking.

Ramsgate.—A proposal to borrow a further £30,000 for the gas undertaking has led to a protest from Councillor Hart. At the last meeting of the Town Council he said it would be wiser to spend £30,000 or £40,000 in electric lighting, which must come eventually and, probably, would come before very long. There was considerable dissatisfaction in the town because of the absence of electric light. He was assured by his neighbours that gas destroyed their goods and that there was a general desire that the Corporation should establish electricity supply in the borough. He advised the Council to amend the proposal so as to include an application for powers to establish lighting by electricity. The Council did not take this advice. Ramsgate and Margate are the only southern seaside towns of importance without electricity works. Dover, Folkestone, Eastbourne, Hastings, Brighton, Hove, Portsmouth, Bournemouth and Torquay all have, and Bexhill, Plymouth and Southend will shortly have, supply works, so that if Ramsgate wishes to retain its position as one of the most popular resorts it will have to speedily follow the example of their enterprising and progressive rivals.

Rochdale.—There was no opposition at a Local Government Board inquiry held here on Wednesday into the application of the Town Council to borrow £30,000 for electric lighting purposes.

Rotherham.—The Council have declined an offer of the Drake and Gorham Electric Power Syndicate to construct an electric tramway between Rotherham and Rawmarsh.

Smithfield Club Show.—The centenary show of the Smithfield Club is being held this week at the Agricultural Hall, Islington, London, and while there is as usual very little to record of an electrical character some fine examples of agricultural machinery and engines suitable for electric lighting work are on show. Among the exhibitors whose stands attract the attention of visitors are Messrs. Clayton and Shuttleworth, Crossley Bros., John Fowler and Co., E. S. Hindley, R. Hornsby and Sons, Marshall, Sons and Co., Robey and Co., and Ruston, Proctor and Co. on the ground floor, while in the gallery are the excellent exhibits of Messrs. W. H. Willcox and Co. Amongst the machines on show by Messrs. Robey and Co. is a "Robey" gas engine fitted with patent self starter, and specially constructed for electric lighting work, a suitable governor being specially provided; also a "Robey" under-type combined engine and locomotive boiler, which is claimed to be extremely economical in fuel, consuming under 2lb. of Welsh coal per indicated horse-power per hour. Special care has been taken with the working parts of this engine, so that it may be relied upon to run safely and economically at high speed. The lubrication of this engine renders it particularly suitable for long runs. Messrs. John Fowler and Co.'s exhibit at Stand No. 7 consists mainly of agricultural machines, but also includes an assortment of models and samples of patent light railway plant and rolling stock, the exhibition space available not being sufficient to enable the firm to display a full-size exhibit. Messrs. W. H. Willcox and Co. show a large collection of tools and general engineers' stores, and the show of belting, lubricants, steam engine fittings, and boiler mountings, &c., &c., invite the special attention of those visitors who own or tend running machinery. Included in this firm's exhibit is a selection of patent roller bearings, Messrs. Willcox and Co. having been appointed sole agents to the Roller Bearings Co. (Limited), for the east, south, west and midland counties and London. Evidence of the plethora of work in the engineering trades is manifest, a number of the exhibitors, including Messrs. Robey and Co., having experienced difficulty in providing the necessary machines for show. In some cases customers have consented to their machines on order being exhibited at Islington, accepting delivery direct from the show.

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Salford.—On the recommendation of the Electric Light committee, the Corporation have decided to appoint a consulting electrical engineer. Mr. Haworth, chairman of the committee, in supporting the recommendation, said that they wanted someone to go through their specifications, and he would like this to be an outsider. Sir Richard Mottram thought it was most important, when they were spending £200,000, that they should spend it under the best possible advice. He had confidence in both the committee and the engineer, but, at the same time, if they passed the resolution, he thought it would be their duty to get the best of experts.

Sheringham (Norfolk).—It has been decided to adopt the Lighting and Watching Act. The surveyor (Mr. C. D. Watts) has submitted to the Parish Council estimates of the cost of electric and gas lighting, and it is probable that the former will be adopted.

South Africa.—The *British and South African Export Gazette* says the question of the erection of electricity supply works at Uitenhage is under discussion. A proposal has been made to utilise water power in the generation of current.

The Bloemfontein Town Council have decided to extend their contract with Messrs. Reunert and Lenz for the electric lighting of the borough so as to provide for supplying current to the whole town, the cost to be over £17,000, instead of £7,500.

The Johannesburg Town Council have accepted the tender, amounting to £11,100, of Messrs. Siemens (Limited) for the electric lighting of Old and New Doornfontein.

A complete electrical installation has been fitted up at the Dunraven gold mine, Rhodesia.

Stanford-le-Hope (Essex).—Some time ago, the Parish Council entered into an agreement for the electric lighting of the district, but the County Council refuse to sanction the laying of mains unless the Parish Council guarantee to make good the roads, &c. This, however, they object to do, unless the contractor (Mr. Simpson) agree to indemnify them against any claims of the County Council.

Telephone Municipalisation.—The Parliamentary Bills committee of the Glasgow Corporation have decided to amend their Telephone Bill by inserting a clause pledging the Corporation Loans Act, in addition to the Common Good Fund, as security for the carrying out of the municipal telephone project. By this means the guarantee rate under the Corporation Loans Act will be employed to secure principal and interest, and, if necessary, an assessment can be imposed for the purpose.

Torquay.—Ald. Kerswill presented a statement at the meeting of the Town Council on Tuesday on the cost of the electricity supply scheme. He said that the works could now give a constant supply of current. The total outlay was £24,867, or £1,726 over estimated cost. From the £24,867 had to be deducted £920, value of material available for the extension of the mains, reducing actual cost to £23,946. The amount sanctioned and borrowed for the undertaking was £22,300, so that the works have cost £1,646 16s. 1d. more than the sum borrowed. The Borough electrical engineer (Mr. P. Storey) reported that when the works were opened there were 40 consumers, now there are 95, and 14 applications were awaiting connection. The revenue from March 17th to Sept. 29th was £1,091.

Underground Electric Railways in London.—It is reported that opposition is to be made to the applications for authority to construct the Great Northern and Strand and the North-West London Electric Railway. The London County Council will be asked by several local authorities to oppose the schemes on the ground that no further electrical underground railways should be sanctioned until the already authorised lines are constructed, and their effect upon the relief of traffic in London is ascertained.

Wakefield.—The Electric Lighting committee are considering the question of extending their arc lighting system.

Whitechapel (London).—The District Board of Works, on Monday, decided to establish electricity supply works, and to borrow £60,000 for carrying out the scheme, which has been prepared by the consulting engineer, Mr. Arthur Wright, of Brighton.

Wolverhampton.—The Electricity Department of the Town Council have more applicants than they can conveniently supply. Four months ago the Council decided upon an extension scheme involving an expenditure of about £30,000, but it is anticipated that it will be at least six months before this additional plant will be available. As a means of relieving the strain on the resources of the lighting station, it has been decided by the Markets committee to have the old gas fittings in the market hall restored, so that, if necessary, the large arc lamps which supply the general lighting of the building may be temporarily cut off in the evening for an hour or so without serious inconvenience.

Worthing.—Mr. E. W. Monkhouse has been instructed by the Electric Light Committee to prepare a report upon the question of erecting a refuse destructor in conjunction with the projected electricity supply works.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. CHAPMAN, *Fel. Chartered Inst Patent Agents, of 70, Chancery-lane, W.C., from whom all information on he subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

November 11, 1898.

23,821. A. E. GILLESPIE and J. GILLESPIE. London. Improvements in and relating to coin freed telephones.

November 12, 1898.

23,827. G. D. BURTON. London. Improvements in the art of electric dyeing and shrinking and in apparatus therefor.*

23,853. S. F. WALKER. Cardiff. Improvements in primary galvanic batteries.

25,890. A. HÄNSEL. London. Improvements in electric velocipedes or other vehicles.

23,895. A. M. CLARK. London. Electric ignition apparatus for internal combustion engines. (La Société Anonyme des Automobiles Pengcot, France.)

November 14, 1898.

23,922. R. LORD and A. R. MILLER. Swindon. Improvements in fire alarms or boxes from which electric signals are given in case of fire.

23,937. J. ATKINSON. Cheshire. Improvements in electrical dynamos and motors.

23,958. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in electric measuring instruments. (E. Thomson, United States.)*

23,976. P. L. GUYENOT. London. Improvements in and relating to electrically-controlled taps or cocks.

23,988. W. P. THOMPSON. London. Improvement in or relating to coin-controlled telephones. (C. H. Kahrs, Norway.)*

24,005. A. J. BOULT. London. Improvements in electrical storage batteries. (Sedneff and Bratasched, Germany.)

November 15, 1898.

24,030. H. RICHARDSON. Birmingham. Improvements in weighing apparatus and electrical weighing machinery.

24,037. A. WATSON. Birmingham. Improvements in electrical switches.

24,051. J. M. MURPHY. London. Improvements in electric switch mechanism.*

24,052. J. M. MURPHY. London. Improvements in electric railway systems.*

24,053. J. M. MURPHY. London. Improvements in roadway structures for electric railways.*

24,055. R. SNOW and DAVY BROS. (LIMITED). London. Improved means of cooling electric machines.

24,155. C. SCHMIDLIN. London. An improved electricity meter.

November 16, 1898.

24,126. R. G. HISLOP. Edinburgh. Improvements in junctions for tubes used as conduits for electric wires.

24,133. H. HIRST and H. BEVIS. London. A new or improved open or enclosed arc electric lamp.

24,164. W. H. BRADLEY. London. An improvement in electric incandescent lamp shade holders and a device for use in connection therewith.

24,171. H. SCHLOSS. London. Improvements in voltaic cells having dry plates which may be regenerated.*

24,172. H. SCHLOSS. London. Process for obtaining a permanent electrical contact at the covers of voltaic cells.*

24,196. C. H. KAHRS. London. Electrically heating plates, dishes and the like.*

24,210. H. H. LAKE. London. Improvements in the manufacture of electrodes for secondary batteries. (v.d. Poppenburg's Elemente und Akkumulatorenfabrik, Wilde and Co., Germany.)

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1897.

27,707. HARTLEY and HARTLEY. Electro-metallic depositing apparatus.

28,823. PRICE and JOHNSON. Covers, caps and lids of gas, sewer, telephone and electrical supply shafts and holes, gullies and the like.

30,427. HOWELL. Metallic ribbon, particularly adapted for battery plates, but useful also for other purposes.

30,544. PARPART. Electric welding of tubes and apparatus therefor.

1898.

4,278. BUSHER. Railway electrical signalling apparatus.

11,075. WISE (The Moore Electrical Co.). Electrical apparatus for producing luminous or similar effects such as Röntgen rays from exhausted receivers.

17,692. VON MÜLMANN. System of reflectors for double globe electric arc lamps.

18,941. ABEL (Allgemeine Electricitäts Geselschaft). Manufacture of homogeneous mixtures for the incandescence bodies of electrical glow lamps.

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COMPANIES' MEETINGS AND REPORTS.

London Electrical Cab Co. (Limited).

The ordinary general meeting of this Company was held on Monday, at the Westminster Palace Hotel, Mr. H. H. MULLINER presiding.

The SECRETARY (Mr. W. John Wood) read the notice calling the meeting.

The CHAIRMAN said: Some of you may remember that at the statutory meeting our *modus operandi* was fully explained, and it was then pointed out that, in the opinion of the Directors, it was certainly advisable, even at the risk of being blamed for not getting to work quickly enough (that is to say, not getting out a large number of cabs), to proceed with the greatest caution. Nothing would have been easier than to put in hand a large number of cabs, but in a new industry like this it would have probably meant that we should have found other improvements advisable, and ourselves in the awkward position of having spent our capital, and not have had perfect cabs. We commenced by building 12 cabs, which did not prove to be perfect for our requirements. Some of these cabs were altered, and we built more new ones, until we had twenty-four in use. The public "caught on," and these cabs were in enormous demand; they were used probably much more than any hansom with two horses to work it in London. They were a great improvement, but still we were not satisfied. We started a system of entering every complaint and every breakdown, however trivial, and the number of these breakdowns and complaints at the time made us all very unhappy; but we went to the bottom of each complaint and localised the reason, and found at least nine-tenths arose from five different causes. It would not be policy to go too minutely into what these causes were: four of them were mechanical or electrical, and the fifth, which was one of the most serious, was the rubber tyres. The result of our energy in localising and remedying these complaints has been that we do not now have one-fiftieth of the breakdowns or troubles that we were having. We experimented with six or seven different sorts of rubber tyres with more or less success, but I think we have now hit upon one which will get over our trouble. The makers also seem confident about it, as they propose guaranteeing their durability for nine months. You may have noticed that our cabs now make slightly more noise than at first. This is owing to the chains which we have had to substitute for those employed at first. Mr. W. H. Preece congratulated us in his inaugural speech particularly on the chains we were then using. We found, however, that they would not stand the severe regular use, and had to be substituted by the present ones. We also had considerable trouble with our drivers; but I am pleased to say things are now on a friendly footing between us, and I believe neither side has any grievance against the other. All the drivers are now paying the full Asquith award without any reduction, and I think this is more than can be said in any other cab yard in London. The intention of your Directors is in future to do all they can to develop the private hire trade; that is, supplying carriages for a fixed term such as by the day, week or month. They believe it will prove more profitable by saving wear and tear, saving the Scotland Yard licenses, and obtaining a slightly increased price. We have some customers (for example, Prince Henry of Orleans) who much prefer our cabs to any form of horse-driven vehicle, and are willing to hire them for extended periods. We believe there are many others who will also be glad to do so, as soon as it is known that we are in a position to supply them. Of companies to deal with electrical carriages alone, I have heard of five or six being started, but I have yet to hear of one single successful vehicle which has been built, or any practical result which they have obtained. It has been pointed out to your Directors many times that our cabs should have been built differently in several respects. Perhaps so. What I can tell you is that a company has been formed in Paris who are working practically exactly the same vehicle under the same patent as we have now in this Company, and before they started they announced that their cabs would be a wonderful improvement on ours. However, after an immense number of experiments and experts' opinions, they decided to build their cabs absolutely and identically as those we are now using, and they have now nearly completed 100 cabs. We have heard a great deal about the French being the pioneers of the motor industry, but as far as electrical vehicles are concerned, they are absolutely the copyists of this Company. Now, I must tell you of our troubles with the electric current and the accumulators. We started with contracts from the London Electric Supply Corporation for current, and with the Electrical Power Storage Co. for cells, and the contracts were drawn up with the very greatest care, but electricity and accumulators are things which are not amenable to contracts, as the unforeseen always happens. I consider we have been badly treated by the London Electric Supply Corporation. Possibly we might have won after a law suit, but it would have been a very big one. However, we have given notice to terminate our agreement with them, and have laid down an installation for manufacturing our own electricity. A plant such as this takes a long time to complete, however, but it has been in working order for the past month and appears extremely satisfactory. Our current is not now costing us a quarter of the amount which it was actually costing us before. I say "actually," as owing to only being able to obtain it during prescribed hours, loss through cells standing hungry or "sulphating," loss owing to transmission through motor generators, extra charges for lighting, &c., the "actual" cost was very different to the nominal one. Had we obtained our current at the same cost that we are now doing, the loss in the balance sheet would have been much reduced. However, this loss will not happen in future. We had to go to a very large expense in purchasing motor generators, but I am pleased to be able to tell you that through the good offices of our consulting engineer, Mr. Manville, we have been able to get rid of these without any loss.

Now, as regards accumulators: My remark about the impossibility of controlling electricity by means of an agreement applies even still more in this case. After innumerable difficulties, discussions and threatened law suits with regard to the guarantee, we have now practically settled upon a working basis which we believe will prove satisfactory to both parties. A scheme for not purchasing any more accumulators, but hiring them at practically the cost as maintenance now amounts to, is occupying the earnest attention of your Directors. This will decrease the amount standing in the balance-sheet under "contingent liabilities," and will give us more working capital. I ask you not to insist on my discussing accumulators too fully, as doing so might prejudice us in sundry pending negotiations. But I certainly can state that accumulators will not prove the impossible barrier to our success which so many kind friends confidently predicted. Your Directors have realised for some time that the days for experiments and tests have gone by, and that the undertaking being now a purely commercial one, a manager must be appointed who could be always there looking after your interests. Such a manager, however, must have a considerable electrical knowledge, and we have every reason to think that Mr. J. Grice Statter, who has been appointed, and whom you will meet if you visit the Company's premises, combines that electrical and commercial knowledge; in fact, personally, I fully believe that Mr. Statter will do much towards the ultimate success of this Company. With regard to the Company's finances, the capital of the Company is £150,000, of which about £75,000 was subscribed. The condition made by the Directors before going to allotment was that the amount paid in cash to the vendors should be in exactly the same proportion as stated on the prospectus (one-third). The vendors have therefore received about £25,000. As to our new cabs, we are not satisfied that these ride as comfortably as they ought to, notwithstanding the extra springs with which they are fitted. This, however, is a fault of the makers which will be put right without charge as soon as possible. We believe that all the cabs will be in working order and regular use by the middle of January. As stated in the report, it is proposed very shortly to make an issue of debentures. We believe that £12,000 will be amply sufficient, but, in order to be on the safe side, this will be part of an issue of £15,000 which remains to be issued at a future period if required. This issue will be made in 500 debenture bonds of £20 each, at 5 per cent., 50 redeemable each year, paying off the whole amount in 12 years. The loss stated in the balance sheet of £6,207. 15s. 6d., although stated as a trading loss, must not be looked upon quite in that light. This balance sheet covers a period of 20 months, and all the losses which I have referred to in connection with construction, experiments, &c., have occurred during that time. This loss no one can deplore more than your Directors, especially considering the different results which we hoped for and which were foreshadowed in the prospectus. But we did not then possess the knowledge we have since acquired from the experience of running electrical cabs 50 miles a day for nearly two years. I am informed that our cabs have run nearly 200,000 miles; nothing approaching this has ever been done before with accumulators. That experience has cost us a great deal, but it is experience which we believe will prove a very valuable asset. I am as certain as I was when this Company was first formed that electrical traction is the future motor power for trade vehicles in London. This Company has had, and will have, difficulties to contend with; the same as every pioneer company is bound to have; the same as the pioneer company supplying electric light in London has had. I think we may congratulate ourselves on the approach of the end of our troubles. Our expenses are now enormously reduced; from the experience we have had we realise what really is required, and we confidently believe that when we meet you next year we shall be able to show a very far more satisfactory result. I now move that the report and statement of accounts to July 31, 1898, be received and adopted.

The Hon. REGINALD BROUGHAM seconded the motion, which, after a short discussion in which the Directors were blamed for not calling the shareholders together earlier, was adopted.

The re-election of the retiring Directors and a vote of thanks to the Chairman for presiding terminated the proceedings.

Cape Electric Tramways (Limited),

The first ordinary general meeting of this Company was held yesterday under the presidency of Col. Sir CHARLES EUAN-SMITH, K.C.B.

The SECRETARY (Mr. S. W. Jameson) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN said: Gentlemen, the Directors may very safely congratulate you not only on the results of the past year's working, but on the very solid prospects that this Company has of assured prosperity and success. The dividend of 5½ per cent. that has been paid on the Ordinary shares is, in the opinion of the Board, a gratifying return for the first twelve months' work of a concern which is, as we hope and believe, strengthening its claims to universal popularity, and this dividend has been paid after provision made for many considerable and, more or less, unforeseen expenses incidental to the formation of a Company of this magnitude, and the commencement of the working of a new system. The extensions that have now been decided on, and the expenses of which will be met from the issue of the remaining £25,000 Debenture stock, will, of coure, result in, as we hope, bringing a very substantial increase to the revenue of the Company. The principal care of the Directors is to maintain your property in a state of the highest possible efficiency, to practice all desirable economies, and in every possible way to endeavour to meet the just demands of the public convenience. They believe that during the year under review they have not been unsuccessful in securing these ends, and they hope on the occasion of the next annual meeting they may have to submit to you a still more satisfactory result of their labours. I now move the adoption of the report and accounts.

Mr. BUTLER seconded the motion.

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Mr. PAGE suggested that the accounts of the local companies should be published. He asked what would be the position at the end of the concession, as only a certain amount of capital had been spent on the tramways, and the balance was "in water," while the reconstruction of the lines would require a large sum ?

Mr. BUTLER reminded the meeting that the cost of the concession purchased from himself, which was a considerable sum, must be taken into account in regard to capital expenditure.

Mr. GARDNER said that there was a rumour that the Port Elizabeth tramways did not pay, and he would like the Chairman to contradict it.

Mr. PARISH (a Director), in replying to the remarks of Mr. Page, said that the position was that when the municipalities purchased the tramways they had both in the case of the Port Elizabeth and the Cape Town to pay for goodwill, and 20 years hence the amount of goodwill would be very considerable. In that time the size and population of Port Elizabeth might be expected to double, and, as regarded Cape Town, the city must extend on both sides of the grand trunk line that ran from Wynberg through Cape Town to Seaport. The Port Elizabeth Company was earning £11,000 a year, and would do still better, and the rumour referred to was utterly without foundation. He saw no objection to the local accounts being published, as they would establish the fact that the state of affairs was even better than at first sight appeared. In 1902 they would begin the amortization of the Cape Town mortgage, which would then be reduced year by year on a sliding scale. The current year, so far, had proved most satisfactory, and for the first five months from July last they showed an increase of £7,245 over last year, or nearly 2 per cent. upon the shares.

The report was adopted and the dividend approved, and a vote of thanks to the Chairman, Directors and staff terminated the proceedings.

West India and Panama Telegraph Co. (Limited).

The report of the directors of this company for the half-year to June 30 last states that the amount to credit of revenue is £39,612. 14s. 2d. against £38,209. 14s. 4d. for the corresponding half-year of 1897, and the expenses have been £21,704. 17s. 5d. against £21,426. 17s. 10d., leaving £17,907. 16s. 9d., which, with £721. 10s. 10d. brought forward, makes £18,629. 7s. 7d., with which it is proposed to deal as follows :—

First Preference Shares—Dividend, six months to June 30, 6s. per share	£10,368	18	0
Second Preference Shares—Dividend, six months to June 30, 6s. per share	1,400	14	0
Ordinary Shares—1s. 6d. per share (free tax)	6,624	1	6
Balance forward	235	14	1
	£18,629	7	7

The shareholders will be glad to know that during the recent war in Cuba and Porto Rico, the cables landing in those islands were maintained in good working order, enabling the company to handle an increased volume of traffic arising from press and official messages.

The traffic receipts for the six months, compared with the corresponding period of 1897, show an increase of £6,738. 2s. 9d., and the revenue of the current half-year is also considerably in excess of that for the corresponding period, but is tending gradually to resume its normal limits. The expenses of repairing cables amounted to £8,907. 3s. 4d., or £143. 3s. 9d. more than those for the corresponding period.

New cables referred to in the last report have been successfully laid between Grenada, St. Lucia and St. Croix, in substitution for the old Trinidad-St. Croix line, and that the Trinidad-Grenada section has also been duplicated. The laying of these cables has considerably strengthened the company's duplicate system.

In September a disastrous hurricane passed over Barbados and St. Vincent, causing great loss of life and property and wide-spread suffering and distress. Feeling confident of the shareholders' approval, the directors immediately forwarded to the Lord Mayor's relief fund a donation of 250 guineas in order to express the sympathy of the company in the heavy calamity that had befallen those islands. The messages relating to the relief of the distress have been sent free of charge over the company's system, and the directors succeeded in having this privilege extended across the Atlantic. Two of the company's cables at St. Vincent were interrupted, and the land lines in Barbados, St. Vincent and St. Lucia were wrecked by the hurricane, entailing considerable expense for repairs.

NEW COMPANIES, STATUTORY RETURNS, &c.

BRITISH SCHUCKERT ELECTRICAL CO. (LIMITED).—This company was registered on Dec. 3, with a capital of £200,000, in £10 shares, to carry on, in Great Britain and her colonies and dependencies, the business of electrical and general engineers, suppliers of electric light, heat and power, electrical contractors, manufacturers of and dealers in plant, machinery, engines, appliances and implements connected with the supply and use of electricity, mechanicians, metal workers, copper smelters, cable and wire manufacturers, &c. The first subscribers, with one share each, are :—Major-Gen. H. Alderson, Major P. A. MacMahon, F. Manuelle, E. Kraftmeier, F. T. Eggers, H. E. Golding and H. J. C. Wells. The first Directors are :—Major-Gen. Sir H. Alderson, K.C.B., A. Hassler, Major P. A. MacMahon, F.R S., E. Kraftmeier, F. Manuelle and F. T. Eggers (managing).

DOULTON AND CO. (LIMITED).—This company was registered on Nov. 29, with a capital of £750,000, in £1 shares (of which 350,000 are £5 per cent. cumulative Preference), to acquire the business carried on as Doulton and Co. at Lambeth Pottery, London, at Rowley Regis and Burslem, Staffs., and elsewhere, to enter into an agreement with Mr. Henry L. Doulton, and to manufacture, sell and deal in Doulton ware, bricks, tiles, electrical and art pottery, &c. The first Directors are :—Henry L. Doulton, Ronald D. Doulton, Benjamin Hannen and William A. Turnbull.

ELECTRIC AUTO-MOBILE SYNDICATE (LIMITED).—This company was registered on Nov. 29, with a capital of £900, in £10 shares, to acquire, develop, work and deal with any patents, concessions, inventions, &c., and to manufacture, sell, let on hire and deal with electric vehicles, motors, machinery, &c.

HIRAM S. MAXIM ELECTRICAL CORPORATION (LIMITED).—This company was registered on Nov. 30, with a capital of £250,000, in £1 shares, to enter into an agreement with the Hiram S. Maxim Electric Lighting and Engineering (Pioneer) Syndicate (Limited), to acquire a certain invention of Mr. Hiram S. Maxim, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity and manufacturers of and dealers in electrical apparatus and plant. The first subscribers, with one share each, are :—M. E. Williams, J. de Meray, M. Devenish, G. Neville, G. Terrell, F. A. English and A. H. English.

INDIAN MICA CO. (LIMITED).—This company was registered on Dec. 2, with a capital of £30,000, in £1 shares, to acquire and develop certain leases and concessions over a tract of land containing mica or mica mines in the district of Hazaribagh, Bengal, or elsewhere. The first Directors are : Sir James Pender, Bart., M.P., C. A. S. Bedford, E. R. Calthorp, Col. H. L. Mitchell, Surgeon-Gen. Annesley, C. C. de Renzy and C. W. Wallace.

TELEPHONE CONSTRUCTION CO. (LIMITED).—This company was registered on Dec. 1, with a capital of £20,000, in £1 shares, to enter into an agreement with Mr. G. Hooper, to carry on the business of a telephone, telegraph and electric light, heat and power supply company, and to establish, work, manage and control telephone exchanges and electric light works. The first subscribers (each with one share) are :—Louis Schramm (electrical engineer), Wm. G. H. Monypenny, R. Curzon, G. Hooper, J. H. Steinhardt, J. A. Brymer and J. Phillips.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Oct. 13, 1898). Price of silver 27½d. per oz. (Dec. 8). Consols (2¾ per cent.) 110¼—110⅜ for money, 110 1/16—110 1/16 for account ; 2½ per cent. 104¼—104¾ (Dec. 8), Stock Exchange Settling Days : Stocks and Shares Continuation Days, Dec. 13 and 28 ; Ticket Days, Dec. 14 and 29 ; Pay Days, Dec. 15 and 30 ; Mining Share Carry-over Days, Dec. 12 and 27.

ALLGEMEINE ELEKTRICITATS GESELLSCHAFT.—The annual meeting of this company was held at Berlin on Saturday. It was stated that the value of the new orders in hand at the beginning of the new financial year amounted to about £5,700,000, and that a further extension of between £2,000,000 and £3,000,000 could be anticipated if the contract with the Berlin municipality was definitely accepted. The experiments made with the new Nernst lamp have, it is reported, been successful.

BRAZILIAN SUBMARINE TELEGRAPH CO (LIMITED).—The Directors of this company have declared an interim dividend of 3s. per share (or at the rate of 6 per cent. per annum) free of tax, for the quarter ended Sept. 30, payable on 23rd inst. The transfer books will be closed from 16th to 22nd inst. inclusive.

BROMPTON AND PICCADILLY CIRCUS RAILWAY COMPANY.—Mr. J. Staats Forbes has been elected chairman of this company.

CANADIAN, BRITISH COLUMBIAN AND DAWSON CITY TELEGRAPH CO. (LIMITED).—The prospectus of this company, which is formed to construct a telegraph line to Dawson City, will be issued in a day or two. As will be seen by an announcement elsewhere, the directorate includes, amongst others, Sir James Grant, K.C.M.G., of Ottawa ; Sir Adolphe Cavon, K.C.M.G., M.P., ex-Postmaster-General of Canada ; and the Hon. J. H. Turner, ex-Premier of British Columbia. Sir Thomas Tancred, Bart., is consulting engineer, and Mr. E. G. Woodford (late State Engineer of the Transvaal) will be resident engineer. We understand that only an issue of Debentures will be offered to the public for subscription.

COMMERCIAL CABLE CO.—A quarterly dividend of 1¾ per cent. and a bonus of 1 per cent. has been declared, payable on Jan. 3, out of the net earnings of this company. The transfer books will be closed from the 21st inst. to Jan. 3 inclusive.

DOULTON AND CO. (LIMITED).—Conformably to the particulars given in our last issue, subscriptions have been invited this week to an issue of 233,334 Five per Cent. Cumulative Preference shares of £1 each and £233,334 First Mortgage Four per Cent. Irredeemable Debenture Stock in Doulton and Co. (Limited), which has been formed to acquire the business and property of the well-known firm of Messrs. Doulton and Co. This issue is for the balance of a total capital of £1,100,000, the remainder being taken by the vendor, Mr. Henry Lewis Doulton, who becomes chairman and managing director of the new company. The business was established in 1815 by the father of the late Sir Henry Doulton. The recent death of Sir Henry and the consequent withdrawal of a portion of his capital has determined Mr. H. L. Doulton to transfer the business to a joint stock company. The management and policy of the business will remain as hitherto. The business is taken over by the new company from Jan. 1 next. The vendor guarantees that the stock-in-trade, book debts, cash balances and other floating assets on that day shall not be less than £400,000. A valuation of the company's properties, plant and fixed machinery, has been made to the value of £663,000. The average annual nett profits are certified at over £67,127, the profits of each year being in excess of the year preceding. As part payment of the price to be paid for the various properties, including working capital and goodwill, &c. (£1,100,000), the

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vendor takes £116,666 in fully paid Preference shares at par, £166,666 in fully-paid Debenture stock at par, £400,000 in fully-paid Ordinary shares at par, and £466,668 in cash. These is no waiver clause in the prospectus, except for purely trade contracts. The list closed on Wednesday.

EASTERN TELEGRAPH COMPANY (LIMITED).—This company announce the payment on Jan. 16 of dividends at the rate of 3½ per cent. per annum, less tax, on the Preference stock of the company for the quarter ending Dec. 31, and an interim dividend of 1¼ per cent. on the Ordinary stock, free of tax, in respect of profits for the quarter ended Sept. 30. The tranfer books will be closed from Jan. 9 to 16 inclusive.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH CO. (LIMITED).—The directors of this company have declared an interim dividend for the quarter ended Sept. 30 last, of 2s. 6d. per share, free of income tax, payable on Jan. 14 next. The share register will be closed from 6th to 13th prox. inclusive. The coupon on the company's Fifty per Cent. Australian Government Subsidy Debentures, due on Jan. 2nd next, will be paid on and after that date by Messrs. Barclay and Co., 54, Lombard-street, E.C. Coupons must be left three days for examination.

GREAT HORSELESS CARRIAGE CO. (LIMITED).—The Directors of this company have compromised the action brought against them by a combination of shareholders, by which the shareholders referred to receive, in three instalments, 16s. in the £. Similarly, the actions brought against Mr. Geo. Salter and the late Earl of Winchilsea were compromised before the death of the latter. Other shareholders in the Great Horseless Carriage Co. may now feel emboldened to come forward and press their claims for reimbursement of their subscriptions on the ground of misstatements in the prospectus.

RICHARD HORNSBY AND SONS (LIMITED).—At the ordinary general meeting the chairman (Mr. H. S. Gee) said the result of the year's operations were satisfactory. Their works had been fully employed. They had made a profit of £37,827 after writing off the usual depreciation and paying interest on debentures and mortgage loan and directors' remuneration. The Directors recommended the payment of dividends on Preference stock of 6 per cent. (including arrears) to Sept. 30, and 6s. per share on the Ordinary shares. £5,000 was placed to reserve and £2,137 carried forward. They had sold some £50,000 more of machinery than in the previous year.

IPSWICH TRAMWAYS CO. (LIMITED).—The Directors of this company have decided to sell their undertaking to the Drake and Gorham Electric Power and Traction Syndicate for £30,000. The lines are to be equipped on the overhead trolley system.

LONDON ELECTRIC SUPPLY CORPORATION.—The transfer books of the Four Per Cent. First Mortgage Debenture stock of this company are closed from 12th to 31st. inst., inclusive.

NATIONAL TELEPHONE CO. (LIMITED).—The Directors of this company have decided to make a further issue of £330,000 Three and a-Half Debenture stock, forming part of a total limited to £2,000,000 (of which £1,339,471 has been issued), and to offer it in the first instance to the shareholders and Debenture stockholders, at par. The stock is a first charge on the entire undertaking, and is irredeemable except in the event of the Government acquiring the concern, when it can be redeemed at 103 per cent. The net revenue for the year to June 30 last is stated at £369,007, and the amount required for the annual interest on the issued stock (including the present amount) is £58,431. It is anticipated that the net revenue for the year ending 31st inst. will show a considerable increase over the above figures. The list closes Friday, 16th inst., at 4 o'clock.

NEW ST. HELENS AND DISTRICT TRAMWAYS CO. (LIMITED).—The list closed on Wednesday, inviting subscriptions to 16,000 Five per Cent. Cumulative Preference and 10,000 Ordinary shares of £5 each in this company, which has been formed to acquire the tramways owned by the St. Helens and District Tramways Co. (Limited). The lines are about 10 miles in length, and are leased from the St. Helens Corporation. Included in the assets is a new lease for 21 years from Oct, 1 last of the old lines and for additional lines to be constructed by the corporation, the whole to be worked by electricity, for which power they are now being equipped.

PRIMITIVA GAS CO.—This Argentina concern, which has a capital of $4,000,000 in paper currency, and a debenture issue of £200,000, is about to be formed into an English company, with a capital of £800,000 in Six per Cent. Cumulative Preference shares, and there will be £400,000 Four per Cent. Debentures to replace the present Five per Cent. issue. The idea is, with the increased capital, to go more largely into electric lighting business, and to introduce the most modern appliances for heating and cooking by gas, as gas is replaced by electricity for lighting and power.

SMITHFIELD MARKETS ELECTRIC SUPPLY CO. (LIMITED).—The Four per Cent. Debenture Stock and Ordinary share transfer registers of this company are closed from Dec. 10 to 23 inclusive.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee has ordered the further issue of £414,526 Sterling Four per Cent. 500-Year Debenture stock of the Commercial Cable Co. to be quoted in the official list.

SULPHIDE CORPORATION (ASHCROFT'S PROCESS) (LIMITED).—At a meeting of the shareholders of this company on Monday, under the presidency of the Earl of Kintore, the directors explained their reasons for discarding the Ashcroft process of electrolytic treatment of ores. A good deal of dirty linen was washed, and there is likely to be some lively proceedings before the subject is closed. Meanwhile, circulars of a more or less vituperative character are circulating. It is proposed to eliminate the words "Ashcroft's Process" from the title and to reduce the capital of the Company.

WESTERN AND BRAZILIAN TELEGRAPH CO. (LIMITED).—This company's traffic receipts for the week ended Dec. 2 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Co., Limited) were £3,159.

WEST INDIA AND PANAMA TELEGRAPH CO. (LIMITED).—The estimated amount of the traffic receipts of this company for the half-month ended Nov. 30 is £2,839, against £2,061 in the corresponding period of 1897.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
*Birmingham Tramways.	Dec. 3	3,916	+ 420	...	...	...
Blackpool Corporation...	,, 1	124	+ 36	35	15,815	+ 2,307
Blackpool and Fleetwood Co.	,, 3	143	...	21	13,850	...
*Bristol Trams & Carriage	,, 2	2,478	+ 272	22	66,650	+ 7,911
City & South London Ry.	,, 4	1,119	+ 22	23	22,637	+ 756
Dover Corporation	,, 3	140	+ 63	35	6,576	...
Dublin United (Southern)	,, 2	515	+ 181	48	20,994	+ 6,752
Liverpool Overhead Rly.	,, 4	1,317	+ 31	23	35,672	+ 3,090
*Sheffield Tramways.....	,, 5	1,164	+ 255	48	48,929	+ 1,974
*South Staffs. Trams.....	,, 2	611	+ 48	48	30,350	- 76

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Nov. 30.		Price Wednesday, Dec. 7.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Week Ending Dec. 7. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.					£ s. d.			
6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	10½	10¾	11	11¼	—	—	—	—
6,000	10	6/8-16	Do. 4½ per Cent. Cumulative Pref.	10¾	11¼	10¾	11¼	3 18 3	—	..	—
£0,000	5	3/0	Charing Cross & Strand Electricity Supply Corp. ..	11½	12¼	11½	12¼	2 16 0	February & August	11¾	..
20,000	5	2/6	Do. 4½ per Cent. Preference	6	6¼	6	6¼	3 9 3	" "	..	..
£34,000	5	2/6	Chelsea Electricity Supply Ordinary	8	9	8	9	3 6 8	March	8⅝	—
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	114	116	114	116	3 18 11	June and December	—	..
£1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red)	103	105	103	105	4 15 8	—	..	..
50,000	10	5/0	City of London Elec. Lighting Ord. 40,001 to 90,000	24	25	24½	25½	4 18 1	February & August	25⅛	24⅞
10,000	10	1/9	Do. Ordinary 90,001 to 100,000	23½	24½	24	25	..	..	..	..
40,000	10	6%	Do. 6% Cumulative Pref.	15½	16½	15½	16½	3 11 9	January and July ..	16½	..
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	127	132	127	131	3 16 1	June and December	130½	..
30,000	10	..	County of London & Brush Prov. Ord. (fully paid)	12½	13½	12½	13½	—	—	13½	—
10,000	10	..	Do. (£8 paid)	10	11	10	11	..	—	..	—
20,000	10	6/0	Do. 6% Cumulative Preference	14½	15½	14½	15½	4 0 0	March & September	14⅝	..
15,660	5	2/6	House-to-House Electric Lighting Supply Ord.	9	10	9	10	2 0 0	—	9 1/16	9 1/16
12,000	5	3/6	Do. 7 per Cent. Preference	9½	10½	9½	10½	3 6 8	March & September	—	—
15,000	5	10%	Kensington and Knightsbridge Ord.	13	14	13	14	3 18 7	..	..	—
10,000	5	6%	Do. 6% 1st Pref.	7⅞	8¼	7⅞	8¼	3 12 9	January and July ..	..	—
110,000	3	..	London Electric Supply Ordinary	3⅝	4	3⅝	4	—	—	..	—
48,050	5	..	Do. Preference	6	6½	6	6½	—	—	—	—
62,400	10	5/0	Metropolitan Electric Supply Ordinary	16½	17½	17	18	3 6 8	April and October ..	18	17
£230,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	121	117	121	3 14 9	June and December	—	—
6,452	10	6/0	Notting Hill Electric Ordinary	15½	16½	16	17	3 10 7	March	—	—
275,000	1	—	Rand Electric	⅞	1⅛	⅞	1⅛	—	—	—	—
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ot'n, Ltd., 5% 1st Mor. Deb	88	93	88	93	5 8 1	—	—	—
150,000	$100	$2	Royal Electric Company of Montreal Shares ..	155	160	155	160	5 0 0	—	—	—
180,900	100	4½%	* Do. 4½% 1st Mort. Debs.	104	106	104	106	4 5 0	April and October ..	..	..
31,980	5	5/0	St. James and Pall Mall Electric Ordinary	16½	17½	17	18	4 8 11	February & August	17½	—
20,000	5	2/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	" "	—	—
£50,000	Stock	6%	* Do. 6 per Cent. Debenture Stock (red.)	105	108	105	108	3 15 6	June and December	..	—
65,000	5	..	South London Electric Supply Ordinary (£3 paid)	2⅞	3⅛	2⅞	3⅛	..	..	..	..
79,900	5	5/0	Westminster Electric Supply Ordinary	16	17	16	17	3 16 6	March & September	16⅝	16⅝
18,848	5	5%	Yorkshire House-to-House	7⅞	8	7⅞	8	3 2 6	February and July ..	—	—
18,626	5	5%	Do. (£4 paid)	5⅞	6⅛	5⅞	6⅛	3 18 5	February and July ..	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Nov. 30.		Price Wednesday, Dec. 7.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 7.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS								
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	101	105	101	105	3 17 0	January and July		
25,000	10	..	Amazon Telegraph	3	4	3	4				
£125,000	100	5%	Do. 5 per Cent. Debentures	92	95	92	95	5 5 3			
£205,56	Stock	15 0	Anglo-American	64	67	64	67	4 10 5	Feb., May, Aug., Nov.	64½	
£3,047,22	Stock	30/0	Do. Preferred	114½	115½	114½	115½	5 4 7	" "	116½	114½
£3,047,22	Stock	..	Do. Deferred	16	16½	16½	16¾			16½	16⅞
130,000	10	5/0	Brazilian Submarine	15½	15¾	15½	15¾	4 15 3	Mar., June, Oct., Dec	15¾	15⅝
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	111	115	111	115	4 8 0	June and December	111½	..
10,000,000	$100	$3½	Commercial Cable Capital Stock	180	190	180	190	4 4 3	Jan., Apr., July, Oct	..	..
£1,232,523	Stock	4%	* Do. 4 per Cent. Debenture Stock	104	106	104	106	3 15 6	" "	105½	104½
15,000	10	8/0	Cuba Submarine Ordinary (Deferred) xd	10	11	10	11	6 7 3	February and August	10⅜	10½
6,000	10	10/0	Do. Preference 10 per Cent. xd	16½	17½	16½	17½	5 14 3	" "	..	..
12,981	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October	..	
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	..	
£30,000	50	4½%	Do. 4½ per Cent. Debentures	105⅝	108⅝	105⅝	108⅝	4 5 0	January and July		
60,710	20	3/0	Direct United States Cable	11½	12	11½	12	5 8 4	Jan., Apr., July, Oct	11⅝	11⅜
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	103	106	103	106	4 6 8	" "	..	..
£4,000,00	Stock	..	Eastern Ordinary	172	177	172	177	3 19 2	Jan., Apr., July, Oct.	176½	174½
£1,295,00	Stock	17/6	Do. 3½ per Cent. Pref. Stock	104	107	104	107	3 5 5	" "	106	105
£1,432,26	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	124	128	124	128	3 2 6	May and November	126	124
£89,90	100	5%	* Do. 5 per Cent. Debentures, 1890	101	104	101	104	4 17 0	February & August	..	..
£500,000	Stock	8/9	Do. Provisional Certificates 50% paid	53	56	54	57	..	..	..	..
250,000	10	2/6	Eastern Extension	17½	17⅝	17½	17⅝	3 18 11	Jan., Apr., July, Oct.	17⅝	17½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	129	125	129	3 2 4	February & August	..	..
£16,200	100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900 (reg.)	101	105	101	105	4 17 1	January and July	..	..
£64,400	100	5%	Do. (Bearer)	102	105	102	105	4 17 1	" "	..	..
£35,100	100	5%	*Eastern and S. African 5 p. c. Mor. Deb., 1900 (reg.)	101	105	101	105	4 17 1	" "	..	..
£46,500	100	5%	Do, (Bearer)	102	105	102	105	4 17 1	" "	..	..
£800,000	100	4%	* Do. 4% Mortgage Debentures, 1909	103	106	103	106	3 16 4	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	103⅞	103⅞	103⅞	106	3 15 9	May and November	..	..
180,227	10	1 9	Globe Telegraph and Trust	12½	12⅝	12½	12⅝	4 0 9	Jan., Apr., July, Oct	12½	12⅝
180,042	10	6%	Do. 6 per Cent. Preference	16½	17	16½	17	3 10 7	" "	17⅛	16¼
150,000	10	5/0	Great Northern of Copenhagen	28½	29½	28½	29½	3 7 10	January, April, July	..	..
£150,000	100	5%	* Do 5 per Cent. Debs., 1883 issue Series "B"	100	103	100	103	4 17 10	March & September	..	..
£97,800	100	4½%	Halifax and Bermuda Cable 4½% 1st Mort. Deb. (red)	101	104	101	104	4 7 0	June and December	..	..
17,000	25	12/6	Indo-European	£4	55	54	57	4 7 9	May and November	56½	..
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904	109	112	109	112	5 7 7	March & September	..	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red)	105	108	105	108	3 14 3	June and December	..	..
11,939	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October	7	
3,381	£100 Cert.	6%	Submarine Cables Trust	133	138	134	139	4 6 9	" "	136	135
15,609	10	..	West African Telegraph	..	..	..	..	..		..	..
£300,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	4 18 0	March & September	100	
80,008	2½	..	West Coast of America	⅛	¼	⅛	¼				
£150,000	100	4%	* Do. 4 per Cent. Debentures	103	106	103	106	3 16 6	June and December	..	..
88,321	10	0/6	West India and Panama	1⅛	1⅜	1⅛	1⅜		May and November	1 7/16	..
34,563	10	6/0	Do. 6 per Cent. 1st Preference	9½	10	9½	10	6 0 0	" "	9⅜	9⅛
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7	9	7	9	6 13 4	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures	106	109	106	109	4 12 10	January and July	..	..
64,269	15	5/0	Western and Brazilian Ordinary xd	12¼	12¾	12¼	12¾	4 13 2	May and November	..	..
33,129	7½	3 9	Do. 5 per Cent. Preferred Ordinary xd	8	8¼	8	8¼	4 8 2	" "	..	..
33,129	7½	1/3	Do. Deferred Ordinary xd	4	4¼	4	4¼		" "	..	..
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	107	110	107	110	3 13 1	June and December	..	..
1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902					6 7 10	Feb., May, Aug., Nov.		
£158,100	100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	98	103	98	103	5 16 6	March & September		
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	2¾	3¼	2¾	3¼	6 8 1	August		
224,850	10/0	1¼d.	Consolidated Telephone Const. & Manufacturing	1/16	3/16	1/16	3/16	6 7 0	July		
28,000	5	4/0	Monte Video Telephone 6 per Cent. Preference					7 5 6	October		
£34,597	5	3/0	National	5½	5¾	5½	5¾	5 4 4	February & August	5⅞	5⅝
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	12	14	12	14	4 5 9	" "	13⅜	13½
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	12	14	12	14	4 5 9	" "		
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	5½	5¾	5½	5¾	4 10 11	" "	5⅜	..
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	100	103	100	103	3 6 8	June and December	101½	..
171,504	1	0/4	Oriental	⅜	½	⅜	½	6 13 4	April and October		
58,000	5	6/0	United River Plate	4½	4¾	4½	4¾	6 6 8	July	4⅜	4⅛
£151,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	106	104	107	4 15 5	June and December		
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	2	1/2⅜	Brush Electrical Engineering	1¾	2	1¾	2	3 0 0		1⅜	1⅛
90,000	2	1/2⅜	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1		2 5/16	2⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	111	115	111	115	3 19 0	February & August		
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	104	105	102	105	4 7 0	June and December		
£20,000	5	5/0	Callender's Cable Construction	9½	10½	9½	10½	6 8 7	" "	10½	10⅛
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	111	114	111	114	4 0 4	November and May	..	..
300,000	1	9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5			
50,000	1	-	Chadburn's Ship Telegraph Ordinary	1⅛	1⅜	1⅛	1⅜				
50,000	1	7½	Do. 6 per Cent. Cumulative Pref.	1	1½	1	1½	4 16 0			
32,098	3	..	Crompton and Co. (Nos. 1 to 32,098)	1½	2	1½	2	..			
£82,850	100	5%	* Do. 5% First Mort. Deb. (red.)	91	96	91	96	5 5 10	January and July		
99,261	5	2/1½	Edison and Swan United ("A" Shares) (£3 paid)	2	2½	2	2⅛	7 4 0	February & August		
17,189	5	3/1½	Do. (£5 paid)	4	5	4	5	6 0 0	" "		
£194,023	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	99	101	99	101	4 0 5	June and December		
17,400	5	5%	Edmundson's Electric Corporation Ord (fully paid)	5	5⅛	5	5⅛	4 10 11	Half-yearly	1/8	
110,000	2	1/2⅜	Electric Construction Co. (Limited)	2⅛	2⅜	2⅛	2⅜	4 12 0	February & August	2⅛	
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Pref.	2⅜	3⅛	2⅜	3⅛	4 6 2	August	3	
£111,100	Stock	4%	Do. 4% First Mortgage Deb. (red.)	105	107	105	107	3 16 2			
91,196	1	..	Elmore's Patent Copper Depositing	⅛	⅜	⅛	⅜	..			
12,500	10	8/0	Henley's Telegraph Works Ordinary	20	21	20⅜	21⅛	6 0 11	February & August	21⅛	20⅜
3,000	10	7/0	Do. 7 per Cent. Preference	18	19	18	19	3 13 8	" "	18⅛	
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 8	" "		
40,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	4 8 11	" "		
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	102	106	102	106	3 15 6	March & September		
37,350	12	12/0	Telegraph Construction and Maintenance	37	41	37	41	4 6 2	March and July	40	38
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	104	107	104	107	4 14 9	January and July	105	
£30,000	5	4/0	Willans and Robinson Ordinary	7⅜	8½	7⅜	8½	4 17 0	April and October		
£30,000	5	3/0	Do. 6% Cumulative Preference	6⅞	7½	6⅞	7½	4 2 9	" "	7⅜	6⅞
£100,000	Stock	4½%	Do. 4½% First Mort. Debs xd	106	108	106	109	3 18 8	May and November		
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	..	Blackpool and Fleetwood Tramways	17	18	19	20	..		18½	18
25,000	10	6%	Bristol Tramways and Carriage	21½	22	21½	22	2 14 7			
25,000	10	6%	Do. (£7. 10s. paid)	18⅜	18⅝	18⅜	18⅝	1 14 1			
£90,410	Stock	4%	Do. 4% Debenture	121	123	121	123	3 5 1			
80,000	10	..	British Electric Traction Ordinary	16	17	16	17	..		18⅜	16½
10,000	10	2/4 1/16	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm.pd.)	12½	13½	12½	13½	4 8 11		13⅛	
£35,250	10	3/0	Central London Ordinary	9⅜	10½	9⅜	10½	2 18 6	June and December	10	
178,303	10	1/9⅜	Do. (£6 paid)	5½	6½	5½	6½	2 16 6	" "	..	..
£680,000	Stock	2½%	City and South London Railway Con. Ordy.	65	68	65	68	2 19 4	January and July	66	65
22,500	10	..	Do. Ordinary (£4 paid)	3½	4	3½	4	..			
9,251	10	5%	Do. 5% Perpetual Preference	14¼	15½	14⅜	15½	3 4 6	January and July		
£137,701	Stock	4%	Do. 4% Perpetual Debenture	134	135	134	136	2 18 10	May and November		
20,000	10	6%	Imperial Tramways Ordinary (old £6 shares)	16⅛	16⅝	16½	16⅝	3 12 9	March & September	16½	16⅜
10,000	10	6%	Do. 6% Preference	15	15½	15	15½	3 18 8	" "		
£70,000	Stock	4%	Do. 4½% Debenture			116	118	3 16 3			
87,500	10	3%	Liverpool Overhead Railway Ordinary	9 5/16	10 1/16	10 1/16	10 3/16	3 3 9	February & August		
10,000	10	5%	Do. 5% Preference	15⅝	15⅞	15	15½	3 4 6	" "		
125,000	Stock	4%	Do. 4% Debenture	108	110	108	110	3 13 1	January and July		
20,000	5	3,3⅛	New General Traction 6% Cumulative Pref	4⅜	5½	4⅜	5½				
£540,000	Stock	3%	Waterloo and City Ordinary	109	114	113	116	2 12 10	June and December	116	113½

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

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CONTENTS OF THE CURRENT NUMBER.

Notes 251
Meetings of Scientific Societies. 254
The Water-Power Installation at Paderno. By G. Semenza. Illustrated 255
Superheated Steam and its Application on Steam Engines. By Paul Schou. Illustrated 258
Delay in the Delivery of Plant 261
Electricity Works Accounts ... 262
Concentric Wiring 264
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe 265
The Commercial and Business Aspects of Municipal Electrical Supply. By A. H. Gibbings, M.I.E.E. Continued 267
Improvements in Magnetic Space Telegraphy. By Dr. O. Lodge, F.R.S. 269
Telegraphy by means of Ultra-Violet Light. By Prof. K. Zickler 271
Correspondence 272
Legal Intelligence 272
Trade Notes and Notices 274
Companies' Meetings & Reports 280
City Notes 283
Companies' Share List... 284

NOTES.

There was a record attendance at the meeting of the Institution of Electrical Engineers on Thursday last week, to hear Dr. Lodge's Paper on "Wireless Telegraphy," the large hall at 25, George-street, being so crowded that there were not seats for all, although as many as chairs could be found for were accommodated at the Council table, irrespective of rank. As we are unable to publish more than the preliminary portion of the Paper this week, we will not anticipate the second portion by describing the experiments with which Dr. Lodge delighted his audience. It will be sufficient for the present to say that, in spite of the alternating current at his disposal in the lecture-room being unsuitable for the purpose, the lecturer's practical demonstration of the principle of his magnifying telephones was as successful as his theoretical one. We look forward to a most interesting discussion next Thursday. In addition to Mr. Evershed's Paper, and some promised experiments by Mr. Preece and Prof. Fleming, we shall expect Mr. Whitehead (who was present at the reading of the Paper) to make a spirited defence of his own mathematical treatment of the screening effect of sea water. Those interested in this part of the subject will find the official abstract of Mr. Whitehead's Physical Society Paper, and of the discussion thereon, in *The Electrician*, Vol. XXXIX., p. 288.

Dr. Lodge referred to three chief methods of electric space telegraphy. He was probably aware of some experiments, recently made with ultra-violet light by Dr. Zickler in Brünn, but perhaps did not think them of sufficient importance to mention. On the same day as Prof. Lodge's demonstration before the Institution of Electrical Engineers an account of some further experiments by Prof. Zickler appeared in the *Elektrotechnische Zeitschrift*. We give an abstract of the article in another column, and it will be seen that he has now succeeded in overcoming distances of nearly a mile with comparatively simple apparatus. As we remarked on the publication of Prof. Zickler's first series of tests, the method may prove of practical value for signalling from lighthouses and lightships already equipped with electrical projectors.

The remarks in our last issue as to the harm caused by the non-delivery of plant in certain central stations have given rise to considerable comment and discussion, and in order that both sides of the question may be heard we have no hesitation in publishing in another column a communication written from the contractor's standpoint. Manufacturers have undoubtedly many difficulties to contend with in being obliged to depart from standard designs to the extent often required of them, and in being under the obligation to complete such special plant in an extremely short time. Of course, we should refuse to entertain any insinuation to the effect that such obligations are accepted without a reasonable conviction that they will be fulfilled. When, however, contractors are prevented by outside circumstances (as, for instance, strikes) from delivering the plant within the time specified, they should refrain from fixing any new time-limit unless they are absolutely certain of being able to keep within it. It is true that the uncertainty as to whether other tenders out for consideration will be accepted or not renders difficult an estimate of the time required for the completion of any particular contract, but it must be remembered that if such estimates are made on the basis of the usual number of hours worked *per diem*, unforeseen contingencies can usually be met by overtime and night-shifts.

When many causes contribute to an unwelcome result, there is generally great difficulty in apportioning the blame and in differentiating between the primary and secondary causes. In the particular case in point, the resident engineer places the blame on the contractor, and the contractor retaliates by censuring the consulting engineer, the resident engineer, or a sub-contractor. We have already insisted on the extreme importance of caution on the part of managers of central stations in adding new connections to their mains before they

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are absolutely certain that they can be efficiently supplied during the period of heaviest load. So far as fogs and the shortness of days in winter are concerned, no alteration can be made to existing conditions, and in consequence it behoves the contractor and the resident engineer to work together to remedy the present condition of affairs and prevent its recurrence. The harm done to electric lighting by the recent inefficient supply is by no means imaginary, and it must not be allowed to extend further.

In reference to this subject, Mr. F. A. Newington, the resident engineer at Edinburgh, informs us that the deficiency had already been made good before the appearance of the Notes in our last issue. The serious difficulties under which the station was working have been overcome after much exertion, and since November 25th current has been supplied at the normal voltage, although the load is considerably increased.

If, however, the electric light in Edinburgh has resumed its normal brilliancy, those of our readers working in the English metropolis know to their cost that the voltage in this city has recently not been up to the mark. The reason given for this is again dilatoriness on the part of the contractors. Five new boilers have recently been erected, two of which have been in use for some time, and a third was to be put in operation on Wednesday evening. There has been considerable delay in the delivery of the steam pipes for these, and although they have been on order since last August, two boilers are ready bricked up, and still waiting to be connected. A sufficient number of alternators is running, but the difficulty is to get an adequate supply of steam at full load.

We report in another part of this issue the proceedings of the Court of Common Council on the presentation of a petition from the Charing Cross and Strand Electricity Supply Corporation, signed by 5,000 ratepayers, praying the City authorities to give their consent to that Corporation being granted a Provisional Order by the Board of Trade. The Charing Cross and Strand Corporation are to be admired for their persistency; but, so far as the Corporation is concerned, only one answer can be given to them and to the other companies who have begged for consent. Although not brought out in the Savory libel suit, the conclusion of which is given in another column, it is a fact that, by their agreement with the predecessors of the City of London Electric Lighting Co., the City authorities are precluded from concurring in any other company's application for a Provisional Order until the year 1911, when the contract for private lighting expires. After that time, the Corporation may itself enter into competition or give its consent to the application of other companies, the City of London Company retaining its Provisional Order for the usual term of 42 years. The report of an important meeting of the Commissioners of Sewers, at which one of the contracts with the Brush Company was considered, and the recommendations of the Streets Committee agreed to, will be found in Vol. XXIV. of *The Electrician*, p. 528, but unfortunately all the meetings could not be reported at the time owing to the Commissioners' occasional habit of discussing the electric lighting question with closed doors. The argument advanced during debate, that, in view of the evidence in the recent suit, the agreement is null and void, does not do credit originator.

In a Paper on "Meters and Systems of Charging for Electrical Energy," recently read before the Institution of Engineers and Shipbuilders in Scotland, by Mr. William Arnot, the author expresses the opinion that "a consumer could refuse to pay a disputed account that was not rendered from a meter duly certified by an electrical inspector." Although Mr. Arnot prefaces this opinion by a statement that he does not profess to be a lawyer; yet, coming from one who has had special opportunities in connection with the important office he has held of accurately informing himself on this subject, it naturally calls for some attention.

For a good many years after the issue of the first Provisional Orders, with the single exception of the Shallenberger meter for alternating currents, certified in October, 1891, for limited use by two companies in London, there was no certified meter in existence. It was not until October, 1896, when the Ferranti and Hookham meters were approved by the Board of Trade, that any meters were generally available to meet the requirements relating to certified meters stated in Provisional Orders. No alteration was made in the form of Provisional Orders consequent upon the approval of these meters, and, unless Mr. Arnot contends that the mere act of approval altered the law, he must be prepared to maintain that down to 1896 no consumer need have paid anything for the current supplied to him. He has evidently overlooked the fact that the clause he quotes requiring the supply to be ascertained by a certified meter contains the qualifying words, "except as otherwise agreed between the consumer and the undertakers." He also appears to ignore another fact, namely, that the choice of a meter is a consumer's matter. The consumer may either fix his own meter, or call upon the undertaker to supply one at his expense. If he takes neither of these courses, but accepts an uncertified meter, the inference must be that he has agreed to pay for the supply upon this basis.

What seemed at first sight to be anomalous when these Provisional Orders came out was that apparently the consumer might at any time have called upon the supply company to provide him with a certified meter. The position at the present time seems to be just the same, except that if the consumer thinks it worth while to demand a certified meter the Undertaker must supply it, which is rendered more easy by the addition in July last of the Aron meter to the certified list; but so long as he is content to go on with whatever meter has been supplied to him, the consumer must be assumed to have agreed to accept its records, subject, of course, to verification in case of dispute.

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Personal.—The Shah of Persia has conferred the Second Class of the Order of the Lion and the Sun upon Mr. T. W. Stratford-Andrews, a Director of the Indo-European Telegraph Co.

Cable Interruptions and Repairs.—

	Date of Interruption	Date of Repair.
St. Louis and Noronha	Oct. 17, 1898 ...	Dec. 12, 1898.
Para—Maranham	Nov. 15, 1898 ...	—

International Telephony.—Frankfort, Brussels, Antwerp Liège and Verviers are now connected telephonically, and another international line has been opened between Frankfort and Basle.

Personal.—The Marquis of Tweeddale attended at Windsor Castle last week, when Her Majesty conferred on him the honour of Knighthood and invested him with the Insignia of the Order of the Thistle.

Long-Distance Telephony.—A long-distance telephone line, said to be the longest in the world, has just been established between Bar Harbour, Me., and Austin, Tex. It is 2,600 miles long and will soon be open to the public. It will connect New York, Washington and all the larger eastern cities of the United States.

Central Technical College.—The following is the list of scholarships awarded in connection with the session 1898-99 of the college:—Clothworkers' scholarship, £60 a year, to A. J. Cook; Mitchell scholarship, £50 a year, to R. H. Collins; John Samuel scholarship, £30 and free education, to F. C. Hounsfield; Institute's three studentships, to R. H. Buckie, A. W. Harrold and W. H. P. Brounger.

The Northampton Institute.—The members and students of this Institute held their first annual conversazione on Friday evening last, when the prizes and certificates were distributed by the chairman of the Governing Body. An extensive programme had been arranged, and among the lectures given was one by Dr. Mullineux Walmsley on "Wireless Telegraphy," and another by Mr. C. V. Drysdale on "Colour Photography." There were also the usual demonstrations in the various laboratories and workshops.

An Automatic Telephone Exchange for Glasgow.—We hear that a contract is being entered into for the erection of an automatic telephone exchange for 25 instruments in the municipal buildings at Glasgow. This is being done as an experiment, and we hope that a full account of the cost of erection and maintenance will, in due course, be published, so that a comparison can be established with the cost of a manual exchange. The results of the test, whatever they may be, will not be applicable to the problem of a 5,000-subscriber exchange.

The Royal Society.—Among the Papers down for reading yesterday were the following:—(1) "Application of Liquid Hydrogen to the Production of High Vacua and their Spectroscopic Examination." (2) "The Boiling Point of Liquid Hydrogen under Reduced Pressure," by Prof. Dewar, F.R.S.; "Ionic Velocities," by Prof. O. Masson; "Note on the Densities of Atmospheric Nitrogen, Pure Nitrogen and Argon," by Prof. Ramsey, F.R.S.; "The Preparation and Some of the Properties of Pure Argon," by Prof. Ramsey, F.R.S., and Dr. Travers; "The Action of Magnetised Electrodes upon Electrical Discharge Phenomena in Rarefied Gases" (preliminary note), by C. E. S. Phillips.

The "Financial News" on Telephony.—The *Financial News* of Dec. 12 contains a well-written description of the "Avenue" exchange of the National Telephone Co. Our contemporary had, in a previous issue, reviewed the company's service in a critical spirit and offered suggestions for its improvement. The National Telephone Co.'s good-humoured reply was an invitation to visit an exchange and view the system in operation, with the result that a readable account of the visit has appeared in the columns of the *Financial News*. On the other hand, although our financial contemporary has now no doubt explained to the officials in person its proposals for bettering the service, no marked improvement has since been noticeable.

Patent Amendments.—Application has been made to amend patents Nos. 8,607 of 1894 and 23,239 of 1897. Both patents relate to forms of automatic telephone exchanges, the former having been communicated from Chicago by A. E. Keith and the latter by the Strowger Automatic Telephone Exchange. Particulars of the amendments desired will be found in the *Patent Office Journal* of December 7th, and notices of opposition must be lodged by January 7, 1899. The reason given for the desired amendment is that the patentee is advised that some of the claims as originally drafted are capable of being interpreted too widely, and that he desires to restrict them to the invention described.

Society of Engineers.—The forty-fifth annual general meeting of this society was held on December 12th, at 17, Victoria-street, Westminster, S.W., for the election of the Council and the transaction of other business. The chair was occupied by Mr. Worby Beaumont, president. Mr. John Corry Fell was elected as president and Mr. George Burt as hon. sec. and treasurer for 1899. It was announced that owing to pressure of private business Mr. Pryce Cuxson had been compelled to resign the secretaryship of the society. Mr. Perry F. Nursey was appointed to fill the vacancy, and will take office on January 1st next. The following were elected honorary members of the society:—Sir J. Wolfe Barry, Prof. A. B. W. Kennedy, Mr. W. H. Preece, and Mr. Alexander Siemens.

Wiring Rules and Officialism in Germany.—As we mentioned in our issue of November 4th, the safety regulations issued by the Verband Deutscher Elektrotechniker have been officially recognised by the German Government. The result of this recognition was that they were circulated to the heads of the police departments of the various government districts to serve as a technical guide to them. These officials seem to be of opinion that the regulations are to be retrospective, and have already in one case forced the owner of an installation to execute extensive alterations in it, although it had been running without a mishap for six years, and although experts, whose opinions were taken, declared it to be free from any danger of fire. The matter has been brought to the attention of the Verband. As is rightly pointed out by the *Elektrotechnische Zeitschrift*, if the regulations are to be retrospective, thousands of installations, which were in existence before the appearance of these rules, will have to be entirely remodelled.

A New Belt-Driven Arc-Lighting Plant.—The plant recently installed by the municipal authority of Chicago for the arc-lighting of the northern and north-western districts of that city is a fine example of the survival of belt-driven plant in the United States. In this case, however, the particular method of driving used has several points in its favour. The nightly load on the station is now 866 arcs of 2,000 nominal candle-power, burning from dusk until daylight. The following particulars are from the *Western Electrician*:—The building is of brick, and there is a brick partition wall between the two rooms. The floors are of concrete. The stack is also of brick, 100ft. high and octagonal in shape. There are four tubular boilers of 100 H.P. each, equipped with Roney automatic stokers, one 500 H P. water-tube boiler and two 1,000 H.P. siphon condensers. Soft coal costing $2.02 a ton is burned, and the feed water is taken from the city mains. In the engine room there are two vertical compound condensing engines, rated at 600 H.P. each, which drive directly on a countershaft extending the length of the room, and the dynamos are belted to this shaft on each side. The shaft is provided with three friction clutches—one at each engine and one in the middle. Thus either engine may drive its adjacent half of the shaft or the whole line. Five of the dynamos are 150-lighters, made by the Western Electric Co., and the other three are Brush machines of 100 lights capacity each. The dynamo leads to the switchboard are laid in iron pipe under the floor, and all the outgoing connections from the board are underground. The switchboard is of white marble, with Western Electric instruments and plug switches. It is arranged for 10 dynamos and 10 circuits, to provide for extension. The new machinery in the plant cost about $37,000, and Mr. E. B. Ellicott, the city electrician, who laid it out, says that the cost of labour for running the station and trimming the lamps is $1,083 a month. The lamps are placed on the regulation side-arm poles adopted by the city, and have single carbons 14in. long and §in. in diameter. A force of 10 trimmers is employed.

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Interruption to Supply at Cardiff.—At about 5:45 p.m., on Tuesday, the 6th inst., the supply at Cardiff was interrupted, and although the failure only lasted for about five minutes, it affected the whole of the system. There were running on the mains at the time a 300 kilowatt Ferranti flywheel alternator and two 40 kilowatt Paxman-Siemens sets. Some water lying in the receiver of the Ferranti plant was carried into the low-pressure cylinder, where, the clearance being only about 3 per cent., it produced a loud report, and the men in charge thinking something had been carried away, shut off steam and ran up the two spare 180 kilowatt sets immediately. There was nothing the matter with the Ferranti plant except that the trap on the receiver did not appear to have been working freely at the time.

Recently Expired Patents.—During the month of November three patents of considerable interest to electrical engineers have expired. The first is No. 14,723, taken out by the Hon. C. A. Parsons on November 7, 1884. It describes a special arrangement of the armature of an electric generator, a form of commutator, and also a method of electrical governing. The second is No. 14,954, of 1884, in which Mr. James Radcliffe describes a simple clip attachment to the handle of a "single needle block" railway signalling instrument, by means of which the handle is locked in the vertical as well as in the diagonal positions, and the unlocking of the handle is facilitated. Finally, No. 15,648, of 1884, granted to William Mather, John Hopkinson and Edward Hopkinson for "Improvements in dynamo-electric machines," illustrates types of single and double magnetic circuit bi-polar machines, and claims a simple method of letting the wrought-iron poles of the field magnets into the cast-iron pole-pieces, and the use of polar extensions of small area.

Electrical Advances in Japan.—The second electric railway undertaking in Japan is the Hoshu electric railway, which will run from Beppu to Oita, in Kyushu. Work was suspended for a while owing to financial difficulties, but these have now been overcome and the construction is steadily advancing. The contract for all materials was let to the Saiga Electric Co. of Kyoto, which Company in turn ordered the following pieces of main apparatus:—Two Lancashire-type boilers of 160 H.P. each (made in Japan); one 160 H.P. McIntosh and Seymour high-speed engine; one six-pole 110 kilowatt General Electric railway generator; 10 No. 21 Brill trucks and 20 25 H.P. railway motors. The engineers in charge of the work are Mr. H. Maki and T. Saiga, president of the Saiga Electric Co. A striking example of modern industrial processes surrounded by the quaint beauties of old Japan is the case of the tobacco factory of the Murai Brothers Co., in Kyoto. In this factory the electric distribution of power is used, the amount being 200 H.P., and upon its tower has recently been placed a large searchlight. The *Electrial World's* Japanese correspondent adds the information that the present name for the searchlight in Japanese is "tan-kai-to," which means the lamp which shines over the sea in the night, this form of apparatus having been first used in the navy, but hereafter, on account of its adoption on land, the name will probably be changed.

A New Source of Carbon for Carbide Furnaces.—The Ottawa correspondent of the New York *Electrical World* states that Prof. V. L. Emerson's invention for the conversion of sawdust and saw-mill refuse into commercial products was recently tested before a large gathering of the prominent lumbermen and citizens of Ottawa, among whom were several members of the Dominion Government. The machine gets its fuel from the gas obtained from the sawdust, so that the process is a continuous one. It runs automatically. First, the sawdust goes through a drying process by having all the excess of heat contained in the burnt gases forced through the sawdust in a drying kiln. Then this sawdust is carried by an elevator to the top of the retort, and by means of an automatic feed is supplied to the machine as required. The retort is an upright iron cylinder, between 15ft. and 20ft. high and about 3ft. in diameter, surrounded by brickwork. Within the retort is a series of hoods on a central hollow revolving shaft, which has perforations under the hoods. The various gaseous products escape through the lower end of the retort, where the liquid products are condensed and separated, emerging through two outlets. At one outlet passes off a wood creosote product, which can be utilised for a variety of purposes, and from the other crude pyroligneous acid, from which can be prepared wood alcohol, acetic acid and various other products. The gases pass through a purifying process, and after being highly heated are forced through the sawdust as it passes down the retort. The excess of gases passes into the furnace, supplying heat, which is practically sufficient to carbonise the sawdust in the retort. The carbon prepared from the sawdust passes out through an opening for the purpose at the lower end of the retort. The remaining product is a pure form of carbon, which, it is claimed, makes especially pure acetylene gas if used in carbide furnaces.

Röntgen Society.—The meeting of the Röntgen Society, held on Tuesday, Dec. 6th, at the Medical Society's rooms in Cavendish-square, was wholly devoted to discussing the important question of "Dermatites in Relation to X-ray Work." Two short Papers were contributed on this subject by Dr. Walsh and Mr. Payne, and the discussion centred itself mostly around certain points raised by the writers. It will be remembered, that, some time ago, the Röntgen Society issued a number of circulars to its members and others interested, with a view to obtaining in a tabulated form any accounts of authentic cases of dermatites which had been produced by the "rays," and at the meeting, the results, so far obtained by this means were laid before the members. The general conclusions arrived at were:—(*a*) that highly exhausted focus tubes are less liable to produce X-ray burning than are "soft" tubes; (*b*) that the ill-effects of the rays are prevented by a layer of clothing; (*c*) that the actual cause of the burning (so-called) is still uncertain and may be due to either the heat emitted by the tube when in action, the cathode rays, the X rays, or by the brush discharges taking place at the terminals of the focus tube. Dr. Holland, of Liverpool, reported some very interesting experiments in which certain troublesome ulcerous conditions had been apparently completely cured by the application of the X rays to the affected area. There is evidently a great deal yet to be done in connection with this question and the efforts on the part of the Röntgen Society will, it is hoped, in the end throw some further light upon the problem. What seems to be most needed is a really properly carried out experimental investigation into the whole subject—a work which might well be undertaken by a committee composed of medical and physical experts, and nominated very appropriately by the Röntgen Society itself.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, December 16th.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7:40 p.m. General Meeting in the Lecture Hall of the Sunderland Literary Society, Fawcett-street, Sunderland.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read: "The Kentish Town Widening, Midland Railway," by Walter Daniel.

SATURDAY, December 17th.

INSTITUTION OF JUNIOR ENGINEERS.

11 a.m. Visit to Messrs. Yarrow's Works, Poplar.

TUESDAY, December 20th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed: "The Ventilation of Tunnels and Buildings," by Francis Fox. Paper to be read, time permitting: "High Speed Engines," by J. H. Dales.

9:15 p.m. Special General Meeting of Corporate Members to consider and, if approved, enact a Supplementary By-law.

WEDNESDAY, December 21st.

ROYAL METEOROLOGICAL SOCIETY.

7:30 p.m. Ordinary Meeting at the Institution of Civil Engineers, Great George-street, Westminster, S.W.

ROYAL MICROSCOPICAL SOCIETY.

7:30 p.m. Meeting at 20, Hanover-square, W.

THURSDAY, December 22nd.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting, when Mr. S. Evershed will read a Paper on "Telegraphy by Magnetic Induction." The discussion on Dr. Lodge's Paper ("Improvements in Magnetic Space Telegraphy") and on Mr. Evershed's Paper will be opened by Dr. Fleming and Mr. Preece, with experimental demonstrations.

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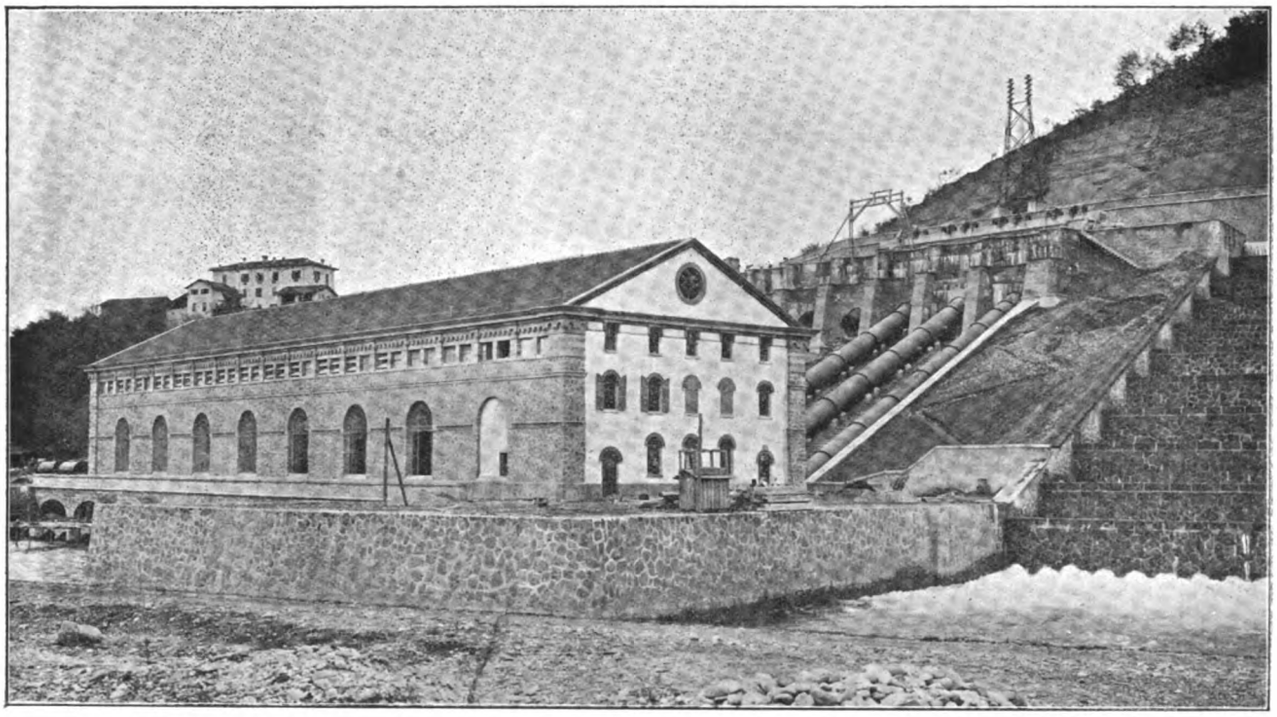
THE WATER-POWER INSTALLATION AT PADERNO.*

BY G. SEMENZA.

(TRANSLATED BY JOHN R. DICK, B.SC.)

The Paderno-Milan power transmission scheme was not the first of its kind, but it was a noteworthy event in the electrical world when the designs for it were got out, and the works actually commenced. There have been installations previously of greater power, but where the energy was transmitted over shorter distances, and there have been instances of the transmission of a few hundreds of horse-power, over considerably longer distances; but there has not been in existence up till now an installation in which 13,000 H.P. is transmitted to a distance of 20 miles. There has not existed, and perhaps there does not exist to-day, another installation so complex and so varied in its applications. Polyphase systems had not then received the sanction of practical experience, and extra high pressure were only in the experimental stage. Much uncertainty thus prevailed upon every point of the problem.



Paderno Generating Station.

For these reasons, the design of the plant at Paderno was a work of the greatest interest, and I hope to day to be able to give you a clear and complete idea of all the reasons which determined the choice of each of its components. Each point was thought out and chosen with that spirit of caution and striving after perfection, which we of the Old World—as opposed to American engineers—are accustomed to carry into new and daring enterprises. And here, I must mention, with gratitude and respect, the late Prof. Galileo Ferraris, who devoted so much care and thought to this enterprise. He was our adviser on the most difficult points, and in the day of success his name should not be forgotten.

As regards the hydraulic portion of the installation the technical journals have already published full partrculars. Still, I think it will be useful to give a short *rèsumé* of the general arrangement of the works, which are of such importance in determining the success of the undertaking.

Several hundred yards down stream from the famous bridge of Paderno, there has existed for about two centuries the canal-regulator of the Naviglio of Paderno, the object of which was to create a navigable channel parallel to the rapids of the river Adda. This regulator was formed of a weir and a pair of large gates which regulated the admission of water to the canal. Advantage was taken of this existing work to facilitate the new; but in order to convey 10,000 gallons of water, neither the height of the weir nor the section of the canal was sufficient. Accordingly the weir had its upper part rebuilt from that point, and the channel was enlarged from 30ft. to 43ft., so as to be able to convey 10,000 gallons with a velocity of 4·5ft. per second. The length of this enlargement is 750 yards, that is to say, for the first section of the Naviglio and up to the point called Conchetta. At this point is the regulator of the new canal, a building which permits the passage of the water by means of seven openings furnished with sluice-gates operated by hand.

A few yards below this, the canal, leaving on the left the Naviglio which runs along the picturesque valley of the Adda, enters a tunnel of 115 yards long, from which it emerges into a deep trench 26ft. wide and 273 yards long. Then follows a second tunnel of 302 yards, a second trench of 385 yards, and finally the last and longest of the tunnels, which measures 1,100 yards. This makes altogether a length of 2,448 yards. The volume of water has a cross-section of 180 sq. ft., and for the delivery of 10,000 gallons the velocity is 8·9ft. per second. The last tunnel terminates at a point in the valley, where the banks, receding from each other, open out into a wide space, and where the configuration of the land lends itself admirably to the development of works for utilising the energy. An ample penstock collects the water which emerges from the tunnel, and allows the motion to be gradually reduced in order to pass under the sluice-gates and to enter the pipes with a velocity of about 3·3ft. per second. On the left of the penstock is the head of the weir, which has to be large enough to dispose of 11,440 gallons of water. It is formed of a flight of steps, 95ft. high and 98ft. wide. The mass of water which runs down it is thus divided and broken up, until the enormous energy it possesses is entirely spent.

The pipes which convey the water to the turbines are seven in number, and are of 6·9ft. diameter. They are made of riveted steel plates, whose thickness is 0·315in. to 0·472in. These pipes are laid to suit the natural slope of the ground, and are 215ft. long. At the top a sluice-gate, electrically

* Lecture given before the Milan section of the Associazione Elettrotecnica Italiana.

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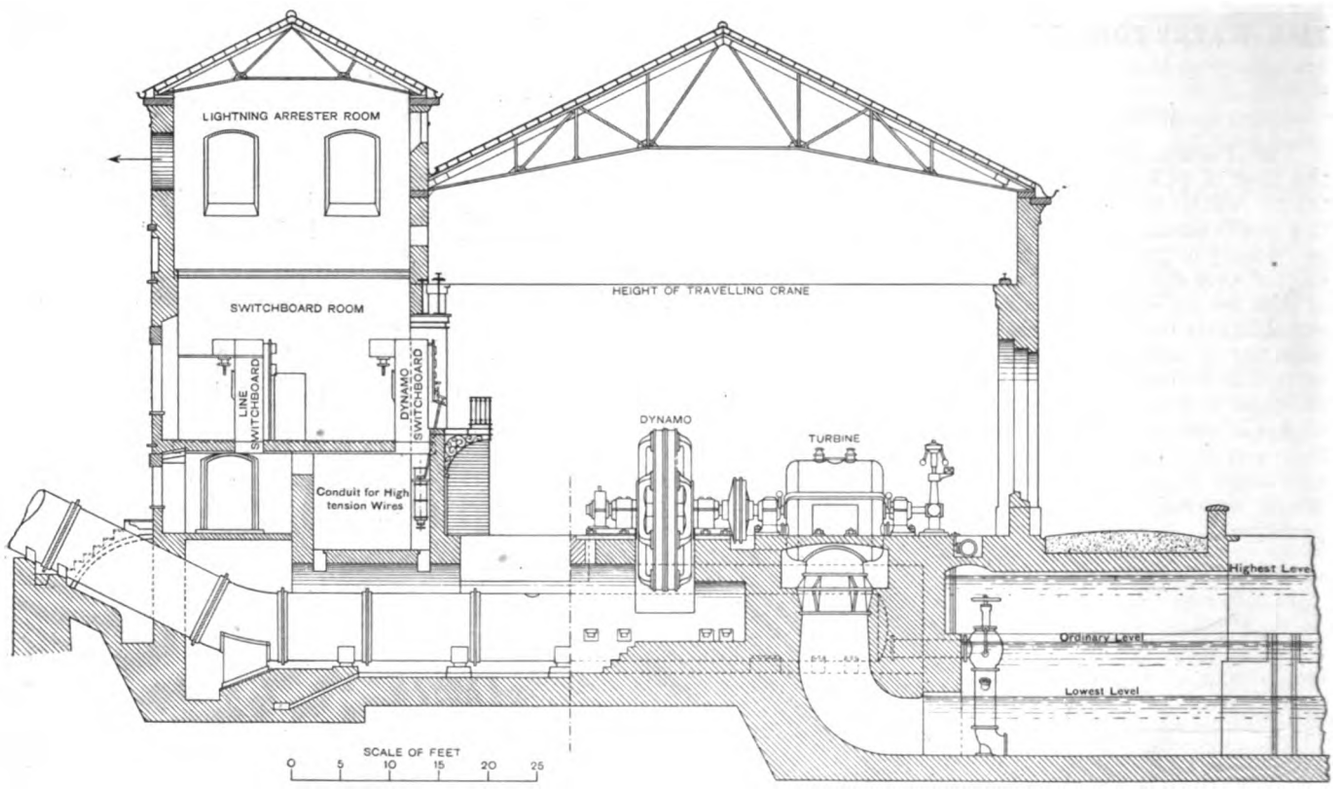
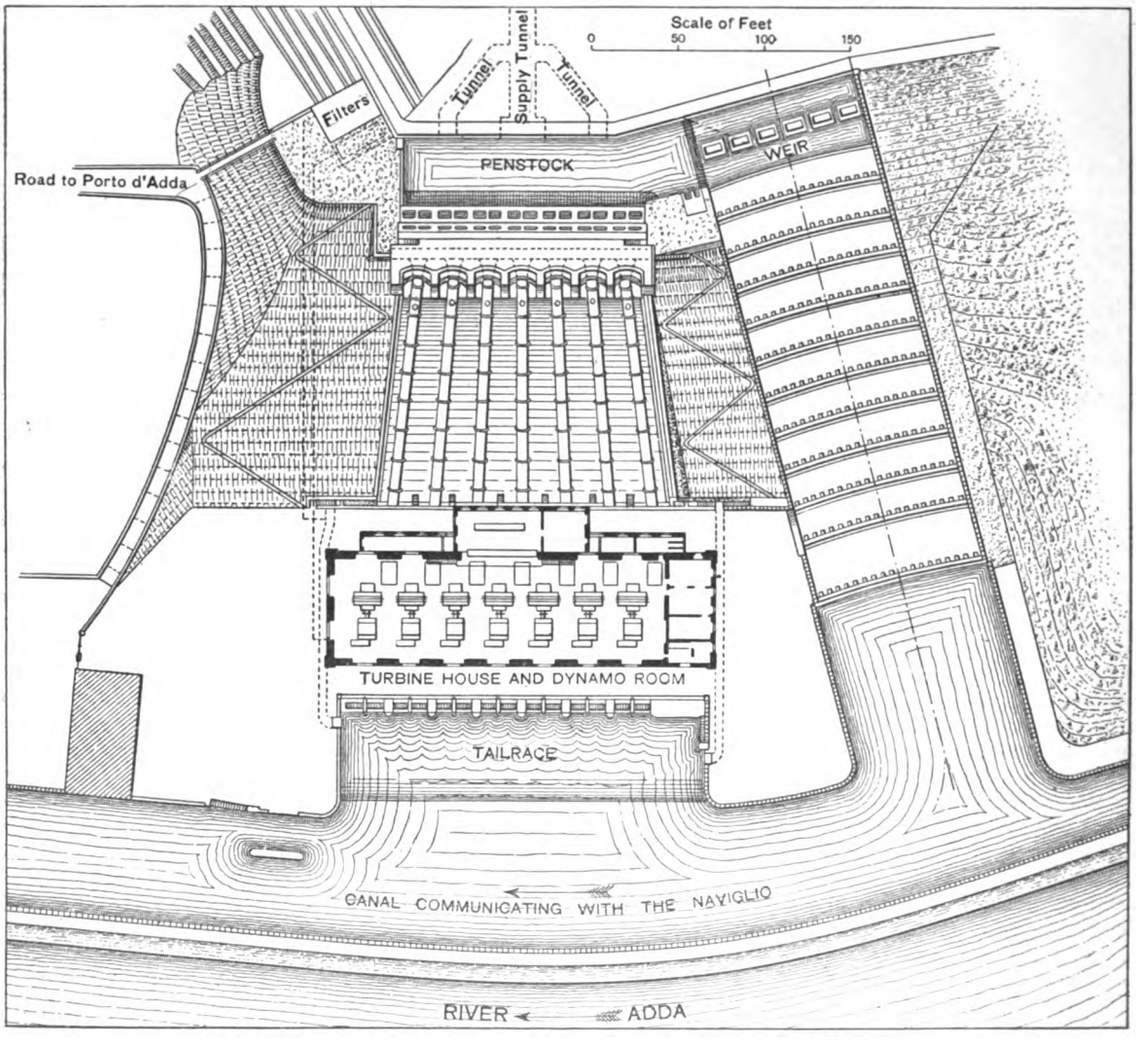


Transverse Section of Turbine House and Dynamo Room.



General Plan of the Buildings.

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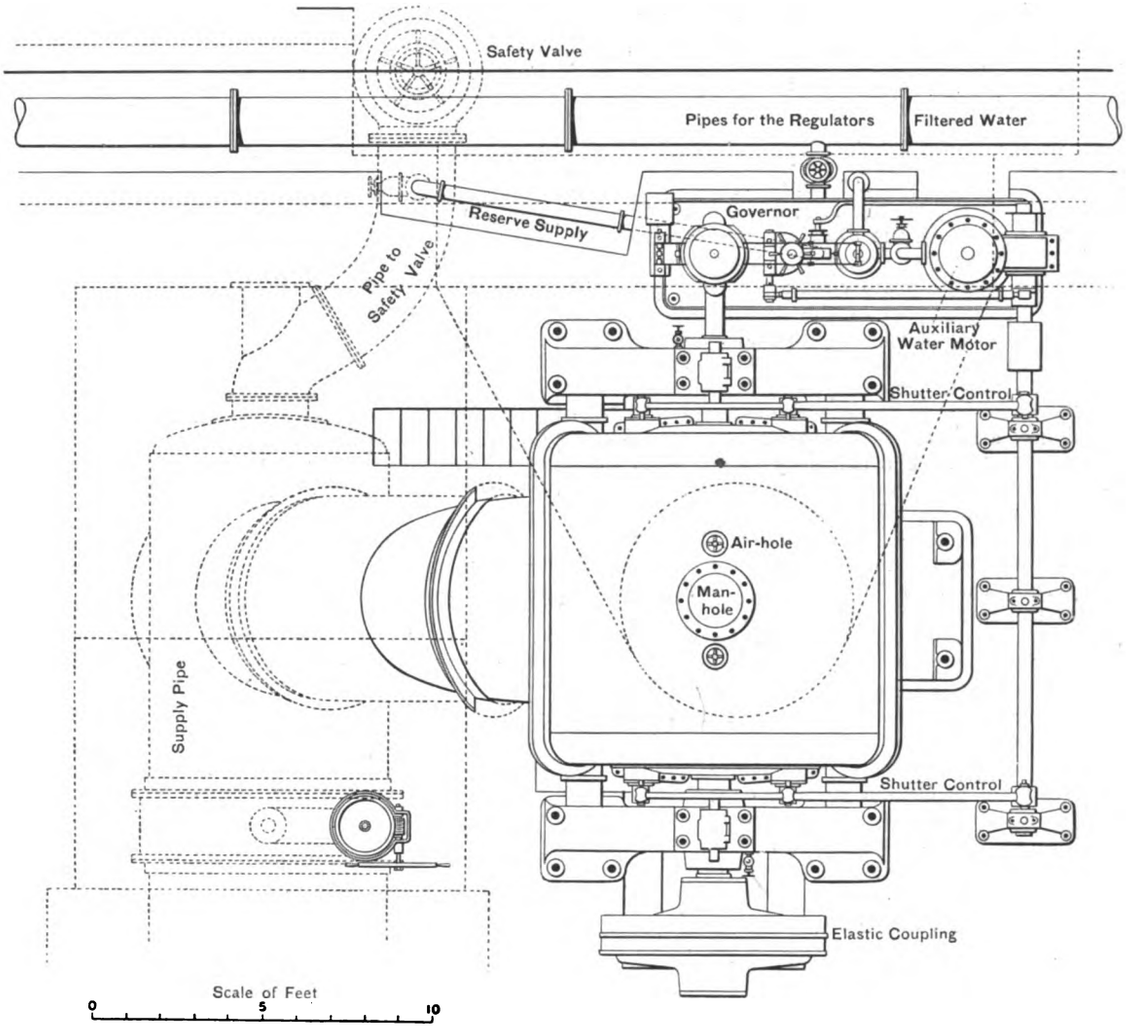
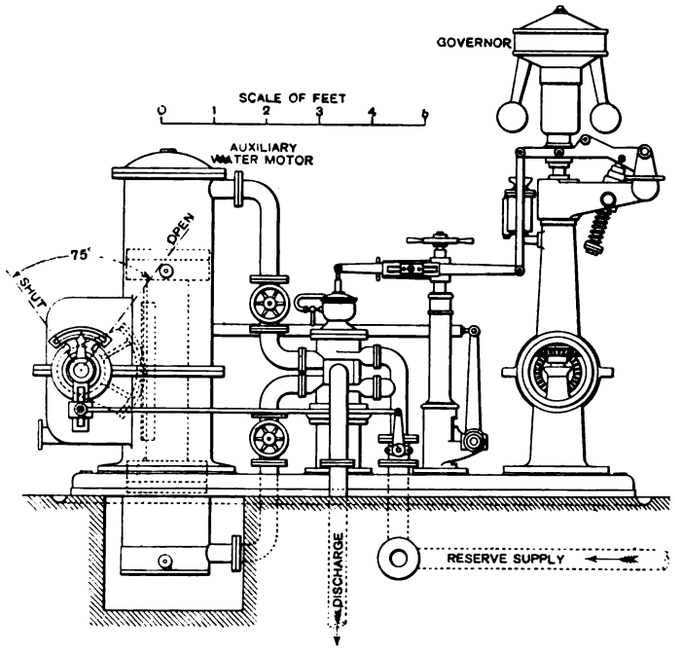
controlled, shuts off the admission, and at the bottom a butterfly valve prevents the flow of the water towards the turbine. From the turbine the discharge takes place into a wide tail-race, which does not communicate directly with the river, but with a canal which is a prolongation of the Naviglio. As the latter re-enters the river about 648 yards above the point where the discharge from the turbines reaches it, in times of drought this section of the river would be practically without water, and would not permit of navigation. The prolongation of the canal of the Naviglio enters the Adda about 438 yards below the point of discharge at a bend of the river very opportunely chosen, and thus returns to the Adda the water which, instead of uselessly consuming its energy in erosive action on the rocks and in heat, is transformed into another form available for commercial purposes.



Plan of one of the Turbines.



Auxiliary Regulating Motors, Ganz type.

The delivery in times of drought is 10,000 gallons. The net fall in the dry season is 94·5ft. In times of flood this is reduced to 81·6ft. It is therefore necessary in order to have the same average power, whatever the height of the water, to increase the delivery in proportion as the fall diminishes, and an easy calculation shows that in times of flood this will have to be 11,500 gallons. All the canals, accessory works, turbines and tail races are designed for this maximum delivery. The power, represented by 10,000 gallons of water per second with a fall of 94·5ft., is to 17,300 H.P., which, with a turbine efficiency of 75 per cent., gives nearly 13,000 H.P. actual output. In dividing this power into generating units, it must be remembered on the one hand that the efficiency of each machine increases with the increase of power, and, on the other hand, that the number of groups should be such that the breaking down of one should not, in practice, be a serious inconvenience. Accordingly it was divided into six units of 2,160 H.P. each, while a seventh was added as reserve.

Considering the great variability in the level of the tail-race, it was necessary to have recourse to suction turbines. The part of the fall which acts by pressure is 75ft., and that by suction is 19·5ft. in times of greatest drought, and 6·6ft. in times of flood. With such a division of the fall it is possible to keep the floor of the dynamo room above the level of the highest flood, which is a matter of great importance.

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The manufacture of these turbines, which (with the exception of those of Niagara) are the most powerful made up till now, was entrusted to the firm of Riva, Monneret and Co., of Milan, after a competition in which the best European firms took part.

The turbine is of the inward-flow type with twin wheels. The blades have a curved surface of a somewhat complex shape. As has been said, it acts by suction, hence the wheels always work submerged. The water enters laterally into an annular casing, 10ft. diameter, made of steel plates, which encloses the arrangement of distributors and wheels, and it leaves by the suction pipe fixed in the concrete of the foundation. As can be seen from the drawing, the bearings are entirely outside the water chamber, so that they may be easily examined when the machines are running. The regulating shutter is a ring forming part of the distributor; when a rotatory motion is communicated to it, the guide blades open or close the admission ports. With this system, all the ports of both wheels are shut simultaneously, and the shock on the shaft is practically nullified. These turbines make 180 revolutions per minute, and each has a maximum capacity of 1,916 gallons per second. The efficiency guaranteed by the maker is 78 per cent. for a given fall and volume of water, hence, in this 22 per cent. loss, is comprised that due to friction in the pipes and bends. The whole of the turbine is easily taken apart, a most valuable feature in an installation whose working should never be interrupted. The governor, which regulates the rotation of the shutter, is of the Ganz type, the variation of speed allowed being 2 per cent. during normal running, and 4 per cent. for 25 per cent. variations of load. In order to facilitate running in parallel, the Siemens system for varying the speed of the governors will be employed. This simply consists of a small motor worked from the switchboard, which stretches or releases the spring opposed to the conical pendulum governor. By this means the switchboard attendant can adjust the speed of each turbine—or their load if running in parallel—by simply pressing a button. The turbine is connected to the alternator by means of an elastic coupling.

(*To be continued.*)

SUPERHEATED STEAM AND ITS APPLICATION ON STEAM ENGINES.*

BY PAUL SCHOU.

The subject I have the honour to lay before you to-night is scarcely new to you, England being the first country where experiments were made, as long as 40 years ago, to use superheated steam in steam engines. The economy obtained at that time was not very great, as only moderately superheated steam could be employed, owing to the difficulties in lubricating the working parts of the steam cylinders, which could not be overcome as the lubricants then used became useless when they came into contact with steam of a high temperature, consequently the steam engine did not work satisfactorily. It was, therefore, soon found that other means would have to be adopted to utilise the steam more economically—this was done by gradually increasing the steam pressure and expanding the steam in more than one cylinder. The economy far exceeded the results obtained by the first experiments with superheated steam. This latter process was, therefore, left alone for many years, and it is only lately that the question of using superheated steam has again come to the front, after it has been found impossible with a triple, or even quadruple engine, to gain any higher economy worth speaking of.

Before describing the application of superheated steam, allow me to explain the reason why we cannot, when using saturated steam, utilise the heat to greater advantage than we already do now. The reason cannot be found in the construction of the steam engine, which has been carried out to perfection, but it must be found in the nature of the saturated steam itself. The great drawback in using saturated steam as a driving power is, that its range of temperature is very limited. On the one side, to raise the temperature of steam we have a rapid increase of the steam pressure, and, on the other hand, we cannot lower the temperature of the steam below the temperature of the condenser. Quite apart, however, from these drawbacks, practice shows us that the heat cannot be transformed into work without great losses. These losses take place principally in the steam cylinder, a part of the steam being condensed when coming into contact with the cylinder walls. The lower the mean temperature of the cylinder walls and the temperature of the steam leaving the cylinder, on the one side, as against the temperature of the admission steam on the other side, the greater are the losses by initial condensation. The earlier the cut-off is, the more the losses increase, as the admission steam only heats a smaller part of the cylinder walls, that is, the mean temperature of the cylinder walls is lowered, consequently, a larger percentage of the steam is condensed during the expansion period.

Through this exchange of heat between the steam and the cylinder walls, twenty per cent. of the heat is lost without doing any work, even in the best existing engines, but this loss very often amounts to fifty per cent., and more in ordinary engines. To minimise these losses two methods have been employed, viz., the fixing of a steam jacket round the cylinder to raise the temperature of same, and expanding the steam in two or more cylinders, so as to reduce as much as possible the difference of temperature between the steam entering and leaving the cylinders.

A third method remains, viz., to superheat the steam by adding so many units of heat above those contained in saturated steam, so that (*a*) the ratio of sensible heat to total heat may be increased, and (*b*) considerable reduction of temperature may occur in the cylinder before reaching the point where condensation commences. The theoretical gain due to (*a*) is expressed by the formula

$$\frac{T_1 - T_2}{T_1}.$$

The gain due to (*b*) is no less important, though it cannot be so simply expressed.

Heat is transmitted from steam to water with such rapidity that the late Mr. P. W. Willans was disposed to attribute the phenomenon of initial condensation almost entirely to the presence of water; whether this theory be correct or not, the fact remains that the adoption of a high degree of superheat practically eliminates initial condensation. The exposed surfaces of iron remain and the steam is there as usual, but there is no water for the simple reason that the walls of the cylinder are maintained hotter than the saturation temperature of the steam in contact with them.

The practical effect of (*a*) and (*b*) taken together is as follows:—

A triple expansion engine, working with 180lbs. steam-preasure, may, under favourable conditions, produce one H.P. with 12½lbs. of steam. The same steam superheated 150 degrees Cent. will, in a compound engine, produce one H.P. with 8¾lbs. of steam; the actual saving in heat units is 22½ per cent. To go still one step further, it would be possible to get the same efficiency in a compound engine working with 11 atmospheres pressure, as in a quadruple expansion engine working with 25 atmospheres pressure. You will, therefore, see that if we could only do away with the initial condensation a double advantage would be gained. First, we could in most cases do away with triple expansion engines; and, second, could reduce the boiler pressure, which would lower the cost of same.

I will now proceed to explain the nature of superheated steam. Superheated steam is dry saturated steam, which has been heated to a higher temperature than that corresponding to its pressure. The higher the temperature of the steam, the more its condition can be compared with a permanent gas, and, therefore, it becomes a bad conductor of heat. If superheated steam is used in a steam cylinder it can be expanded to a certain point, according to the degree of superheat, before reaching the so-called saturation point. A certain part of the heat is naturally lost during the expansion period through the exchange of temperature between the steam and the cylinder walls, but this loss is small compared with the loss of the latent heat in the steam which takes place through initial condensation. Superheated steam has, however, another great advantage—viz., that its specific volume is greater than that of saturated steam of the same pressure. If you, therefore, have two cylinders of exactly the same size, both working with the same degree of expansion, the weight of steam will be less in the cylinder working with superheated steam. The volume increases in proportion to the superheat; in other words, the more you superheat the less steam is used per horse-power. If, therefore, a considerable economy has to be obtained, it can only be done by using highly superheated steam, but I am sorry to say that in this country, engineers do not seem yet to have grasped this fact. The general opinion seems to be that, if you only superheat the steam a few degrees you get all the economy worth having. One of the reasons may be that the superheaters which, up to now, have been in the market here, cannot work with highly superheated steam for any length of time.

Mr. Schmidt, of Cassel, was the first engineer to introduce a complete plant working with highly superheated steam. The task was a difficult one. Mr. Schmidt was working for fourteen years before he was able to construct a plant to withstand the most severe test. The result has been very striking indeed, and now over 200 complete plants are working satisfactorily in various parts of the

* Abstract of Paper read before the Northern Society of Electrical Engineers at Manchester, on Thursday, December 8th.

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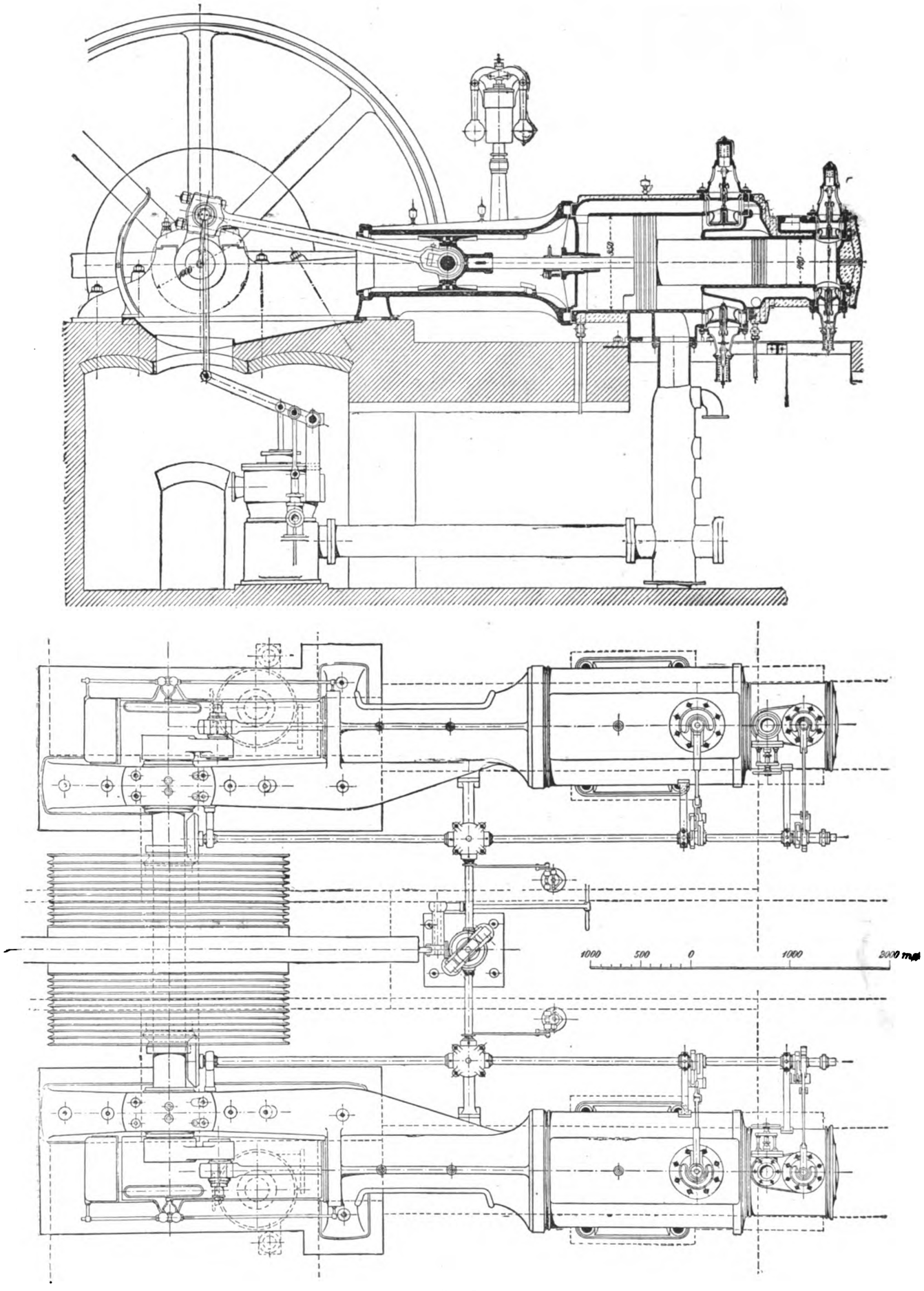

FIG. 1

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world. That superheated steam can also be used for large plants may be gathered from the fact that a 750 H.P. compound engine plant has been running now for 3½ years, night and day continuously, without the slightest hitch. The engine is used for a mill, rolling fine steel sheets, and the power given off by the engine varies from 400 to 750 H.P. The economy has been remarkable, viz., only 8¾lbs. of steam being used per indicated horse-power per hour. The boilers are heated by producer gas, the consumption being equal to 1lb. of coal per indicated horse-power per hour. This result, without doubt, is the best ever obtained on any steam engine in the world. As a proof that this plant has been a success, the existing steam power will be replaced by a Schmidt plant of 4,000 H.P. The economy for smaller plants has also been very remarkable. The writer has made very careful tests on a 70 H.P. tandem compound engine, which is driving an ice factory in Ireland, and the steam consumption was 10·2lb. per indicated horse-power per hour, and the coal consumption 1·4lb. per indicated horse-power per hour.

The steam enters the high-pressure cylinder, forcing the piston forward; when the piston moves back the steam is led into the receiver. On the next forward stroke the steam passes from the receiver into the low-pressure cylinder. Although the high and low-pressure cylinders are single acting, the engine is, to a certain extent, double acting, through the novel arrangement of the receiver in which a certain part of the work is performed.

The construction of this engine adapts itself very well to working with steam at high temperatures, for the following reasons:—(1) the high-pressure cylinders require no steam jackets; (2) the heat taken up by the high-pressure cylinder walls, during the admission period is not lost, but serves to heat the receiver; (3) the low-pressure cylinder is heated by the receiver steam; (4) the high-pressure piston is cooled inside by the receiver steam; (5) there is but a single stuffing box, which is only in contact with the receiver steam. The lubrication, therefore, is as in an ordinary engine. At first sight, it may be said that this engine has one

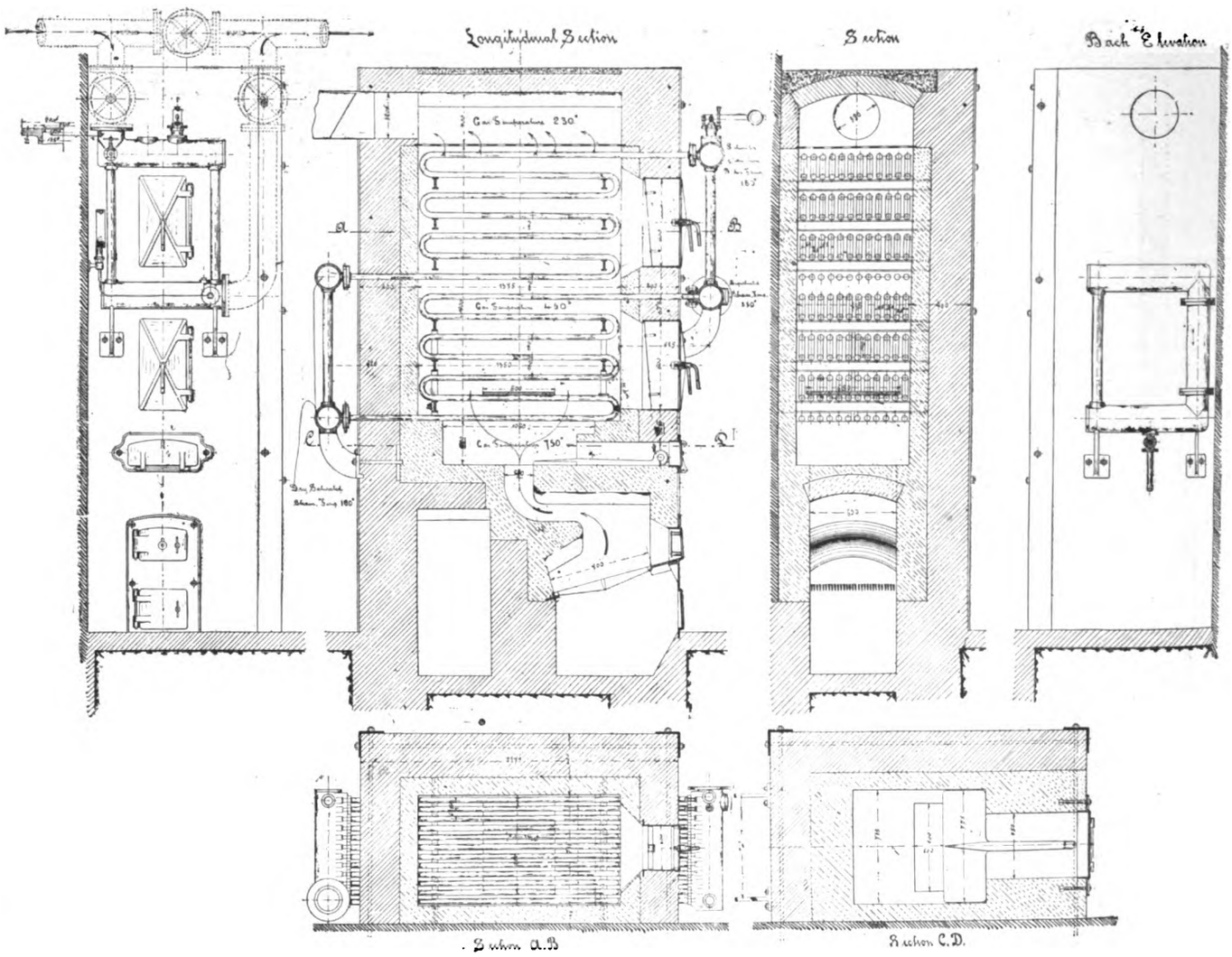

FIG. 2.

The difficulties which had to be overcome, before making it possible to construct plant to work with highly superheated steam, have been, first of all, to construct the superheater in such a way that the tubes in which the steam is superheated would withstand the high temperature of the gases; and secondly, the proper lubrication of the working parts of the steam engine. As, however, it is now possible to obtain a mineral oil with a flashing point of 380 to 400°C., the difficulties which were met with so many years ago have disappeared. Even, with this special oil, the best way of lubricating the gearing for admitting steam into the cylinders and the piston rings had to be devised.

Most of the steam engines, working with highly superheated steam, have been single acting, so as to prevent the piston rings coming into contact with the steam during the admission period. The most interesting type of this kind, and the one which has given the best result, is the Schmidt tandem compound engine, shown in Fig. 1. The pistons for the high and low-pressure cylinders are made in one piece: the front part of the cylinder forms the receiver, the ring-space A being the low-pressure cylinder. drawback, viz., that the high and low-pressure cylinders are only separated from each other so long as the piston rings in the high-pressure cylinder keep tight. The difference in pressure between the high and low-pressure cylinders is, however, not so great as to make it difficult to keep the piston rings tight, when one considers that when the steam is admitted to the high-pressure cylinder, the low-pressure cylinder is connected to the receiver and that there is only vacuum in the low-pressure cylinder when the high-pressure cylinder is connected to the receiver. Diagrams of this type are shown in Fig. 3.

There are various other arrangements in compound engines, viz., a single acting high-pressure cylinder, and a double-acting low pressure cylinder, but of course with all these types of engines, if adopted for very large powers, the cost is rather high on account of the superheated steam only working in a single-acting cylinder. Schmidt, therefore, has made experiments to use superheated steam in double acting engines, which, however, is only possible after introducing quite a new way of using the steam. This new idea consists in superheating the steam according to the

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degree of expansion in the cylinder. This may be carried out in several ways, one being to connect two steam pipes to the cylinder, one coming from the superheater and the other direct from that part of the boiler where saturated steam is produced. The governor on such an engine has two duties to perform, viz., to regulate the degree of expansion and to regulate the temperature of the steam. To regulate the temperature a valve is fixed in the pipe containing the saturated steam, which is connected by levers to the governor. When working with an early cut off only superheated steam is admitted to the cylinder, and as the degree of expansion increases the governor opens the regulating valve, allowing a certain amount of saturated steam to mix with the superheated steam, lowering its temperature; by this arrangement any temperature required may be easily obtained.

The principal object of this idea is to make it possible to produce a low mean temperature of the cylinder walls, so that steam of high temperatures may be used with safety. In double-acting engines the idea to superheat according to the degree of expansion has been carried still further, by also superheating the steam in the receiver, between the high and low-pressure cylinders. A large plant is now working in Russia very satisfactorily, constructed on this principle, and, although no exact tests have been made, Mr. Schmidt expects the steam consumption to be only 8lbs. per indicated horse-power.

Having now described the steam engine, I will proceed to describe the superheater. The Schmidt superheater consists of a series of tubes, varying in diameter from 1in. up to 2in., according to the size of superheater, the coils being welded together in long lengths, so as to prevent any joint coming into contact with the flue gases. The coils are formed in either a spiral or zigzag shape, to suit existing circumstances. The superheaters may

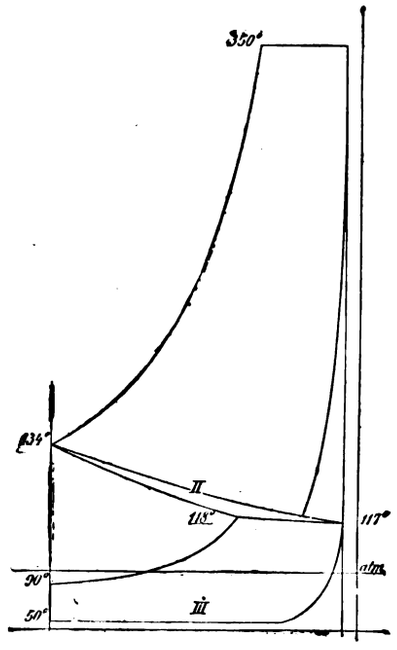

FIG. 3.

either be arranged in the flue behind the boiler, or altogether separate from the boiler plant, the latter type being fired direct by coal or gas; either kind of superheater may be attached to any existing boiler.

In the superheater arranged in the flue behind the boiler the steam travels through the superheater coils in the following way:—Suppose the gases from the boiler enter the superheater from the bottom, then the saturated steam from the boiler is led into the superheater through the top coil and travels through one-half of the coils in the opposite direction to the gases, and is then led to the bottom coil of the superheater, arriving there perfectly dry, but not superheated. The steam then travels in the same direction as the gases, being led off from the superheater at about the middle of the coils. By this arrangement, the coils, which are placed nearest to the gases having the highest temperatures, are cooled inside by the steam preventing the coils from becoming too highly heated. This, of course, is the only way to prevent deterioration for any length of time. Further, all the heat of the gases is utilised as economically as possible.

I should like, here, to say a few words about the economiser invented by Schmidt, which he arranges behind the superheater so as to still further reduce the temperature of the gases before entering the chimney. The principle of this economiser is to work with distilled water in the coils arranged in the flue and passing the distilled water through the feed-water heater. The advantage of this economiser is its great simplicity, it being possible to make the coils in long lengths, as no deposit takes place inside them and, therefore, no cleaning is required. Further, the feed-water being heated indirectly by the distilled water passing through the economiser, the temperature of the distilled water returned from the feed-water heater is sufficiently high that the vapour contained in the flue gases coming from the boiler does not condense when coming into contact with the economiser coils. The result is that the soot does not adhere to the coils and may be blown off with a small jet of steam in the course of a few minutes, say, every week or fortnight, according to the nature of the coal.

The direct fired superheater (Fig. 2) is constructed on the same principle; the gases entering the superheater from below, and travelling in an upward direction. This type of superheater is specially applicable to cases where a boiler plant already exists, the only alteration required being to lead the steam through the superheater, instead of direct from the boiler to the steam engine. Although extra coal is used for heating the steam, a total coal saving of 20 to 25 per cent., even on the best compound engine, can be obtained from adopting this kind of superheater.

Before concluding I may say, that especially for steam engines driving large electrical supply stations, there is a great future for the utilisation of superheated steam, as the heavy losses which now take place, on account of the steam engine, having during certain parts of the day to work with only half loads, can be prevented by adopting the Schmidt system, and I hope I have been able to show that the practical difficulties attached to this system have been overcome. In your own town, Manchester, there will shortly be laid down two boilers, both being connected with a Schmidt superheater—each plant being capable of producing 10,000lb. of steam per hour. The boilers will be heated by Mond's producer gas, and the steam will drive a 1,000 H.P. Raworth engine, to be used for electric power distribution.

DELAY IN THE DELIVERY OF PLANT.

The following communication appears to embody the manufacturers' point of view on the question of the non-delivery of electrical plant:—

It may be worth while to consider to what extent the present rapid development of electric lighting is due to the unceasing attention which manufacturers have for years past paid to the development of plant suitable to their customers' requirements. Most of the time, be it remembered, manufacturers have been struggling to keep their heads above water, with no inducement to extend their factories, they doing the work and the lighting companies making the money. Now, when success has crowned the efforts of manufacturers to perfect their designs, and electric lighting is, in consequence, progressing by leaps and bounds, they are further to be penalised for not having facilities to turn out the plant as rapidly as required.

It cannot be denied that in this country purchasers have little regard to the types of plant which can be most rapidly produced; each must have his own specification adhered to, and after months or years of dallying a specification is issued at the last moment. With little idea of what is reasonable in regard to time, the manufacturer is then expected to rush the plant through, regardless of obligations to other customers.

In tendering, manufacturers generally have the force of circumstances entirely against them; they cannot with any accuracy gauge the amount of work they will actually receive, and in fixing the time for delivery, they have to be guided more by the pressure put on them by the purchaser than by their own capacity for production, knowing that if they do not comply with the time prescribed by the specification, their tenders will not receive consideration. The result is that while each customer considers his interest paramount, the manufacturer has to distinguish between many customers, and, however much he is behind, he must deal with orders in rotation. He has, too, troubles with regard to the supply of material, especially at a time when all trades are so busy, and often he may have to wait for some time for a trifling item in order to complete an order, and although the delivery of the whole may depend upon a trifling part, he cannot bind the sub-contractor to any penalty on account of its small value. New types, also, often take longer to elaborate than

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could be anticipated when the order was taken, and as almost every order involves some fresh departure it is not to be wondered at that delays occur. Let everyone consider the variety in output, speed, voltage, periodicity and design in all classes of dynamos or alternators, and the numerous types of transformers, boosters, balancing machines, &c., which now go to make up a central station, and he will gain a faint idea of the amount of labour and uncertainty which has, up to the present, beset the manufacturer on all sides, with so small a return.

BOOKS RECEIVED.

"Michael Faraday: His Life and Work." By Prof. Silvanus P. Thompson, F.R.S. (London: Cassell and Co.) Price 5s.

"The Free Expansion of Gases." Memoirs by Gay-Lussac, Joule and Thomson. Translated and edited by J. S. Ames. (New York and London: Harper and Bros.) Price 3s.

"Prismatic and Diffraction Spectra." Memoirs by Joseph von Fraunhofer. Translated and edited by J. S. Ames. (New York and London: Harper and Bros.) Price 2s. 6d.

"Matter, Energy, Force and Work." By Silas W. Holman. (New York and London: Macmillan and Co.) Price $2.00.

"The Official Gazette of the United States Patent Office." Nos. 8 and 9. Vol. LXXXV. Published by authority of Congress. (Washington: Government Printing Office.)

"Sull' Applicazione della Trazione Elettrica All' Esercizio Ferroviario." By E. Cairo and P. Lanino. (Milan: Tip. Lit. Degli Ingegneri.)

"Marine Boilers." By L. E. Bertew. Translated and edited by Leslie S. Robertson, with a preface by Sir William White. (London: John Murray.) Price 18s.

"Annuaire du Bureau des Longitudes" for 1899. (Paris: Gauthier-Villars.) Price 1f. 50c.

"The Electro-Platers' Handbook." By G. E. Bonney. Third Edition. (London: Whittaker and Co.) Price 3s.

"Scheinwerfer und Fernbeleuchtung." By F. Nerz. (Stuttgart: Ferdinand Enke). Price 2 marks.

ELECTRICITY WORKS ACCOUNTS.

Birmingham Electric Supply Co.

The first of our two analyses this week is that of the accounts of the fifth and sixth completed years of working of the Birmingham electricity supply undertaking.

The whole of the authorised share capital, which stands at £200,000, has been received on the issue of 40,000 £5 shares. A total of £219,077, representing £146 per kilowatt of plant capacity, has been expended on capital account, £35,250 having been expended during the year, included in which amount is the expenditure on works in connection with the new boilers and extensions at the Dale End station.

During 1897 an equivalent of 26,712 8 c.p. lamps was added to the mains, thus raising the total lamp connection at December 31 last to 78,464, showing an increase of nearly 52 per cent.

The corresponding increase in the output was over 56 per cent., being 1,183,539 units sold in 1897, as compared with 756,428 in 1896, and as a result the average revenue per unit has dropped from 5·67d. to 5·14d. Reductions in the management and property charges have had the effect of reducing the total costs per unit in spite of a slight rise in the works cost through the fuel and distribution items.

The net result of the year's working is an increased ratio of the costs to revenue and a working profit of £12,733, out of which £4,460 has been carried to the depreciation fund, and £120 paid as bank interest. A balance of £1,043 from 1896 has enabled a dividend to be paid of 5 per cent. on the Ordinary shares, leaving £989 to be carried forward.

At the close of 1895 the connection to the mains was an equivalent of 36,398 8 c.p. lamps, and the output for the year had been 490,000 units. The lamp additions to the mains since the end of 1897 brings the total equivalent lamp connection up to considerably over 81,000 8 c.p. lamps. In view of the continually increasing output and the large number of motors added to the circuit, extensive additions to the plant at the Water-street station are in progress.

The capital has been raised from £200,000 to £300,000 by the creation of 20,000 additional £5 shares.

Sheffield Electric Light and Power Company.

December 31, 1897, marked the end of the fourth complete financial year of working of the Sheffield undertaking. The steady and rapid progress which has characterised it has been well maintained during 1897, and very material economies also effected. The total capital received amounts to £112,975, £87,975 accruing from the issue of 14,000 £7 shares (on 10,000 of which only £6 per share has been called up), and £25,000 raised on 4½ per cent. Debentures. At December last the total capital expenditure stood at £123,023, representing £133 per kilowatt of plant capacity.

During the year 154 additional consumers, with an equivalent of 13,323 8 c.p. lamps, were connected to the mains, raising the total lamp connection to 55,988. The output for 1897 was 747,063 units sold, as compared with 483,427 units in 1896, an increase of nearly 55 per cent.

Consequent upon a reduction at the beginning of the year in the price charged per unit, the average price obtained has dropped from 6·2d. to 5·24d. Very material reductions in the costs have been made, generating costs having been reduced from 1·45d. to 0·98d. The actual fuel bill is, in spite of the increased output, less in 1897 than it was in the preceding year.

Management and property charges per unit have also been reduced—viz., from 0·6d. to 0·45d. The already low figure of 36 per cent., representing the ratio of costs to revenue, has been improved upon in 1897 by being reduced to 29·6 per cent. A working profit of £11,477, representing no less than 10·9 per cent. on the mean capital for the year, was made. Out of this, £1,209 was paid as interest on loans, and the balance, with £100 from 1896, permitted of a dividend of 12½ per cent. being paid on the Ordinary shares, leaving a balance to carry forward of £903. Nothing, however, appears to have been carried out of the nett revenue to any reserve fund, although the sinking and depreciation funds have both been augmented by addition voted from the premiums accruing from the issue of shares.

In 1893 the output was 131,752 units sold, and the revenue from supply was £3,556; in 1894 the output was 192,220 and the revenue £4,849, while in 1895 the revenue from supply was £6,935, with an output of 288,406 units sold. The total cost per unit was in 1893 5·14d., in 1894 3·8d., in 1895 3·6d., in 1896 2·23d., and in 1897 1·55d. On March 31 last the price charged for current for lighting was reduced from 5d. to 4d. per unit.

Further additions to the plant in the station are in progress.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Ayr (Municipal)	Nov. 11	Islington (Vestry)	June 24
Bedford (Municipal)	Mar. 4	Kens'gton & Knightsbr'ge (Co.)	Sept. 30
Belfast (Municipal)	Sept. 23	Kingston-upon-Hull (Municipal)	Aug. 19
Blackpool (Municipal)	Oct. 7	Kingston-upon-Thames (Mun.)	Mar. 25
Bournemouth (Company)	June 3	Lancaster (Municipal)	Oct. 21
Bolton (Municipal)	Dec. 9	Leeds (Company)	April 8
Bradford (Municipal)	May 20	Leyton (Municipal)	Sept. 23
Brighton (Municipal)	May 6	Liverpool (Municipal)	Aug. 12
Bristol (Municipal)	July 29	Manchester (Municipal)	July 29
Burnley (Municipal)	Sept. 16	Newcastle and District (Co.)	Dec. 2
Burton-upon-Trent (Municipal)	April 15	Newcastle-upon-Tyne (Co.)	April 29
Bury (Municipal)	Nov. 25	Northampton (Company)	April 15
Cambridge (Company)	June 17	Norwich (Company)	Dec. 2
(Central) Kensington (House-to-House (Company)	Sept. 30	Notting Hill (Company)	Mar. 11
Charing Cross (Company)	April 22	Nottingham (Municipal)	Oct. 28
Chelsea (Company)	May 20	Oldham (Municipal)	Nov. 18
Cheltenham (Municipal)	Oct. 7	Oxford (Company)	April 1
Chester (Municipal)	Oct. 14	Portsmouth (Municipal)	Nov. 4
Clerkenwell (Company)	Mar. 18	Preston (Company)	Oct. 28
Derby (Municipal)	Dec. 9	Reading (Company)	Sept. 16
Dewsbury (Municipal)	Nov. 25	Richmond (Company)	Mar. 4
Dover (Company)	Mar. 11	Scarborough (Company)	April 1
Dundee (Municipal)	Nov. 4	St. James' & Pall Mall (Company)	July 1
Eastbourne (Company)	July 22	St. Pancras (Vestry)	May 13
Edinburgh (Municipal)	Oct. 14	Shoreditch (Vestry)	May 27
Exeter (Municipal)	Aug. 5	Southampton (Municipal)	June 3
Glasgow (Municipal)	Aug. 12	Stafford (Municipal)	Oct. 21
Guildford (Company)	May 13	Sunderland (Municipal)	Aug. 19
Halifax (Municipal)	Nov. 18	Taunton (Municipal)	Aug. 5
Hammersmith (Vestry)	June 10	Tunbridge Wells (Municipal)	July 22
Hampstead (Municipal)	Sept. 9	Walsall (Municipal)	Nov. 11
Hanley (Municipal)	April 8	Wandsworth (Company)	Mar. 18
Harrow (Company)	Sept. 9	Westminster (Company)	April 22
Hastings & St. Leonard's (Co.)	April 29	Wolverhampton (Municipal)	July 15
Hove (Company)	May 6	Worcester (Municipal)	May 13
Huddersfield (Municipal)	Mar. 25	Yarmouth (Municipal)	June 17

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	BIRMINGHAM.		SHEFFIELD.	
Undertaking Worked by	The Birmingham Electric Supply Company.		The Sheffield Electric Light and Power Co.	
Date of Commencement of Supply	April, 1891.		March, 1893. [and houses.	
System of Supply	3-wire continuous-current, with batteries.		Alternate-current transformers in sub-stations	
Chief Engineer	J. C. Vaudrey.		W. Johnson.	
YEAR ENDED	DEC. 31, **1896.**	DEC. 31, **1897.**	DEC. 31, **1896.**	DEC. 31, **1897.**
QUANTITIES—				
Units generated	—	—	636,071	1,043,428
„ **SOLD (TOTAL)**	756,428	1,183,539	483,427	747,063
„ sold to consumers	—	—	483,427	747,063
„ sold for public lighting, &c.	—	—	—	—
„ used on works	—	—	—	—
UNITS SOLD PER 8 C.P. LAMP CAPACITY	16·1	25·3	19·3	25·8
Maximum supply demanded	—	—	663 kilowatts	887 kilowatts
Number of public lamps	—	—	—	—
Number of consumers	—	—	350	504
Connections to mains in 8-c.p. lamps	51,752	78,464	42,665	55,988
CAPACITY OF PLANT IN 8-C.P. LAMPS	46,900	46,900	25,000	28,900
CAPACITY OF PLANT IN KILOWATTS	1,500	1,500	800	925
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	—[a] —	—[a] —	— —	— —
Share	£200,000 £133	£200,000 £133	£98,000 £123	£280,000 £303
Loan (including Debenture charges)	—[a] —	—[a] —	—[a] —	—[a] —
RECEIVED (TOTAL)	150,000 100	£200,000 133	87,769 110	112,975 122
Share	150,000 100	200,000 133	62,769 78·4	87,975 95·1
Loan (including Debenture charges)	— —	— —	25,000 31·3	25,000 27·0
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— —	— —	— —	— —
Share (unissued)	50,000 33·3	— —	13,272 16·6	182,000 197
Share (uncalled)	— —	— —	21,959 27·4	10,025 10·8
Loan (including Debentures)	— —	— —	— —	— —
REPAID (TOTAL)	— —	— —	— —	— —
RESERVE OR SINKING FUND	1,000 0·667	7,136[i] 4·76	— —	2,689[h] 2·91
DEPRECIATION FUND	9,951 6·63	14,412 9·61	4,740 5·923	6,643[i] 7·18
EXPENDED (TOTAL)	183,827 122·5	219,077 146	87,009 109	123,023 133
Lands and buildings	38,193 25·5	41,526 27·7	16,472 20·6	30,559 33·0
Plant	53,555 35·7	68,695 45·8	36,445 45·6	49,011 53·0
Mains	86,587 57·7	103,045 68·6	32,475 40·6	40,880 44·2
Miscellaneous	5,492 3·66	5,811 3·87	1,617 2·02	2,573 2·78
BALANCE OF CAPITAL ACCOUNT	−33,827[b] −22·6	−19,077[b] −12·71	760 0·95	−10,048[e] −10·9
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£17,862 5·665d.	£25,338 5·140d.	£12,477 6·200d.	£16,307 5·242d.
Revenue from supply	16,643 5·280d.	24,093 4·885d.	11,042 5·482d.	14,319 4·600d.
„ meters, &c.	564 0·179d.	797 0·162d.	207 0·103d.	307 0·099d.
„ public lighting	— —	— —	— —	— —
„ sale of lamps, &c.	303 0·096d.	— —	9 0·004d.	1,596 0·513d.
„ miscellaneous sources	351 0·111d.	448 0·091d.	1,219 0·605d.	85[f] 0·027d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£8,774 2·783d.	£12,605 2·557d.	£4,500 2·235d.	£4,829 1·552d.
WORKS COSTS	5,288 1·678d.	8,479 1·719d.	3,285 1·632d.	3,420 1·100d.
Generation of electricity	*5,142[d] 1·630d.*	*7,391[f] 1·477d.*	*2,924 1·452d.*	*3,063 0·985d.*
Fuel (including cartage, &c.)	2,237 0·710d.	3,557 0·722d.	1,164 0·578d.	1,003 0·322d.
Oil, waste, water, stores	573 0·182d.	717 0·145d.	180 0·089d.	190 0·061d.
Wages at station	1,761[c] 0·559d.	2,172[c] 0·440d.	1,175 0·584d.	1,367 0·440d.
Repairs and maintenance at station	536 0·170d.	817 0·166d.	405 0·201d.	504 0·162d.
Distribution of electricity	— —	—[c] —	*361 0·179d.*	*357 0·115d.*
Wages, &c.	—[c] —	—[c] —	148 0·074d.	207 0·067d.
Repairs, renewals of mains, &c.	146 0·046d.	1,188[g] 0·241d.	213[b] 0·106d.	150 0·048d.
Public lighting	— —	— —	— —	— —
Attendance	— —	— —	— —	— —
Renewals	— —	— —	— —	— —
MANAGEMENT AND PROPERTY CHARGES	3,486 1·106d.	4,126 0·837d.	1,215 0·604d.	1,409 0·453d.
Royalties	— —	— —	— —	— —
Rent, rates, taxes	*1,032 0·327d.*	*1,218 0·247d.*	*348 0·173d.*	*364 0·117d.*
Management	*2,454 0·779d.*	*2,908 0·590d.*	*867 0·431d.*	*1,045 0·336d.*
Salaries	1,811 0·575d.	1,942 0·394d.	491 0·244d.	550 0·177d.
Stationery, &c.	95 0·030d.	100 0·020d.	125 0·062d.	96 0·031d.
Establishment charges	256 0·081d.	252 0·051d.	105 0·052d.	199 0·064d.
Law charges, &c.	292[e] 0·093d.	614[h] 0·124d.	146[c] 0·072d.	200[g] 0·064d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£9,088 5·68%	£12,733 6·315%	£7,977 10·25%	£11,477 10·93%
Sum carried to Depreciation Fund	2,918 1·824%	4,460 2·206%	1,000 1·285%	— —
Sum carried to Reserve or Sinking Fund	— —	— —	1,000 1·285%	— —
Net interest on loans (incl. Debenture charges)	207 0·129%	120 0·060%	1,175 1·510%	1,209 1·151%
BALANCE FROM LAST ACCOUNT	771 0·482%	1,043 0·517%	88 0·113%	100 0·095%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	6,734 4·205%	9,196 4·560%	4,153[d] 5·337%	10,368 9·880%
Deficit	— —	— —	— —	— —
ORDINARY DIVIDEND PAID	4½% —	5% —	7½% —	12½% —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	49·1%	49·8%	36·1%	29·6%
Expenditure per kilowatt capacity	£5. 17s. 0d.	£8. 8s. 2d.	£5. 12s. 6d.	£5. 4s. 5d.
REVENUE PER KILOWATT CAPACITY	**£11. 18s. 0d.**	**£16. 18s. 0d.**	**£15. 12s. 0d.**	**£17. 12s. 7d.**
Expenditure per 8-c. lamp capacity	3s. 9d.	5s. 4½d.	3s. 7½d.	3s. 4d.
REVENUE PER 8-C.P. LAMP CAPACITY	**7s. 7½d.**	**10s. 9½d.**	**9s. 11¾d.**	**11s. 3½d.**
REVENUE PER 8-C.P. LAMP CONNECTED	**6s. 10¾d.**	**6s. 5½d.**	**5s. 10¼d.**	**5s. 10d.**
Price charged for lighting, per unit	7d. to 4½d.	7d. to 4½d.	6d.	5d.
Price charged for power, per unit	4d. to 2d.	4d. to 2d.	4d.	4d.
Price charged for public lighting	—	—	—	—

BIRMINGHAM.—REMARKS—*a* No limit fixed. *b* Over-expended. *c* The wages at the transformer stations are included under wages at the generating station. *d* Includes £35 to petty expenses. *e* Includes £82 to auditing, £52 to bad debts, and £125 to insurance. *f* Includes £29 petty expenses. *g* Includes £558 loss by sale of lamps, &c. *h* Includes £89 to auditing, £174 to bad debts, and £128 to insurance. *i* Of which £6,136 was voted out of the premiums obtained on issue of remaining share capital.

SHEFFIELD.—REMARKS—*a* Not limited. *b* Includes £52 to arc lamp maintenance. *c* Includes £49 to auditing, £57 to bad and doubtful debts, and £20 to insurance. *d* After writing £445 off formation expenses and £291 off suspense account. *e* Over-expended. *f* Includes £76 from rents. *g* Includes £54 to auditing, £88 to bad debts, and £23 to insurance. *h* Includes £1 000 from the 1896 working profits, and £1,689 voted out of premium realised through issue of shares. *i* Includes £1,903 voted out of premium realised from issue of shares.

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The Electrician.

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All Editorial letters to be addressed to The Editor.

All letters for insertion in "The Electrician," or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.

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CONCENTRIC WIRING.

Since the introduction of pressures of from 200 to 250 volts at consumers' terminals, it has become usual on three-wire systems to connect the middle or neutral wire to earth. This development of central station practice, forbidden at one time by the Board of Trade when lower terminal pressures were in vogue, and now strongly recommended, if not mildly insisted upon, by the same authority, leads one to the consideration of a system of house-wiring which has hitherto been almost ignored by engineers devoting themselves exclusively to the public supply of electrical energy. The form concentric wiring has usually taken is that of an insulated conductor on which all the fuses and switches are connected, entirely enclosed by another conductor serving simultaneously as an armouring for the wire or cable and as an uninsulated return circuit for the current. It is usual to make this return conductor of slightly larger sectional area than the internal one, and to preserve its continuity throughout, from the caps of the lamps themselves, through all branch and main fuse-holders and switches to the switchboard in the dynamo room. When this system is carried out thoroughly the switches and fuse-holders have not only metal covers, but also metal bases, the latter actually forming part of the circuit, and where the fittings do not afford in themselves a continuous conducting sheath of sufficient section from the lamp-holders to the metal ceiling rose, joint-box or socket, "concentric flexible" takes the place of "twin flexible" or "electrolier wire." A system involving the use of an uninsulated return circuit could naturally not be employed in connection with networks of mains each pole of which had to be maintained well insulated from earth, and in consequence this form of concentric wiring was not used until quite a recent date in any house connected to public supply mains. Obviously the outer conductor could be insulated as well at the inner one, but this destroys to a considerable extent the simplicity of the system, renders the jointing more difficult and increases the cost. The

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only system of concentric wiring with both poles insulated which has been employed to any considerable extent is, we believe, one devised by the engineer of the Harrogate electricity works, in which town it is used on several consumers' premises.

Possibly the chief advantage of concentric wiring with an uninsulated return is that it permits of no half measures so far as faults are concerned; leakages to earth and wire-to-wire faults are one and the same thing. Any damage to the wire, unless it occasion an absolute discontinuity in the outer conductor, can do no more than cause a current to flow through the insulation from one conductor to the other until it has assumed sufficient magnitude to melt the fuse protecting the circuit in question. Another great advantage is that the number of fuses required, and consequently the number of extinctions through stale and loose fuses, is diminished by a half. The system also simplifies and improves the design of lamp sockets and lamp-holders. For instead of it being necessary to have two contacts in the lamp socket for use in bayonet holders, and two spring pins in the holders themselves, one only is required. Lastly, the replacement of the mechanically weak porcelain by metal, in the bases of fittings, appeals strongly to the engineer. The fact remains, however, that the present double wiring is safe enough and good enough, and a decrease, say, of 50 per cent., in the extremely small number of electrically-caused fires, and a similar decrease in the number of local interruptions of electric current would not justify any appreciable increase in the cost of electric light fitting. Patentees and manufacturers of concentric systems of wiring often urge that their systems are as cheap as, or cheaper than, the rival systems in wooden casing or in iron tubes, but at present we do not think that this is the case when a fair comparison is made. It is obviously unfair to take, as is sometimes done, on the one hand, the usual system of two wires encased in wood and buried in the plaster of walls, and, on the other, a concentric system of bare armoured wire placed on the surface; and if the estimate for a drawn-in system is adopted for comparison the concentric system estimated for should be a drawn-in one also. Are, then, the advantages gained by the use of an improved method of wiring worth an additional expense? The answer is no, not in the present condition of the electric lighting industry. But given an opportunity for this class of electric light fitting to be more widely used, so that both the manufacture of the various fittings and their erection may be done in a more economical manner than now, it will, we believe, be able to compete on an equal footing as regards cost with the methods more popular to-day. We may go a step further. With ordinary wiring, as it is at present carried out in buildings, a potential higher than 250 volts above that of the earth, would be associated with danger to person. However carefully the wiring be carried out, there is a possibility of accidental contact with a bare wire or piece of metal. The risk is, we admit, a small one; but we may mention that a case has recently been brought to our notice in which a person inserting a wall-plug received a serious shock and burn (presumably through a bare flexible wire) on an installation connected to a system where there are 400 volts between the outers. With concentric wiring, however, the chance of receiving a shock is very minute indeed, every part of the inner or charged conductor being surrounded by the outer conductor at a comparatively low potential. When higher potentials than 250 volts are allowed within buildings it will probably be after a general introduction of concentric wiring.

One question remains to be settled, however, before concentric wiring can be extensively connected to public supply mains. Where is the earth connection to be? The only town in which concentric wiring has been exclusively adopted is Guildford, where the public supply has been provided by the Safety Concentric Wiring Co. Here there is no direct earthing at all, either at the station or at the feeding points. The mains from the station 'bus bars are bare concentric, run in wooden troughs filled with bitumen, the service wires are jointed "solid" to the distributors, and are also insulated from earth until the house terminals are reached. Within the houses, however, the outer conductors are bare. The supply is on the three-wire system with a pressure of 200 volts on each side. Up to the present we believe no cases of electrolysis have occurred, nor any complaints of disturbance to telegraph circuits, but it must be borne in mind that the system is a very small one, there being only seventy-two consumers, and it has been in operation but two years. It appears to us that to make a good earth at the feeding points would afford more security. At Guildford a consumer might find it possible to utilise the difference in potential between a water or gas pipe and the sheathing of his wiring, say, to ring his electric bells or to light miniature lamps. Electrolysis under natural conditions need not be anticipated, however, if there is an earth somewhere on the system, for it is the neutral wire of the three-wire system that is earthed, and the currents through it are therefore mostly local. At all events, the 7 volts drop in pressure allowed to tramways on their return circuits would hardly be approached.

We will mention one more point, this time adverse to earthed concentric systems, although perhaps not of supreme importance. A cable-fault developing in a side by side or insulated concentric system can, with proper testing arrangements, often be detected in the form of a slight earth before it has any serious effect on the supply. But so soon as the system is earthed throughout, *i.e.*, at more than one point, no insulation tests during supply are of any avail (except perhaps in the case of feeders), and a defect in the network is not noticed until it has become a short-circuit. Thus, what is an advantage in house wiring becomes a drawback so far as the street mains are concerned.

In concluding this somewhat lengthy examination of the arguments for and against concentric wiring, we will express the hope that another central station will follow in the lead of Guildford, and adopt it experimentally.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Magnetic Deflection of Open-Air Discharges.—The analogy between open-air and vacuum discharges has already been well established by Toepler's work on their stratification. It remains to show that open-air discharges are subject to magnetic deflection. J. Precht proves that they are. The amount and distribution of the deflection depends upon the shape of the electrodes, but deflection is equally observed in spark, brush, and glow discharges. If the anode is pointed and the cathode blunt, the length of gap 8mm., and the difference of potential 8,600 volts, a field of 7,000 units produces a very decided deflection of the path of the sparks, accompanied by a fall in the potential by about 1,000 volts. The deflection is limited to that portion of the path which lies between the centre and the cathode, and is accompanied by a brightening. When the gap is widened, brush discharge sets in, but the spark discharge is restored by a strong magnetic field. On still further widening, the brush discharge is re-established, but the magnetic field alters its oval shape, and

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concentrates it into the equatorial plane. At the same time, a plane anode is strongly etched. A peculiar phenomenon is observed when the magnetic field is parallel with the spark gap. On mounting the electrodes over a sensitive plate, the end of the anode column detaches itself from the neighbourhood of the cathode and wanders slowly towards the anode, leaving a track on the plate which is curved according to the direction of the field.

[PRECHT, *Wied. Ann.*, No. 12, 1898.]

A New Influence Machine.—W. R. Pidgeon has improved his influence machine in the direction of cheapness and utility for X-ray work. The machine consists of one or more pairs of glass discs mounted on a spindle and running in opposite directions, with earthing brushes arranged similarly to a Wimshurst machine. But the sectors receive their charge at a moment when they stand between two charged inductors, and their capacity is at a maximum. The machine may be regarded as a condenser, the plates of which can be charged in one position, then shuffled to bring the positives and negatives together, and thus discharged. Each sector is embedded in an insulator, and only the brass contact knob projects. Hence it can receive a charge on each face as it stands between the disc and the inductor, like a plate in a condenser. It, therefore, carries forward a double charge as compared with that carried forward by a machine without inductors. Again, the drop of capacity and consequent rise in potential of the sector as it moves away from the inductor is so great that the induction of the machine is also practically doubled, and hence the total output is multiplied by four. To quote some figures: A Pidgeon machine with one pair of plates requires 18 sq. ft. of area to pass the collecting brushes for spark. A 15in. Wimshurst machine requires 70 sq. ft. The Pidgeon machine will work in any weather, since hardly any metal is exposed.

[PIDGEON, *Phil. Mag.*, December, 1898.]

Genesis of the Point Discharge.—Let a needle-point be mounted opposite a metallic surface earthed through a galvanometer. If the needle-point is then maintained at a potential which exceeds a certain value the galvanometer indicates a constant current traversing the air between the point and the metallic surface. Hence, under the influence of the electric force, the air has been converted into a conductor of definite conductivity, though this conversion may possibly be confined to the immediate neighbourhood of the needle-point. E. Warburg endeavours to solve the question as to what amount of time elapses between the establishment of the proper difference of potential between needle-point and surface and the passing of the discharge. He mounted a fine platinum point, obtained by tearing a glowing platinum wire in a nearly closed metallic sphere, and determined, by an automatic interruptor, the current passed immediately after the establishment of the potential, and the current passed after the potential had been established for some time. The results show that the discharge reaches the full value 0·007sec. after establishing the proper difference of potential, and that, therefore, the air does not require more than that short interval to acquire its full conductivity. The retardation which attends spark discharges between spheres is not observed in this case.

[WARBURG, *Wied. Ann.*, No. 12, 1898.]

A Dispersion Model.—Several types of models have been suggested for illustrating the behaviour of waves of various periods when encountering media capable of absorbing such of them as have a particular wave-length. J. H. Vincent has designed one which not only illustrates it roughly, but shows an agreement with Helmholtz's formula of dispersion, $\mu^2 = \frac{n^2 - a^2}{n^2 - b^2}$, where μ is the refractive index, and n the frequency of the incident vibration. Vincent's model consists of a long spiral spring suspended horizontally by a series of vertical threads. Such a spiral spring has often been used to illustrate the propagation of sound and light. In Vincent's model it is loaded with leaden bullets at intervals of about five turns, and to each bullet is attached a weight twice as heavy as the bullet, by a thread 56cm. long. Without these weights the loaded spring represents the open ether. With the weights added it represents a material medium. One end of the spring is set in vibration by means of a metronome. As the frequency increases from 0 to b, the wave-length and the velocity of propagation decrease. When $n = b$ the lower particles are thrown into violent agitation, but when n is a little greater than b the model altogether refuses to propagate the motion, and no waves are observed until n exceeds a. When the frequency is higher the hanging weights are unaffected, and the velocity becomes independent of the frequency. The same thing happens when short impulses are given, corresponding to the X-rays of modern theory.

[VINCENT, *Phil. Mag.*, December, 1898.]

Conductivity Method of Studying Solutions.—The conductivity method of determining whether or not double salts exist as such in solutions consists in a comparison of their observed conductivity with what it is supposed their conductivity would be if the constituent salts were entirely uncombined. The difficulty which has always presented itself has been to determine what the conductivity would be on this assumption. The difficulty vanishes in the case of extremely dilute solutions, because in their case it follows from the principle of the superposition of small effects alone, that, if no double salt exists, the specific conductivity will be equal to the arithmetical mean of the solutions of the constituents taken separately. J. G. MacGregor and E. H. Archibald show by practical demonstrations that, once the molecular conductivities at infinitive dilution are known, the conductivities of fairly complex salt solutions can be calculated with the aid of the dissociation theory of electrolytic conduction, even in its present imperfectly developed form. Thus the conductivities of all solutions containing two electrolytes with a common ion is calculable up to a concentration of about 1 gramme-equivalent per litre. The conductivities of mixtures of equi-molecular simple solutions of zinc and copper sulphates, or of potassium and sodium sulphates are calculable within the limits of observational error up to a concentration unity.

[MACGREGOR and ARCHIBALD *Phil. Mag.*, December, 1898.]

Genesis of Electric Sparks.—By an extension of the work of Feddersen and of Trowbridge, B. Walter has obtained some photographs of electric sparks which elucidate several hitherto doubtful points. He mounted a rapid plate upon a little car moving on rails and driven by a falling weight. The rotary interruptor of the induction coil was worked at such a rate that at least two sparks were recorded on the moving plate. This, while ensuring a record, also furnished a measure of the time. The records all agreed in showing several discharges succeeding each other at intervals of $2{\cdot}7 \times 10^{-4}$sec. The first discharge was by far the strongest, and the track of the spark showed several branches and brushes. The portion of the spark at the negative pole was always more strongly marked than that at the positive pole, evidently owing to the difference in the actinic powers of the anode and the cathode light. The successive partial discharges, though all in the same direction, show an alternate weakening and strengthening, due to the surgings of the primary current in the condenser. A further analysis of the sparks reveals a process of a more complicated but highly interesting nature. It is seen that every spark is preceded by several brush discharges. Each brush discharge is separate from the preceding one, which is usually of the opposite sign. Thus a small brush will start from the negative pole, and another shortly afterwards from the positive pole. Then a larger brush will start from the negative pole through the path marked out by the first one, and will then bend aside and proceed a step further, and so on until the whole gap is bridged and the first spark passes. When the analysis is not very minute the preliminary brushes appear as appendages to the first spark. Such appendages are also seen in lightning photographs. Lightning flashes are, therefore, probably also preceded by pilot brush discharges.

[WALTER, *Wied. Ann.*, No. 12, 1898.]

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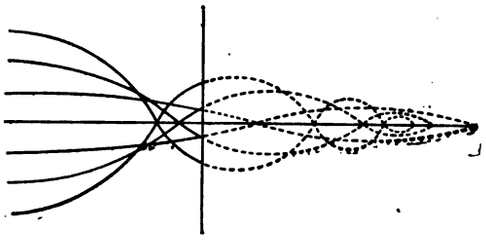
Magnetic Suction of Cathode Rays.—Early this year (see *The Electrician*, Vol. XL., p. 782), Wiedemann and Wehnelt described the appearances presented by cathode rays, propagated, not across a magnetic field, but along it, towards the pole of a magnet. They stated that the rays were twisted into a series of nodes and ventral segments. K. Birkeland amplifies these facts by further studies, showing that the arrangement of the nodes is not quite so simple as described by the former investigators, but is equally within the grasp of the emission theory. He mounted a Maltese cross in the path of the rays, and brought the magnet gradually nearer to the end of the tube impinged upon by the cathode rays. By moving the cross and the magnet into various positions, the course of the rays could be completely mapped out. As the magnet approached, the shadow of the cross, upright at first, turned about the magnetic axis, and both the shadow and the luminous spot diminished in size. The rotation was such that when the rays were directed upon a north magnetic pole, the cross, as seen from the pole, turned in the direction of the hands of a watch. The patch alternately increased and



decreased in size. The general course of the rays is seen in the figure, where the outer rays show more numerous segments than the inner ones.

[Birkeland, *Archives de Genève*, September, 1898.]

THE COMMERCIAL AND BUSINESS ASPECTS OF MUNICIPAL ELECTRICAL SUPPLY.

BY ALFRED H. GIBBINGS, M.I.E.E.

(*Continued from page 82.*)

Hiring-out of Motors, Arc Lamps, and other Apparatus.

The hiring-out of electric motors and other apparatus is an innovation of very recent growth in connection with municipal electricity supply. The scheme was first put into operation in November, 1896, by the Bradford Corporation, who were also the first municipality to own an electricity supply station. The movement is, of course, merely a corresponding enterprise to the letting out on hire of gas stoves, which not only every municipality owning a gas works, but also every gas company, knows to be a sound and valuable commercial arrangement. It is true that there must be but a very few, if any, instances in which gas engines are let on hire, and the reasons are palpable. They are cumbersome, heavy and complicated machines. They occupy considerable space, and cannot conveniently be stored. They consist of many parts which have to be separately conveyed to the place of erection, and the engine then built up. They cannot be sub-divided into a number of small engines for direct-coupling as in the case of electric motors, and their operation requires skilled attendance, and involves comparatively frequent overhauling. The chief reason, however, why gas engines are not more extensively let out on hire is undoubtedly the fact that the necessity for developing business in this direction has not been felt, nor is it likely to be. Even with regard to electric motors, the matter of selling so many more units is not in itself nearly so important as the time of the day during which those units are sold. It is the "day load," however comparatively small, which is such a beneficial factor in the economical production of electricity. In the case of gas, this factor is practically negligible, owing to the immense superiority of storage possibilities. In addition to this, the gas stove is an admirable subsidiary in the business of gas supply, for it is as much more efficient than an electric stove for cooking purposes, as the electric motor is superior to the gas engine for power purposes. Up to such a point, gas and electricity seem to stand pretty much on an equal footing, considered as business enterprises, but in one respect municipalities possess an important privilege in connection with gas undertakings. For the purpose of purchasing gas stoves to let on hire, a local authority has power to borrow money. Up to the present time, the Local Government Board have refused to sanction similar borrowing powers for purchasing electric motors for hire. The reasons have been already given in the first portion of this series of articles, to which, therefore, we refer the reader. As an expedient, however, the necessary capital can be raised by a rate, which could be redeemed when, at some future time, perhaps, borrowing powers may be granted. The advantages of the electric motor have already been fully dealt with in the preceding section, and hence we have now to deal only with the reasons for encouraging the wider and more rapid adoption of electricity generally and electric power in particular. Such reasons will apply equally to motors, arc lamps, and any other piece of apparatus considered useful to the supply. The claims herein set forward have been substantiated by two years of actual experience in connection with the Bradford Corporation Works. The extent to which it has grown will be seen in the tables and references given. Bradford has the advantage of a 3-wire continuous current system of electricity supply, with potentials of 230 volts on each side of the system respectively. Motors can, therefore, be wound for either 230 volts on 460 volts. Arc lamps are arranged to burn 2 or 4 in series or 230 volts, and heating and cooking apparatus is designed for 230 volts.

It is often asked what are the obstacles which stand in the way of the more general adoption of electric motors and electric lighting. These, upon investigation, will be found to be one or more of the following, viz.:—

1. The extreme aversion to innovations which characterises the industrial world, in this country especially.
2. The existence of other motors in good working condition, such as steam, gas, oil and hydraulic engines.
3. The unsuitability of high-periodicity single phase alternating currents of electricity for motive power purposes.
4. The want of capital to lay out in new machinery or apparatus.
5. The want of confidence in the electric motor by the non-technical manufacturer,

The first and last of these are very often overcome by the hire system. The incentive to give a new article or method a trial is generally created when the risk of failure is reduced to a minimum and the pecuniary condition is small. This has been exactly the experience in Bradford, where it was found that after both motors and arc lamps had been let on hire for six months in many cases offers were made to the Corporation by the users to purchase the apparatus outright. It will also be seen by reference to Tables XVI. and XVII. how rapid has been the increase in the demand for motors and arc lamps. The most probable explanation in this case is that the singularly appropriate form of supply has created the demand. The advantages of these particularly efficient classes of apparatus has soon been appreciated, with the result that ordinary business competition has rendered their adoption absolutely necessary.

With regard to the second of the obstacles given above, it is only a question of time, for, of course, existing motors, sooner or later, will have to be replaced. An instance which recently occurred in Bradford may be of interest. A small manufacturer had a breakdown with his gas engine. He applied immediately for an electric motor on hire from the Corporation. He was informed that he could not be supplied, as his workshop was a considerable distance from the Corporation supply mains. At first he threatened to have his gas engine repaired, but found this did not have the desired effect. Shortly afterwards another application was made by the same individual for an electric motor for premises adjacent to the existing mains. He had decided to remove from his original premises and to extend his works for the sake of driving by electricity.

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Where the power to purchase exists the buyer will probably have little or no experience or knowledge of electrical matters to guide him in his purchase. If his means are at all limited he will be tempted to venture on a cheap line, and become the dupe of those who simply make to sell. The solution of these difficulties, which to my mind appears the most satisfactory, because it is the one fraught with the most advantages to all concerned, is that the owners of electricity supply undertakings—whether a public company, municipality, or other local authority—should themselves purchase good reliable motors, &c., and let them out on hire. Antecedently this scheme may appear a sort of parental regime, but it is suited to present circumstances at any rate, and experience proves it to work well.

The following Tables, No. XVI. and XVII., will show the development which has occurred in the adoption of motors and arc lamps respectively since the hire system has been introduced at Bradford :—

Table XVI.—(*Motors*).

Year.	Number of motors supplied from Corporation mains.		Total.	Board of Trade units sold per annum.
	Owned by consumer. (Not on hire.)	Owned by Corporation. (On hire.)		
1895	35	nil	35	35,919
1896	23	7	30	54,972
1897	14	39	53	117,176
*1898	6	46	52	63,820

* Six months only.

From this table it will be seen that the increase in electricity supplied for motive power in 1896, in which year the hire system had been in operation for *two months only*, was 19,053 units; in 1897 the increased sale over 1896 was 52,204 units; and in the present year the increase is likely to be 82,824 units, or a sale of 200,000 units or 41 per cent. over 1897.

Table XVII.—*Arc Lamps*.

Year.	Number of arc lamps supplied from Corporation mains.	
	Owned by consumer. (Not on hire.)	Owned by Corporation. (On hire.)
1889	50	Nil.
1890	44	,,
1891	57	,,
1892	68	,,
1893	61	,,
1894	52	,,
1895	52	,,
1896	74	14
1897	21	66
*1898	12	100
Total.....	491	180

* To Sept. 30, 1898.

The following are the conditions upon which electric motors are let on hire by the Bradford Corporation :—

1. The rent is due in advance on January 1st and July 1st in each year, the first payment to be made at the time of signing the agreement, and before the motor is connected to the Corporation mains. In the event of the accounts for hire or for current becoming overdue the supply will be cut off.

2. The rent will include the conveyance of the motor from the Corporation stores to the premises of the hirer, if such premises are upon the ground floor. If, however, the motor is required in a basement or upon a higher level than the ground floor, the hirer must pay the cost of raising or lowering the motor to such position, as follows :—

½ H.P. and 1 H.P. motors	10s.
2 ,, 3 ,, ...	20s.
4½ ,, 6 ,, ...	30s.
10 H.P. motors	50s.

3. The hirer must also provide suitable foundations (timber being usually sufficient) upon which the motor will be secured by the Corporation. Sizes of foundations for the different sizes of machines may be obtained at the offices.

4. The rent includes supplying and fixing the necessary starting switch, but all other accessories, such as oil, carbon tips, special pulleys, &c., must be paid for by the hirer and obtained from the Corporation stores, Bolton-road. The fortnightly inspection by an authorised inspector (who will be in uniform) will be free of charge.

5. The necessary wiring from the Corporation terminal box to the motor, including cut-outs, main switches, &c., must be provided by the hirer, and will be subject to the same conditions and tests as apply to wiring for the electric light. The meter must in all cases be fixed adjacent to the service terminal boxes.

6. The supply of the motor and the current will also be subject to the Board of Trade Regulations relating to electricity supply, to the Rules and Regulations of the Electricity Department of the Corporation and the Electric Lighting Acts, 1882-1889.

Rent and Particulars.—Motors.

Horse-power.	Speed.	Diameter of pulleys.	Volts.	Amperes.	Rent per annum.
½ B.H.P.	1,700	4in.	230	3	£1 10 0
1 B.H.P.	1,450	4in.	230	5	2 0 0
2 B.H.P.	1,200	5in.	230	9	2 10 0
3 B.H.P.	1,100	5in.	230	12	3 0 0
4½ B.H.P.	1,000	6in.	230	18	4 0 0
6 B.H.P.	800	7in.	230	22	5 0 0
10 B.H.P.	800	10in.	230	36	8 0 0

The following are the conditions under which arc lamps are let out on hire by the Bradford Corporation :—

1. The rent is due in advance on January 1st and July 1st in each year, the first payment to be made at the time of signing the agreement, and before the arc lamps are connected to the Corporation mains. In the event of the accounts for hire or for current becoming overdue, the supply will be cut off.

2. The rent will include fixing the lamps in the premises of the hirer. The hirer must provide and fix in position the necessary hooks or brackets on which the lamps are to be placed, and a sufficient length of electric cable must be left at the brackets to enable the lamps to be connected up.

3. The lamps will be supplied complete with globes and resistances, and will be left in satisfactory working order. In the event of any globe being broken, or any terminal or portion of the lamp becoming burnt, the hirer must pay the cost of replacing the defective part. These defects and breakages must be remedied with the least possible delay.

4. The rent includes periodical inspection by an inspector in uniform, whose duty it is to report upon the condition of the lamps and installation.

5. A separate meter must be placed in the arc light circuit, in the event of there being also incandescent lamps in the same installation.

6. The necessary wiring from the Corporation terminal box to the arc lamps, including cut-outs, main switches, &c., must be provided by the hirer, and will be subject to the same conditions and tests as apply to the other installation wiring.

The supply of the arc lamps and the current will also be subject to the Board of Trade Regulations relating to electricity supply; to the rules and regulations of the Electricity Department of the Corporation; and the Electric Lighting Acts of 1882-9.

Rent and Particulars.—Arc Lamps.

Type.	No. in series.	Amp.	Approx. c.p. of each lamp	Rent per annum.	Total cost per hour for current.
Enc. arc (single carbon)	2	5-6	500	£1 1 0 each	5d.
Open arc (double carbon)	2	5-6	500	1 1 0 ,,	5d.
,, ,,	2	10-12	1,000	1 1 0 ,,	10d.
Open arc (single carbon)	4	5-6	500	0 10 6 ,,	5d.
,, ,,	4	10-12	1,000	0 10 0 ,,	10d.

The enclosed type arc lamp requires re-carboning once every 100 hours.

Prices and Sizes of Carbons.

12 millimetres and	12 millimetres (for enclosed arcs)	3d. per pair.
18 do.	11 do.	1⅜d. ,,
12 do.	7 do.	1d. ,,

(These carbons are of the best quality only; inferior carbons are likely to give dissatisfaction and trouble.)

Basis of Charge.—The basis upon which the annual charge for hire should be made is arrived at by adding all the charges consequent upon the capital outlay. These are (1) Interest; (2) Sinking Fund; (3) Depreciation and Repairs. The interest may be taken as an average of 3 per cent. per annum. The Sinking Fund will be variable according to the period over which the capital is borrowed. Usually this is 25 years, and the amortisation is practically equivalent to another 3 per cent. per annum. The rate for depreciation and repairs will depend upon the nature of the apparatus on loan. For motors and arc lamps, the "life" may be reckoned as ten years, and the repairs at the rate of 4 per cent. per annum. This gives a total rate for depreciation, &c., of 14 per cent. per annum. Hence the total charge should be :—

Interest	3	per cent. per annum.
Sinking Fund.....	3	,, ,,
Depreciation, &c.	14	,, ,,
Total	20	,, ,,

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Therefore, 20 per cent. of the capital outlay should be the annual rental charge. In Bradford, as will be seen in the "Rent and Particulars" already given, only 10 per cent. is charged. The 10 per cent. for actual depreciation has been taken out of the annual rental and allowed for in the price charged per unit. By this arrangement it was considered that greater inducement would be offered to adopt the apparatus on hire. This department may also with advantage undertake the sale of such articles as are required for the use and operation of the apparatus on hire. For motors, oil, carbon brushes, &c., should be sold, and for arc lamps carbons and globes.

The following rules, printed on stout card or strawboard, should be supplied with each motor and hung up in a convenient place adjacent to it:—

Directions to be Observed to Ensure the Safe and Satisfactory Working of Electric Motors.

1. The motor must never be started with the load on.
2. The motor must always be started and stopped by the starting switch. The main switches may be left *open* when the premises are not occupied, but they must always be *closed* before starting the motor.
3. If the starting switch is in order the speed of the motor will be slow on first closing the circuit, but full speed will be attained after 15 to 30 seconds. It must not be used until full speed has been attained.
4. If the motor appears to start up too rapidly notice should at once be sent to the electricity office, Town Hall, as the motor may be damaged if the defect is not remedied.
5. If the motor starts up too rapidly, or with the load on, the main fuse will probably be blown.
6. Before starting see that the oiling arrangements are satisfactory; oil should not be allowed to run on the bearings when the premises are closed.
7. Suitable oil may be obtained at the stores, Bolton-road Electricity Works. Price 2s. per gallon.
8. The brushes (*i.e.*, the carbon contacts on the commutator) must not be lifted under any circumstances. If the carbon has worn down too low, which may be ascertained by the loud, scratching noise which the holders make on the commutator, new carbons should be at once put in and the attention of the inspector called to the matter, or notice sent to the Town Hall. Neglect of the above will cause scoring of the commutator and will damage the machine.
9. The inspector will examine the motor once a fortnight. You are requested to allow him to start and stop the motor and to make what examination he thinks necessary.
10. The inspector will be in uniform, and will also carry a ticket of authority to inspect.
11. The motor should not be left running when not in use; observance of this will tend towards considerable economy.
12. Irresponsible persons, or those unacquainted with electric motors, should not be permitted to do anything whatever in the nature of a repair or adjustment under any circumstances. Attention will always be given to irregularities on notification at the office at the Town Hall or in writing.

(To be concluded).

IMPROVEMENTS IN MAGNETIC SPACE TELEGRAPHY.*

BY DR. OLIVER LODGE, F.R.S.

PART I.—*First Portion.*

The general principles of electric space telegraphy—or wireless telegraphy, as it seems to wish to be called—are fairly old; and without going into the history of the subject, with which I need not trouble you, since it has been admirably summarised by Prof. Silvanus Thompson in his lecture to the Society of Arts, I may recapitulate the three chief methods that have been tried. First and oldest the earth current or leakage method, wherein a powerful current conveyed to the earth or sea by two well-separated electrodes causes a slight difference of potential between two other well-separated tapping electrodes at a distance, and thereby produced a feeble current through a joining wire, which can be detected telephonically or galvanometrically, or in any other convenient and known way. I am under the impression that this utilisation of earth conduction for the purpose of conveying messages has played a greater part in the past, and is perhaps destined to play a greater part in the future, than most people suspect. When, for instance, as in Mr. Langdon Davies's experience, phonoporic currents have been heard in very distant telephone trunk lines, it is difficult to be sure how much of the effect is due to a true induction from wire to wire, and how much of it is due to conduction—not only conduction through the soil from earth-plate to earth-plate, but conduction also through metals, whether gas pipes or overhead wires or other conductors arranged for other purposes. Whenever an open circuit is employed, with earthed terminals, conduction is liable to assist induction; and this may very likely be regarded as an advantage. It may also be to some extent a disadvantage, owing to its resulting in the mixing of messages; it may, in fact, contribute to ordinary telephonic cross-talk.

The second method that has been tried for purposive space telegraphy is the method by magnetic induction between two insulated line wires stretched parallel to one another along opposite coasts. This method, as is well known, has been tried under the auspices of the British Post Office, and is known as Mr. Preece's method. It is, I think I am right in saying, the only system in actual regular work; for near Cardiff, between Lavernock Fort and the neighbouring fort on the island of Flat Holm, I have myself seen it at work, and have admired the ingenious system of "call" devised by Mr. Evershed and there employed. I desire to say that when I gave a short preliminary note to the British Association at Bristol this year, on a "call" that I had invented, I was unaware of Mr. Evershed's work in the same direction. He has undoubtedly achieved the result there aimed at, though with the expenditure of a good deal of power; and had I known, I should certainly have referred to it in my communication at Bristol. But after the Bristol meeting Mr. Preece gave me permission to visit Lavernock, and I went in company with Mr. Partridge, the telegraphic superintendent at Cardiff, to whom also I am obliged.

In the third system of space telegraphy—that by Hertz waves—the public owes its knowledge and interest also to Mr. Preece; for, had Mr. Preece not taken up the subject, very few persons would, in all probability, have heard of Hertz waves and Branly detectors and coherers to this day. As it is, owing to Mr. Preece's great influence and power of lecturing, this third and most recent method has become the best known of all; and, indeed, Italy is generally credited with the whole discovery. I do not intend to refer to this interesting method again to night, but before leaving it, it may conduce to clearness if I explain wherein the Hertz-wave method, at which I have also worked in conjunction with Dr. Alexander Muirhead, differs from the older magnetic inductive method of Mr. Preece, Willoughby Smith, and others.

Every alternation in a suitable medium produces waves in one sense, but the intensity of those waves is immensely dependent on the rapidity of the alternation. A rapid pulsation of air, in and out of a hollow vessel like a resonator, may cause an extremely loud sound; a slow pulsation, of the same or even of much greater amplitude, would cause no perceptible effect, beyond an alternate rise and fall of a sensitive barometer. Again, a reed vibrating slightly but quickly is audible at a distance, while a fan vibrating strongly but slowly is not audible at all. The waves emitted by the one are strong, by the other are exceedingly weak. A magnetic alternation of sufficient rapidity induces an alternating electrostatic field, and is, therefore, accompanied with emission of energy. A slow magnetic alternation is practically unaccompanied by any electrostatic effects, and so, practically, all the energy emitted at each pulsation returns again to the source. For a progressive wave must necessarily have half its energy static, and half of it kinetic energy; whereas in ordinary current induction all the energy is kinetic.

Interrupting the explanation for a moment to touch on a practical point: It might seem, from what we have so far said, as if all the advantages lay with the rapid vibration or wave method. But when really large distances are contemplated, or when obstacles intervene, its advantages diminish and ultimately disappear; for slow magnetic pulsations are independent of all obstacles, except actual iron, if they are slow enough, and are only slightly weakened by conductors, whereas rapid pulsations or true waves are stopped by conductors, and are greatly affected by obstacles. It is probable, as I have hinted above, that earth-conduction plays a considerable part in some of the coherer signalling which is supposed to occur by means of waves in space; and in all cases it is a possibility to be constantly borne in mind. The coherer is a detector of electric jerks transmitted by the earth or by uninsulated conductors such as gas pipes, and the response of a coherer is no conclusive demonstration of the receipt of actual Hertz waves.

To detect the radiation of energy, something capable of responding to waves, such as an ear, an eye, or a coherer is appropriate; to detect the fluctuations of pressure or of magnetic field, something akin to a barometer or magnetometer would seem to be appropriate; but, inasmuch as these instruments only indicate the state of things at their immediate locality, another device can be employed which shall integrate the effect over a considerable area and therefore be much more sensitive. Such a device is afforded in the case of magnetism by Faraday's current-induction. A circuit connected with any electric detector, such as a telephone, may surround a large area and give an induced current depending on the variation in the total lines of force passing through the entire area.

In the Lavernock signals, considering them as due to wire induction, the inducing and induced areas are both long narrow strips in a vertical plane, with their long sides horizontal and their faces parallel; each being constituted by the space between a long over

* Paper read at the Institution of Electrical Engineers, Dec. 8, 1898.

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head line on posts and the return earth—or, rather, sea—circuit. But in some interesting experiments made by Mr. Stevenson near Edinburgh he employed a horizontal coil of wire approximately circular—in one case utilising some farm fencing, I believe—and by means of a battery and key at one station was able to hear Morse signals in a telephone in another like coil half a mile away. This certainly resulted from pure induction, and it may be considered to represent the closest approach hitherto made to the method I have to bring forward to-night.

Unfortunately, Mr. Stevenson made a slight error in the theory, and perhaps for that reason did not continue the attempt over larger distances. He says that with a given number of ampere-turns the hearing distance increases with the square root of the diameter of one of the coils, or with the simple diameter of both coils, thus making it necessary to double the size, quadruple the area, of each coil if the distance is to be doubled; and, since he used 1,600 yards of wire in each coil to signal half a mile, he may have considered the cost prohibitive for any really great distances, as, indeed, it is, with mere unaided coil induction. But, in truth, the law of distance is not the square root of the diameter, but the two-thirds power, *with a given primary current;* and so doubling the circumference of each coil will enable signalling over more than double the distance, if other things can be kept the same. It is true, however, that for such magnification the thickness of the wire must be magnified likewise, or else more power will be consumed in the enlarged coil; and this consideration, together with others shortly to be stated, does speedily make the cost prohibitive, unless some fresh revolutionary devices are employed.

The devices I have to lay before you to-night contain nothing new in principle—*i.e.*, they involve no discovery—but, inasmuch as they make practical over big distances what has been actually successful over small distances, I venture to attach some importance to them, and think them worthy of your attention. First I have to explain my system of magnetic induction telegraphy, and next the extra sensitive receiving instrument which may be employed with it.

The chief feature of my magnetic system is the outcome of an electric resonance experiment which I described eight years ago (see *Nature*, Vol. XLI., p. 368), viz., the experiment of the syntonic Leyden jars. The term "resonance" is generally and properly understood as having an acoustic significance, and where no reference to sound is intended I advocate the use of the more general term "syntony" to denote the sympathetic response between two vibrators attuned to the same "note," or more generally to the same frequency of vibration, whether that vibrator be mechanical or electric or magnetic. Two similar Leyden jars connected to similar circuits are, or may be, thus syntonised, and any electric oscillation in one causes a feebler electric oscillation in the other; the medium of communication in this case being the alternating magnetic field between the two circuits, the lines of force of the one circuit penetrate the other, and by their fluctuation cause an alternating electromotive force of feeble intensity. In a distant circuit *not* containing a Leyden jar, and therefore not susceptible of any tuning, because it has no natural frequency of vibration, nothing can be perceived; but when a Leyden jar exists in a circuit, that circuit has at once a natural frequency of vibration which may be syntonised with that of the emitting circuit, and in that case the intensity of the reverberating induced electromotive force may rise as high as several thousand volts, and cause a spark over a very perceptible air-gap.

Now, for telegraphic purposes, I replace the Leyden jar by a condenser of considerable capacity, and the circuit of the jar becomes a large horizontal coil of wire—it may be of one turn or it may be of more; and the frequency of vibration, instead of being the million or so per second appropriate to Leyden jars, becomes the thousand or even hundred per second appropriate to sound. Hence, instead of using a spark gap to detect the disturbance, I use either a coherer or else a telephone as a shunt to the receiving condenser. Further, although the momentary oscillation of a spark constitutes a possible sender, I generally employ some form of alternating or intermitting machine of considerable power as the sending appliance, and carve its fluctuating current into long and short spells, as everyone else working at the subject has done.*

I have at my house a cable a quarter of a mile long altogether, enclosing an elongated rectangle, say, 150 × 30 square yards, and with that I can hear all that goes on in the neighbouring telephone wires, and can even answer back with a suitable microphonic transmitter; but there being, I suppose, no phonopore in the neighbourhood, I hear no stray musical note; the only musical note I hear is the one belonging to the desired signals when they are being sent to me from an equal length of cable round an equal but squarer contour at the College about two miles away, or 2·5 kilometres in a direct line.

I may say that, although the Leyden jar or condenser constitutes a leading feature of my system, I have occasionally, as an experiment, dispensed with it, and tried what could be done with the area-enclosing circuits alone. But under those conditions, with the power I had at my disposal, I was not usually able to hear anything. I was using a small low-frequency dynamo of the Pyke and Harris pattern, and at the sending end had a current of 10 or 12 amperes going round the circuit, sometimes as much as 25 amperes. Under these circumstances, on the ordinary National Telephone Co.'s telephones, the sound could be heard many miles away—away over in Cheshire, towards the Dee, the signals could be clearly heard, while close to the college the subscribers, unfortunately, became rampant; but through empty space the signals only became audible at a distance of two miles, when a condenser was used and the circuit properly attuned. I am speaking now of the early trials, when no suitable receiving telephone was employed, but only the first to hand. The cable, bought for the purpose of the trial, was described as anti-inductive telephone cable (not exactly the variety required), and it was very badly insulated, having been bought as little more than old materials; but still it might, perhaps, have been expected to do better. Directly the circuits were syntonised, however, there was no difficulty in hearing the note and the signals. I should say that I did not work with the fundamental frequency of the dynamo—128 per second, or thereabouts—but with the third harmonic, which is fairly strong in these Pyke and Harris alternators, of frequency 384. Such a note is pleasanter to listen to than a deep bass, the ear is far more sensitive to it; and, moreover, to attune the circuit to the lower frequency would have entailed a prodigious capacity. As it was I used 28 microfarads, and had to insert the thick wire of a hedgehog transformer in the circuit too, in order to get the induced circuit frequency as low as 384 with the quarter-mile length of cable once round.

I generally used a couple of Ader telephones in series, each of about 70 ohms resistance, and connected them thus as a shunt to the receiving condenser. The resistance of the receiving cable itself was only 0·07 ohm (it consisted of 100 No. 18 wires all in parallel), so that if the telephone had been in series with it a very low resistance winding would have to be employed, and in the early trials I did not happen to have such a telephone handy. I did, however, use a Western Electric loud-speaking telephone of 2 ohms resistance occasionally. A transformer, of course, was sometimes used, but it wastes power. Besides, the low resistance of a transformer winding is apt to be rather illusory when its higher resistance secondary is closed.

At the sending end also condensers were employed, in series with dynamo and coil, in order to strengthen by resonance the third harmonic at the expense of the fundamental. The cable there was about 400 yards of well-insulated telephone cable, consisting virtually of 20 strands of separately insulated No. 16 wire, slung on poles round a squarish contour; but, unfortunately, it was again sheathed in lead so as to be nominally "anti-inductive." I found it best usually to join these 20 wires in five series of four strands each; and the current in each strand being then, say, 6 amperes, I call the whole current in the cable 24 amperes.

The receiving cable I could also at first employ in separate strands, for its 100 wires were supposed to be insulated with thin india-rubber. The first time I heard the note I had 19 of these strands in series without a condenser, constituting a coil of 19 turns, connected to an Ader telephone. Since then, however, the insulation has so much broken down that I am constrained to use all the wires in parallel, which for many purposes is not so convenient.

Advantage of Syntony.

Now proceed to consider more particularly the elementary theory of magnetic induction telegraphy between two large distant horizontal coils, first without, then with condensers; taking the case, however, of an alternating current, and not the simple make-and-break battery arrangement employed by Mr. Stevenson, which obeys somewhat different laws.

The first proposition I wish to maintain is that no unaided simple induction process can work satisfactorily over really big distances unless an altogether prohibitive amount of wire or an extravagant amount of power is employed. This proposition I prove by considering the strength of current induced in the distant circuit. Let a and b be the radii of the two coils, considered circular, n and m their turns of wire, and r their distance apart from centre to centre, this last being considerable: then the mutual induction coefficient—*i.e.*, the total lines of force passing through one coil due to unit current in the other—is

$$M = \frac{n\pi a^2 m\pi b^2}{r^3}.$$

The resistance is

$$\frac{2n\pi a}{\pi c^2}\rho \text{ for one, and } \frac{2mb}{a^2}\rho \text{ for the other.}$$

* Note.—In the original Paper a detailed quotation of Mr. Stevenson's experiment was here quoted, under the belief that signalling to a lighthouse at the Shetlands had been tried; but this was a mistake. The experiment was only a preliminary one near Edinburgh, and does not appear to have satisfied the P.O. officials who helped to conduct it.—O. J. L.

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The self-induction is

$$4\pi\mu n^2 a\left(\log\frac{8a}{c}-2\right);$$

or, for present approximation—accurate if one coil is like the other magnified—i.e., if they are really "similar coils"—the self-inductions are

$$kn^2a \text{ and } km^2b.$$

Now, if E is the electromotive amplitude maintained in the primary, the current-amplitude induced in the secondary is

$$x=\frac{p\mathrm{ME}}{\mathrm{J_1J_2}},$$

when J_1 and J_2 are the impedances.

For rapid alternations and good stout wire the value of J is not much bigger than p L; hence the most favourable case for the mere pair of circuits without condensers gives

$$\frac{x}{\mathrm{E}}=\frac{\mathrm{M}}{p\mathrm{L_1L_2}}=\frac{nm\pi^2a^2b^3}{pn^2m^2k^2ab\rho^3},$$

which is, therefore, the "virtual conductance" of the whole system.

The first and most important thing we observe here is that p occurs in the denominator, so that high frequency is actually disadvantageous—other things being equal, which they usually are not, because high tones are best to listen to. The next thing to notice is that number of turns of wire occurs in the denominator, so that a single contour is much better than a coil of many turns; except in so far as many turns help to emphasise self-induction at the expense of resistance, and so to bring about the above "most favourable" conditions where resistance can be neglected. Lastly, we observe that the linear dimensions of each coil occurs only once in the numerator, and that their product is, therefore, incompetent to cancel the cube of the distance in the denominator, when both wire and distance are magnified in the same proportion, and when both are big. Observe, we are not here taking the case of a *given current* in the primary, but the more practical case of a given E M.F.

Moreover, we see that extra thickness of wire gives no advantage: if the wire is thin, the induced current will be less than the above; but no increase of thickness can make it greater than the value of x now calculated, viz.:

$$x=\frac{\pi^2ab\mathrm{E}}{k^2pmn\rho^3}.$$

Hence I say that no simple induction system can work over really big distances, unless an altogether prohibitive amount of wire or an extravagant amount of power is employed. If for a certain distance a total length of wire is just sufficient, it is best disposed in equal contours of one turn each; and the ratio between the induced secondary current and the applied primary E.M.F., without allowing anything for the impedance of the receiving telephone, is then

$$\frac{l^2}{16k^2p\rho^3}. \quad \ldots\ldots\ldots \quad (1)$$

To signal double the distance $2\sqrt{2}$ times the length of wire is necessary; and to signal 10 times the distance the necessary length of wire is 32-fold, its thickness being increased at the same time so as to keep resistance down.

Introduction of Condensers.—But now, directly condensers are introduced both into sending and receiving circuits, and are adjusted until each circuit is attuned to the applied frequency, the conditions are greatly altered. When the correct note is reached all self-induction is abolished, and the impedance becomes simple resistance. Hence in this case the induced current is

$$y=\frac{p\mathrm{ME}}{\mathrm{R_1R_2}},$$

or

$$\frac{y}{\mathrm{E}}=\frac{pab\pi^2c^2d^2}{4\rho^2r^3}.$$

The most important thing to notice here is that p occurs in the numerator, so that high frequency is specially advantageous. The number of turns is immaterial, instead of being objectionable, as in the former case, and this fact is often convenient for tuning. And a great gain results from increasing the thickness of the wire, whenever a big distance is to be attempted.

If the whole bulk of wire employed is V, and if it be distributed equally between the two stations, in a single turn at each, the ratio between the secondary induced current and the applied primary E.M.F., again without allowing for the resistance of the receiving telephone (its "reactance" has been already neutralised if it is connected in series), is in this case

$$\frac{p\mathrm{V}^2}{64\rho^2r^3}. \quad \ldots\ldots\ldots \quad (2)$$

Comparing this with (1), the chief difference consists in the position of p; but this is a tremendous difference—representing something like a million-fold factor.

To take a numerical example in illustration of the two cases. Let the applied E.M.F. be 100 volts, the frequency 400 per second, the total length of wire, say, 2 kilometres, and its thickness 2 centimetres (about 5 tons of copper altogether): then

$k=125$ about, $p=2{,}500$, and $\rho=1{,}600$ sq. c.m. per second.

So at a distance of 100 kilometres the maximum received current possible is, by simple conduction without condensers,

$$\frac{4\times10^{10}\times10^{10}}{16\times(125)^2\times2{,}500\times10^{21}} \text{ C.G.S. units,}$$

or 0·0064 *micro*ampere; which is quite insufficient to affect a telephone. Whereas with proper condensers the current might be

$$\frac{2{,}500\times(6\times10^5)^2\times10^{10}}{64\times(1{,}600)^2\times10^{21}} \text{ C.G.S.}$$

or 0·5 *milli*ampere, which is quite a strong telephonic current.

(To be continued.)

TELEGRAPHY BY MEANS OF ULTRA-VIOLET LIGHT.*

BY PROF. K. ZICKLER.

In my previous detailed discussion of this subject,† I concluded by promising to make further experiments over greater distances so soon as I had a metallic projector at my disposal. By the kindness of Messrs. Schuckert and Co. and their manager, Dr. F. Nerz, and with the assistance of their Mr. A. Siegert, I have been enabled to carry out my intention. A parabolic reflector, made of a German-silver alloy, was used as transmitter. Its diameter was 800mm., and its focal length 200mm. It was fitted with a regulating arc lamp requiring normally 60 amperes at 47 volts, and it was placed with its carbons horizontal and in the axis of the mirror, so that only the rays reflected from the mirror were used, and not those coming directly from the carbons. As in my former experiments, I used a receiver in which the electrodes were 5mm. apart, and the rarefaction of the air could be varied and measured. For convenience in the experiments, the glass shutter for screening off the ultra-violet rays was placed at the receiving end instead of at the transmitting end, the object of the experiment being merely to determine if the rays emanating from the projector were sufficient to start the sparks in the receiver.

The experiments were carried out on October 5th and 6th. In tests made on the first day across a distance of 60 metres the rays caused sparks to pass in the receiver without any rarefaction of the air, and without the employment of any means to concentrate the active rays upon the cathode. This pointed to the possibility of overcoming far greater distances now that the transmitter was of greater power. The distance was, therefore, increased to 450 metres. The same quartz lens was used as in former experiments, its diameter being 4cm. and its focal length 15cm. With an air-pressure corresponding to 340mm. of mercury sparks occurred on the removal of the glass plate. This experiment was made with the sun shining. The second day's experiments were made across a distance of 1·3km., when, with the same lens, but a pressure of 200mm., satisfactory results were obtained.

Thus the use of a reflector has increased the distance over which signals could be transmitted 6·5 times. It may or may not be that the use of a larger arc has also assisted, for in my former experiments better results were obtained with a long arc and smaller current than with a short arc and larger current.

I intend to make further experiments with projectors made of a material more suitable for the reflection of ultra-violet rays; the one used in these experiments was of a copper-nickel alloy, and not expressly prepared for the purpose. I will also experiment with larger quartz lenses, and with gases other than air in the receiver.

Wireless Telegraphy.—The *Standard's* Vienna correspondent announces that experiments were made a few days ago at Pola, and are shortly to be repeated, with an improvement of Marconi's system of wireless telegraphy. It is, he says, already possible to determine the presence and course of a vessel distant from six to eight English miles. The improvement is the invention of a young student at the Buda Pesth Polytechnic, named Bela Schefer. The next trials will be made in the presence of Admiral Baron Spaun and several naval engineers. No further details are yet to hand.

* Abstract of an article in the *Elektrotechnische Zeitschrift* of Dec. 8.

† *Elektrotechnische Zeitschrift*, 1898, Nos. 28 and 29; *The Electrician*, Vol. XLI., p. 720.

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ELECTRIC POWER TRANSMISSION AT A SWEETMEAT FACTORY.

Messrs. Geipel and Lange have forwarded us the following particulars of an important installation of alternate-current electric motors for driving the machinery at Messrs. Fuller's new sweetmeat factory at Hammersmith :—

There are in all 14 motors, each of which, with one or two exceptions, drives its own machine. The motors vary in horse-power from 7 H.P. down to ¼ H.P. They are operated by current supplied by the Hammersmith Vestry at a pressure of 110 volts, alternating, with a frequency of 50, and are of the Brown-Boveri single-phase type. The smaller motors are started by means of a resistance, while for the larger sizes the usual condenser is employed. The ease with which the motors can be started by the various attendants is a special feature of the whole installation. It may be noted, for example, that for working the lift there is in use a 2 H.P. motor, which starts up readily with the whole of the belting and gearing thrown on, and yet the starting current does not exceed the full-load current. It has also been found that at times the load on this motor has been double of that for which it was designed, though there has been no breaking out of step, or any damage whatever to the motor. This adaptability of the alternate-current motor to overloading is a feature which is frequently lost sight of, and in this respect it affords a favourable comparison with the continuous-current motor, in which overloading means sparking and wear and tear of the brushes and commutator. It has been noticed in several cases that the motors have been bespattered with sticky sugar and chocolate ; this does not appear to affect their working in the slightest. On the other hand, had they been fitted with exposed commutators, as in the continuous-current system, serious trouble might have been the consequence. The curves in Fig. 1 give details as to the efficiency, drop in speed, power factor, &c., of one of the motors.

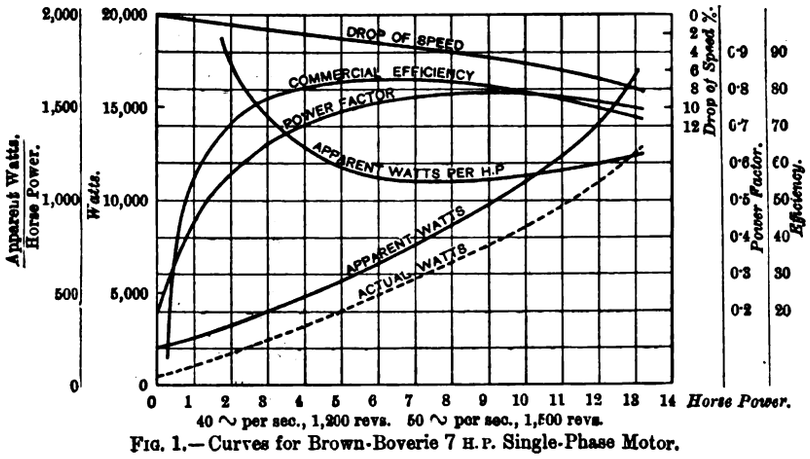

FIG. 1.—Curves for Brown-Boverie 7 H.P. Single-Phase Motor.

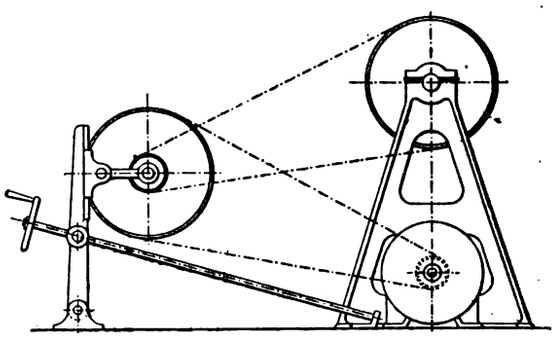

FIG. 2.—Geipel and Lange's Patent Gear for Electric Motors

The speed of the factory machinery being slow, it was found necessary to adopt some form of speed-reducing gear. The three following alternatives were considered :—Spur gearing, worm gearing, and belting. The first two were objected to, chiefly owing to the difficulty of designing special gearing for each machine, the speed of these differing. It was, therefore, decided to adopt belting. This involved the use of a countershaft, and as it was specially desired to obviate the unsightliness and trouble due to countershafts fixed on ceilings, resource was had to a special gear patented by Messrs. Geipel and Lange, which has for its object the transmission of power from the motor to the machine by exceedingly short belts. It will be seen from the sketch of the gear (Fig. 2) that it consists of a swivelling countershaft which can be adjusted to give the exact amount of tension required for the two belts by means of a hand-wheel. It will be seen that by turning the hand-wheel in one direction, the standard is inclined forward, thus loosening the belts and permitting the motor to start light. When the motor is started, the hand-wheel is turned in the reverse direction, thus moving the standard backwards and tightening the belts. This operation is necessary only when starting up on full load. The gearing is compact, and takes up but little floor space, and it obviates the necessity of sliding foundations. It may be interesting to note that no trouble whatever has been experienced by the employees either in operating this gear or in starting and stopping the motors.

It was decided to adopt a separate motor for each machine for several reasons :—

1st. Because it was important that the very best light should be thrown on to the work, and this is not possible with overhead gearing and belting.

2nd. Because the machines are scattered, and are in many cases a long distance apart, which, under another arrangement, would have necessitated running long lines of shafting, with the consequent serious and continual loss of power therein.

The suitability of the separate motor system in this particular case is proved, for it is found that most of the motors are standing for a very large fraction of the whole time, and consequently no power is being lost, as would be the case if a large motor were employed for driving the whole of the machines by long lines of shafting.

The factory is lighted throughout by electricity, there being about 260 lights. The whole of the wiring is on the Andrews' Safety Concentric system, the lamps being arranged in small groups, while each motor has its own circuit direct from the main switchboard, on which are grouped all of the fuses, so that there are no fuses whatever scattered throughout the building.

The whole of the work has been carried out by Messrs. Geipel and Lange, who are agents for Messrs. Thos. Richardson and Sons, while Messrs. Fuller have been advised throughout by their consulting engineer, Mr. A. H. Howard.

CORRESPONDENCE.

THE BRIGHTON BREAKDOWN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : I have to thank both Dr. Fleming and Mr. Philip for the explanations which they have been good enough to give of the results following the short circuit of a shunt-wound dynamo, but I am sorry that I cannot fully agree with either of them as to the proposed remedies. Dr. Fleming seems to have overlooked the fact that the first case mentioned in my previous letter was one in which separate shunt-wound exciters were used, and that the result of a severe short circuit was that both dynamo field and exciter field were either demagnetised or reversed.

It would appear to be beyond doubt that the primary effect of a sudden heavy increase of current in the armature tends in the first place to demagnetise or overpower the field, and in the second place, by the withdrawal of lines of force from the field, to induce a current in that field, in the same direction as the normal, but, since the field is now a source of E.M.F., of opposite terminal polarity. Fig. 1 is a diagram, based upon Dr. Fleming's, but extended to show the circuits of a separate exciter, with the direction of the currents marked by arrows. Fig. 2 shows the circuits, as I read them, during an external short circuit, and which should, of course, be taken as superimposed by the oscillating currents which Dr. Fleming mentions. It will be seen that, while the momentary induced current tends to strengthen the dynamo field, it is reversing that of the exciter field, the exciter being in this case shunt-wound. Following the rupture of the short circuit, we have an induced current in the dynamo field, reversed in direction from the normal. This induced current, other things apart, tends to remagnetise

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the exciter field in the original direction, but reversing the direction of current in its armature (*see* Fig. 3). With series-wound exciters this last induced current would reversely magnetise the field, and also reverse the direction of current in its armature (Fig. 4).

This is my difficulty—trying to find a remedy for the effect, of induced field current by elongating the inductive chain, by increasing the number of its links. To me it seems that, if there is any remedy, it is to be found by destroying these links, not adding to them. Obviously, if this be the cases the source of E.M.F. for the excitation of our dynamo fields must be of a non-magnetic character. To couple these fields to the 'bus bars is simply to link them together; to couple them to one set of storage cells is also to link them together. Therefore, I would suggest, with all deference, that it would be better if these fields were separately connected to independent non-magnetic sources of E.M.F. That this would not prevent the demagnetisation, or even reversal momentarily, of the fields I am quite prepared to admit, but the power of recovery given and the raising of the current value necessary for demagnetisation would, I think, practically effect a remedy. As to whethe: such a method will be adopted in central stations I have very little hope. For my own part I am prepared to leave things as they are and risk it!

Mr. Philip asks as to whether a case of the generation of a pulsating current by an armature earth is one of actual observation or not. About three years ago such a case did happen,

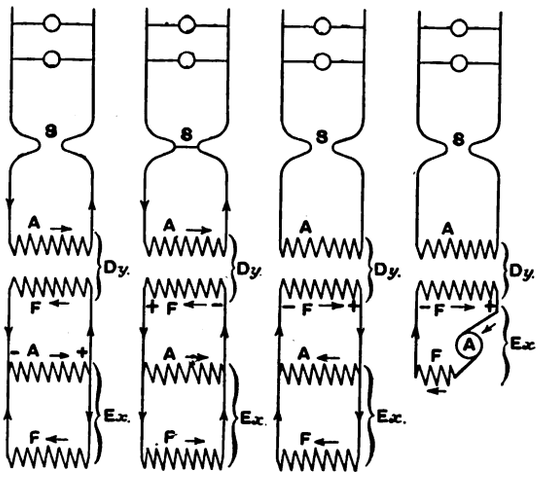

Fig. 1. Fig. 2. Fig. 3. Fig. 4.

and at the Brighton Works. My attention was called to a very visible pulsation in the lighting of the lamps connected to the supply, and also to the fact that the neutral earthing fuse had blown. Parenthetically, I may say that the earthing of the neutral was effected in the following manner:—A connection was made to the neutral main through a lamp to earth, the terminals of the lamp being short-circuited by a fuse of about 20 amperes capacity. It will be seen that an earth on either of the outer poles would blow this fuse and light the lamp. I immediately went to the engine room and saw that the pulsation, which was visible in the ordinary lamps, was much more marked in this earth signal lamp. A consideration of the conditions will show that the branch containing this lamp was being subjected to an alternating current of low periodicity. With eye to the lamp and ear to the engines, I traversed the engine room until I found the engine whose speed synchronised with the pulsation of light in the lamp. It was then withdrawn from the circuit and, on testing, an earth was found in the armature. I may say that the minimum cut-out did not act in this instance.

I am afraid that Mr. Philip's suggestion as to insulating the dynamo is not a very feasible one, certainly not with direct-driven sets such as are now almost invariably used.—Yours, &c.,

Robt. C. Quin.

Blackpool, Dec. 12, 1898.

LEGAL INTELLIGENCE.

Savory v. Edward Lloyd (Limited).

(*Continued from p. 240, Dec. 9*).

The further hearing of this action was continued before Mr. Justice Day and a special jury on Friday last.

Mr. J. B. BRAITHWAITE, Jun., re-examined by Sir E. Clarke, said: In handing over the contract with the Commissioners of Sewers the Brush Company obtained a contract to do such works for the new City of London Company as were within its scope. The Pioneer Company paid the Brush Company £21,750 for works completed. It was impossible to bring out a company with the capital of the City of London Electric Lighting Co. without large preliminary expenses. The difficulty of placing capital at that time was very great. His firm and another each found £50,000 towards the required capital to enable the company to go to allotment.

Alderman F. GREEN said that in Feb., 1890, he was elected chairman of the Commission of Sewers. The contract of May, 1890, was considered to be in the best interests of the ratepayers. Plaintiff had nothing to do with the matter. There was no influence brought to bear upon the Commissioners with regard to the transfer of the Brush Company's contract. He first heard that plaintiff had made a profit in connection with the formation of the Pioneer Company in court the previous day.

Mr. W. H. PANNELL said he had been a member of the Corporation of the City of London since 1874. His firm were employed to audit the accounts of a great many companies, including the Pioneer and City of London Companies. He had, apart from that, no interest in any of the companies of any kind. His only interest was that the City of London should be well lighted.

Mr. W. BROWN, a member of the Commission of Sewers, said that he sold 20 shares in the Pioneer Company as soon as he became a Commissioner at an actual profit of £32. Until he had disposed of them he took no active part in the proceedings of the Commission.

Mr. J. L. SAYER, member of the Corporation and chairman of the Streets committee in 1891, also said he considered the contracts entered into by the Commission of Sewers were advantageous to the ratepayers. As a member of the Streets committee he was a party to the making of the contracts. He had taken an immense amount of trouble in the matter of the electric lighting. The contract for the public electric lighting was extremely favourable to the authorities, although the private lighting might not be quite so cheap.

Mr. MacGEAGH said he was a member of the Commission of Sewers. The plaintiff in this action had nothing to do with electric lighting. He, personally, held some shares in the City of London Company, but did not vote with regard to electric lighting while he held a single Pioneer share.

Mr. C. E. SMITH, a member of the Commission of Sewers and of the Streets committee in 1891, said the plaintiff had never communicated with him in any way with regard to electric lighting. He applied for 25 shares in the City of London Company, and was alloted five only. He only held them a week. He could not say that he quite approved of the then Lord Mayor having made a profit on his electric lighting shares.

This closed the plaintiff's case.

Mr. ROBERT DONALD was then called. He said he was the editor of *London* and the writer of the article complained of. He saw the circular of Mr. Brooke-Hitching and the report of the E'ectric and General Investment Co. He then made independent inquiries and wrote the article. He had no personal knowledge of or ill-will towards the plaintiff. By "monopolistic rights" he meant the Pioneer Company, which extinguished competition in 1891. That monopoly was created by several members of the Corporation. The Streets committee managed the matter. In 1890 only one person named in the article was on that committee. In 1891 Messrs. Walter Brown, Smith and Pannell were on the committee. Witness did not impute dishonesty to these three gentlemen. He imputed wrong, not personal dishonesty. He maintained that their action was against a high standard of municipal honesty. He knew they did not vote or take part in the discussion, but they were present when the Commissioners of Sewers discussed the question. He did not know if they were present when the Streets committee discussed it. Witness charged Mr. Pannell with becoming auditor of both companies while he was a member of the committee which had to deal with the companies on behalf of the City. He held that a man elected as a commissioner did not fulfil his duty by abstaining from voting.

Mr. CARSON, Q.C., for the defence, said the point of the charge was that a Lord Mayor of London had become a promoter of these two companies, and had used his official position to make private gains for himself and his family and friends. Defendant had, in writing the article complained of, first set out the facts of the case absolutely truly. He had then proceeded to draw his conclusions. Whether those conclusions were wrong, the public, having all the facts before them, could judge. It could not be denied that the price charged by the City of London Company for current had been too high, for the £10 shares were now worth £22 to £24 each. That showed that the ratepayers' interests had been sacrified to the shareholders. Mr. Brooke-Hitching proposed a scheme by which the Corporation should buy out the monopoly. The difficulty of the matter arose from the way in which the Company's £1,200,000 of capital had been increased, by the prices charged for lighting, to £2,500,000. The defendants had acted in the public interest, and not out of spite towards the plaintiff, and after due investigation. The charges were that the Corporation created a monopoly and that the then Lord Mayor became a promoter of that monopoly and obtained private gain for himself and his family therefrom. That was a state of things upon which comment could hardly be too severe. Mr. Braithwaite, jun., had told the jury that when the Brush Company tendered for the contract there was no intention of

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the company carrying it out. It was intended to part with it to the Pioneer Company, and to so make additional profits. In November, 1890, plaintiff became Lord Mayor, and *ex officio* member and chairman of the Commission of Sewers, and of every sub-committee appointed by the Commission. He was, therefore, actually chairman of the Streets committee. The Brush Company had among its directors Mr. J. B. Braithwaite, jun., and the Duke of Marlborough. The City of London Electric Lighting Company was brought into existence merely to carry out a contract which they had no power to investigate. The Electric and General Investment Co. was formed to finance the Pioneer Company. Mr. Braithwaite and the Duke of Marlborough were directors of that company also. In both capacities they refused to take the risk of advancing the sum needed in February, 1891, to carry on the lighting scheme. So they made themselves into a third company—the Pioneer Company—and the defendants alleged and would stand to it that the Pioneer Company was only formed to make money for the Savorys and the Braithwaites. The three companies meant three sets of fees for directors and brokers; and shareholders in the Pioneer Company who advanced their money for six months got it back with 50 per cent. interest. The Pioneer Company was a sham, and it was for the jury to say whether the Lord Mayor of London ought to have appeared on the prospectus of such a company, and also whether he and all his family ought to have made 50 per cent. out of such a company. Contracts were made between all these companies. Mr. Braithwaite and the Duke of Marlborough, as one company, made agreements with the Duke of Marlborough and Mr. Braithwaite as another, and in each case commissions were paid. £25,000 was paid to the Electric and General Investment Co. for negotiating a contract for the Brush Company and the Laing, Wharton and Down Co. The plaintiff never looked into these matters, and never made any inquiries before appearing on the prospectus of the Pioneer Company. Negotiations followed between the Sewers Commission, of which the Lord Mayor was chairman, and the Pioneer Company, of which the Lord Mayor was chairman. How was it possible for the plaintiff to do his duty to both sides? If the Press was to be gagged when it commented on an affair like this, they would soon see the profits growing larger. Then came the City of London Electric Lighting Co., with the Duke of Marlborough and Mr. Braithwaite on the board. It was said all this was rendered necessary by the Baring crisis. Why? The Barings were not electrical engineers. It was also said that at that time the future of electric lighting was very uncertain. That was not the story that appeared in the prospectus. In the prospectus there were stories of magnificent profits, and the profits had since been actually made. Those were the facts, and yet the plaintiff complained of the comments made upon those facts. The comment in the article complained of was fair and honest, and he disclaimed any desire to attack Sir Joseph Savory, and suggested that he might have been the dupe of Mr. Braithwaite. But if that was so he must take the consequences.

Sir EDWARD CLARKE, Q.C., replying for plaintiff, contended that definite accusations of shameful transactions had been made against plaintiff. The evidence that had been given ought to satisfy every one inside or outside the court that nothing had gone on of which Sir Joseph Savory need be ashamed. It had been shown that Sir Joseph had taken no part in the giving of the contracts for electric lighting in the City. The plaintiff was not a member of the Streets committee or of the Sewers Commission in any but a technical sense. No Lord Mayor ever attended the Sewers Commission more than once or the Streets committee at all. In 1890, after 20 years of consideration, a scheme was arranged by which, for electric lighting purposes, the City was divided into three parts. In each of these areas one company had a monopoly upon terms approved and adopted in May, 1890, and which had continued ever since. It was not until months after this approval had been given that the plaintiff became even a nominal member of the Sewers Commission. The accusation now made was that the plaintiff had caused the City to pay too highly for its light. But, as a fact, the City was very well and very cheaply lighted, at least, so far as the public lighting was concerned. In February, 1891, the contracts with the Brush and the L.W. and D. Companies were on the point of breaking down, and that would have meant the indefinite postponement of the scheme. It was to prevent this that the Pioneer Company was founded, and that the plaintiff, as Lord Mayor, came forward. A report of the Sewers Commission in 1889 had recommended the lighting of the City by one large company rather than several small ones, and it was with this object that the Pioneer Company was founded. At the time it was impossible to bring out a large company, owing to the Baring crisis, which upset the whole life of the City, and the Pioneer Company was necessary to pave the way for the flotation of a larger company. The plaintiff's action throughout was for the benefit of the City. His action was public, and might have been attacked at the time, but no one had said a word against it for seven years. As to what had been said about the series of companies, of course it might be wrong for one company to promote another where such an arrangement was a cover for fraud. But in this case there was no allegation that anyone had made an illegitimate profit. The sums paid by the Brush and L. W. and D. Companies to the Electric and General Investment Co. were only their shares of the expenses of promoting the single large company. Mr. Brathwaite had done nothing which could in any way be objected to. He was a connexion of the plaintiff's and acted for various members of the Savory family. There was nothing in the evidence to support the charges of corruption made against plaintiff.

His LORDSHIP said the question was whether the statements made were true, and whether the comments on those statements were fair and without malice. On the evidence it was clear that there could be no foundation for any charge of corruption against the plaintiff, although he might have been indiscreet. On the other hand, there seemed no ground for suggesting that the defendants had any personal ill-will against the plaintiff. It seemed that plaintiff had been indiscreet in joining the Pioneer Company. The matter was one with which plaintiff had nothing whatever to do. It was said that he only joined under pressure; but it appeared that the pressure was exerted by two persons who could hardly be of much consequence in the City—Mr. J. B. Braithwaite, jun., and the Duke of Marlborough. If the charges made by defendants were unfounded they had acted in a very reckless way. It was for the jury to say whether these charges were true.

The jury, after a short consultation, found for the defendants.

Electric Construction Co. v. Imperial Tramways Co.

This case came before Mr. Justice Stirling on the 9th inst., on a motion by plaintiffs for an interim injunction restraining the defendants from the alleged infringement of a patent.

Mr. BOUSFIELD, Q.C., said he supposed defendants had hardly had time to prepare answers to the affidavits which had been filed, and were not, therefore, in a position to proceed with the motion. It was, however, a matter of some urgency, as plaintiff's patent expired in August next.

Mr. WALTER (for defendants): His clients were running a line of tramways between Stockton and Middlesbro' and Thornaby, which was a public tramway, and it could not be suggested that they were going to run away, or that they had not plenty of funds. They were perfectly willing to keep an account. The matter in question related to an unfought patent, and his instructions were that other companies had been doing for years the same as the defendants were doing.

His LORDSHIP: Well, that is a question of laches.

Mr. WALTER: Defendants had not been working publicly for more than four months.

Mr. BOUSFIELD: It is a case of absolute infringement, about which there is no doubt whatever.

Mr. WALTER: My instructions are that there is no infringement.

His LORDSHIP: This is a case in which it would be right to expedite the trial, and I order the motion to stand over till 16th inst.

National Telephone Co. (Limited) v. Commissioners of Inland Revenue.

This case came before the Court of Appeal on the 9th inst., as an appeal by the National Company from the decision on a case stated by the Commissioners of Inland Revenue under Section 13 of the Stamp Act, 1891. In February, 1897, an instrument was presented on behalf of the Company to the Commissioners for the opinion of the Commissioners as to the stamp duty chargeable. The instrument was headed: "The South of England Telephone Co. (Limited)," and ran as follows:—"March 9, 1896: The undersigned hereby agrees with the South of England Telephone Co. (Limited) (subject to above conditions) to pay them the sum of £12 per annum yearly in advance, the first payment to be made on the first day of the month succeeding that in which the wire and apparatus are fixed on the premises of the undersigned, and each subsequent payment to be made on the corresponding day in each and every following year, for the use of a private wire between No. 155, North-street, and the South of England Telephone Co.'s local exchange system in Brighton. Either the company or the lessee may put an end to this agreement by giving to the other three calendar months' notice in writing expiring on the day previous to the rent being due in any year. No verbal notice can be recognised. N.B.—All rentals are payable yearly in advance, and the first year's rent becomes due on the first day of the month succeeding that in which the wire and apparatus are fixed on the premises of the renter." The conditions and covenants entered into between the Telephone Company and the renter were not material to the present issue. The South of England Telephone Co. had been united with the National Company. The Commissioners decided that the instrument was chargeable with the duty of 7s. 6d., and the Court in the previous action affirmed the decision of the Commissioners. Hence the present appeal by the Telephone Company.

Their Lordships now held that the document in question was a contract in writing, whereby an obligation was undertaken to pay a sum of money at stated periods for an indefinite period, and so liable to the duty of 7s. 6d. They, therefore, dismissed the appeal with costs.

CITY OF LONDON CORPORATION AND ELECTRIC LIGHTING.

At the Guildhall yesterday the members of the Court of Common Council were, under the presidency of the Lord Mayor, engaged for some time in discussing a petition presented by Mr. E. Lee, on behalf of the Charing Cross and Strand Electricity Supply Corporation, setting out that the Corporation were desirous of supplying electrical energy within the City areas. The petition bore 5,000 signatures. The views of the petitioners were expressed in the following terms?—

1. That monopoly of supply by any one company is adverse to the interests of the ratepayers and the public.

2. That the rate charged for supply of electric energy by the Corporation is very considerably less than that charged within the City by the present Supply Co.

3. That the service of the Corporation is a more economical, steady and efficient service.

4. That the low-tension distributing system is a safer system for many reasons, among others the avoidance of fireproof transformer rooms or apparatus on the premises supplied with energy.

5. That the low-tension direct current system appears *inter alia* to be the best adapted for arc lighting and motive power purposes.

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Mr. E. WILMOT SEALE (Secretary of the Company) acted as spokesman of the deputation.

Mr. Deputy SAYER: Do the company undertake to give an electric supply for less than 2½d. per unit?—We do not propose to do so.

Mr. T. H. ELLIS: What is the object of your wishing to enter the City? Is it for the purpose of extending your business?—Yes, but this petition is that the memorial should be placed upon the records of this Court.

Mr. T. H. BROOKE-HITCHING: Is not the chief reason to make a profit for the shareholders out of the pockets of the citizens?—I want the reason clearly stated. Of course, such a reason does enter into our calculation, as we do not pose as philanthropists, but we are perfectly certain that if we came into the City the ratepayers will not regret it.

Are you aware that there are 7,000 consumers of the light in the City?—Yes, and I can imagine that there will be 30,000 when we come in.

How can you account for the fact that out of 7,000 consumers you have secured only 5,000 signatures?—We did not attempt to get the name of every consumer, but if time permitted we might have obtained a great many more signatures.

Mr. J. H. LILE: By placing this petition upon our records, shall we stand in a worse position afterwards?

The TOWN CLERK: A record of what takes place here to-day will, of course, be taken. The fact that the petition was received must be recorded.

Sir ALBERT ALTMAN: What is the difference between the price of the public and the private lighting in your district?—In St. Martin's in the Strand the price ranges from 6d. per unit to 4d. for lighting, and 3d. to 2d. for motive power. If we came into the City it would be proposed to charge a maximum of 5d. for private lighting, and a minimum of 4d. and 3d. to 2d. for motive power.

Mr. M. WALLACE: Assuming that the Corporation becomes in the future the lighting authority of the City, would you regard it as an act of bad faith?—Certainly not. There might be a sentimental reason, but we should not regard it as an act of bad faith.

Mr. H. T. GORDON: You are aware, I suppose, that there are other public electric lighting companies applying to this body? There are the Smithfield Markets and Metropolitan companies.—Yes, that is so.

Mr. A. C. MORTON: Do you present these signatures from persons who are dissatisfied with their present supply?—That is so, undoubtedly.

And you would agree to any conditions for the protection of the citizens?—Certainly, any reasonable conditions that might be proposed.

Mr. E. LEE said he never remembered having presented a more representative petition, and he moved that the petition be placed on the records of the Court.

Mr. MORTON asked Mr. Lee if he would amend his motion so that the petition should go to the Streets Committee.

Mr. LEE: Certainly.

Mr. MORTON then seconded the motion. He had never known a more important petition to be presented. Within the last four or five days circumstances had occurred which had entirely changed matters. He referred to the verdict of the jury in a recent case. That verdict, he said, had entirely altered the position, and it was one great reason why the memorial should be referred to the Streets committee. The Corporation was now practically free to give its consent to competing companies. Mr. Morton then read clause 42 of the City of London Sewers Act, 1848, and said it was clear under that clause that no member of the late Commission should have been interested directly or indirectly in the undertaking, or furnish materials or labour for carrying it out, while for each offence a member was liable to a fine of £100. He had heard a member of that Court swear in a witness box within the last few days that he was interested to the extent of £600, and according to the City Sewers Act the contracts which the late Commission had entered into were null and void. Mr. Morton said he thanked the jury to which he had referred and the Royal Courts of Justice for having released the Corporation from the captivity it entered into in 1891.

Mr. BROOKE-HITCHING said whether the Corporation was able to invalidate its agreement with the City of London Electric Lighting Co. he could not say, but he wished it could do so honestly. He hoped that one of these days the Corporation would itself become the lighting authority of the City. He objected, however, to the Corporation, after placing themselves in the hands of one public company (and escaping, perhaps) running into the arms of another. The memorial, he said, had nothing whatever to do with the Corporation, but was a matter for the Board of Trade; but the fact was that the company in question was trying to push itself in front of two other companies which had offered equally good terms.

Mr. WALLACE expressed a hope that the action of the Corporation would clearly indicate a change of policy, and that the members would hesitate before they handed over the interests of the ratepayers to a public company.

Mr. PANNELL, in supporting the motion, declared that the greater the inquiry was and the wider the publication of the past, present and future action of the Corporation the better it would be for all concerned. He reminded the members that in 14 years' time the Corporation would be able, under the existing agreement, to take over the private lighting of the City.

The motion was carried by a large majority.

The following is the text of c. 42, 11 and 12 Vic., referred to by Mr. Morton in the above discussion:—

"Provided also, and be it enacted, that no person, being a Commissioner, or a member of the Court of Aldermen, or of the Common Council of the City, shall be directly or indirectly interested or concerned in any contract which shall be made or entered into by or on behalf of the Commissioners for the execution of any works by this Act directed or authorised to be done or executed, or for furnishing materials or labour, or for any other matter or thing whatsoever, upon pain that every such contract shall be null and void, and that the person who, being a Commissioner, or a member of the said Court of Aldermen or of the Common Council, shall be so interested or concerned therein, shall for every such offence forfeit and pay the sum of one hundred pounds to any person who shall sue for the same, to be recovered in any of the Superior Courts by action of debt or on the case."

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. The Author hopes that, besides Telegraph and Telephone Engineers, it may, perhaps, also prove of service to those in charge of cables for the transmission of light and power. The localisation of faults has been very fully investigated, including the different degrees in which the various methods are affected by the presence of a second fault or of general leakage.—*Extract from Preface.* Demy 8vo, fully illustrated. 10s. 6d., post free; abroad 11s.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition now ready.*

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"ELECTRIC MOTIVE POWER," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"WIRELESS TELEGRAPHY: SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES."—By Dr. O. J. Lodge, with many original illustrations. *Enlarged Edition*, 2s. 6d. net, 2s. 9d. post free.

"LABORATORY NOTES AND FORMS."—With the above title we have ready the New Edition of a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"The Electrician" Electrical Trades' Directory and Handbook.—An important announcement in connection with the 1899 issue of the "Big Blue Book" will be found in an advertisement on another page of the present issue, to which our readers will please refer.

TENDERS INVITED.

As will be seen from an advertisement, the Corporation of *Sunderland* require tenders for the supply of three 125 kilowatt, direct current, high speed, steam dynamos. Specifications, &c., may be obtained from the borough electrical engineer (Mr. J. F. C. Snell), Dunning-street, Sunderland. Tenders, addressed to chairman of Lighting committee, Town Hall, Sunderland, to the office of the town clerk (Mr. Fras. M. Bowey), by noon of Friday, 30th inst.

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As announced in our advertisement columns the *Glasgow* Corporation invite tenders for providing and erecting generating plant at one or other of their new electricity works, including two 200 I.H P., two 400 I.H.P., three 1,100 I.H.P. and two 2,200 I H.P. engines, with dynamos and condensing plant. Copies of specification, &c., may be obtained from the city electrical engineer (Mr. W. A. Chamen), 75, Waterloo-street, and tenders must be lodged with the town clerk (Sir J. D. Marwick), City Chambers, Glasgow, by Tuesday, Jan. 3.

The *Leeds* City Council require tenders for the supply of underground conductors, switchboards, &c., in connection with the extension of their electric tramways. Additional particulars are given in an advertisement elsewhere. Plans and specifications may be obtained from the city engineer, Municipal Buildings, Leeds, or from Messrs. Hopkinson and Talbot, 26, Victoria-street, Westminster, S.W. Tenders, addressed to the town clerk, must be in by 10 a.m. of the 29th inst.

The Corporation of *Dublin* invites tenders for the supply of a high-tension single pole switchboard. Copies of the specification, &c., can be obtained after to-day (Friday) of the city engineer, City Hall, Dublin, and the specification and drawings can be seen at, but not obtained from, the office of Prof. A. B. W. Kennedy, 17, Victoria-street, Westminster, London. Tenders have to be sent in to the town clerk, Mr. Henry Campbell, City Hall, Dublin, not later than 10 a.m. of Wednesday, 28th inst. An advertisement elsewhere contains some further particulars.

The Committee of Visitors of the *Cumberland* and *Westmoreland* Asylum invite tenders for the supply and erection of an electric tell-tale clock, with 30 stations. Further particulars can be had from the Medical Superintendent and tenders must be sent in to the Committee, Garlands Asylum, Carlisle, not later than 2nd Jan. next. Some further particulars are given in an advertisement.

The Corporation of *Burnley* invite tenders for the supply and delivery of underground cables. Specifications, &c., may be obtained from the borough electrical engineer (Mr. W. R. Wright). Tenders to the chairman of the Electricity Supply committee, Town Hall, Burnley, by Tuesday, Jan. 10. Further particulars are set out in an advertisement elsewhere.

The *Edinburgh* City Council require tenders for the supply of switchboards and boosters for their Macdonald-road electricity station. Copies of specifications, &c., can be obtained from the resident engineer (Mr. F. Newington), Dewar-place. Specifications and drawings may be seen at, but not obtained from, the office of Prof. A. B. Kennedy, 17, Victoria-street, London, S.W. Tenders to the town clerk (Mr. Thomas Hunter, W.S.), City Chambers, Edinburgh, by Jan. 2. Further particulars are given in an advertisement elsewhere.

The *Londonderry* Corporation require tenders for arc lamp globes and carbons for the year ending Dec. 31, 1899. Further particulars may be obtained from the city electrical engineer (Mr. R. V. Macroy), and tenders must be sent to the town clerk (Sir R. N. Chambers, Kt.), Guildhall, Londonderry, by 30th inst. See also advertisement.

The Commissioners of the Burgh of *Stirling* invite tenders for the following :—(1) Lancashire boilers, with mechanical stokers ; (2) engines, dynamos, pumps, steam pipes, &c., Green's economiser and tools ; (3) storage batteries ; (4) switchboard and boosters ; and (5) arc lamps. Tenders to town clerk (Mr. Thomas L. Galbraith) by Jan. 2.

Hull Corporation require tenders for pipes and fittings for power station and condensing main from dock ; builder's works for two car sheds, &c. ; steel roof trusses, columns, &c., for sheds. Tenders to chairman Works committee by 30th inst.

The Yorkshire Bacon Curing Co. (Limited), Selby, Yorks., require tenders for the supply of accumulators. Particulars from the manager (Mr. J. E. Prossor).

The Baths committee of the *Manchester* Corporation invite tenders for the electric lighting of the Osborne-street and Gorton Baths. Tenders to the chairman by Dec. 21.

The Electric Lighting committee of the *Dublin* Corporation also invite tenders for constructing transformer sub-stations. Tenders to chairman, City Hall, Dublin, by 21st inst.

The *Shanghai* Council invite tenders for a concession, for a period of thirty years, for the exclusive right of establishing and working a telephone system in Shanghai. Particulars may be obtained of Messrs. John Pook and Co., 8, Jeffrey's-square, London, E.C. Tenders to the secretary (Mr. J. O. P. Bland), Shanghai, by noon of Friday, March 31.

The *Shanghai* Council also invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system. Particulars from Messrs. John Pook and Co., 8, Jeffrey's-square, London, E.C. Tenders to Mr. J. O. P. Bland, secretary, by noon of Wednesday, March 15, 1899.

TENDERS RECEIVED AND ACCEPTED.

The tender of Messrs. Siemens Bros. and Co. for the supply of two steam dynamos at £4,150 has been accepted by the *Bradford* Corporation.

The tender of Messrs. Reunert and Lenz has been accepted by the *Kimberley* (South Africa) Town Council for lighting business establishments and private houses electrically.

The *Liverpool* Corporation have accepted the tender of Messrs. Willans and Robinson for the supply and delivery of four sets of plant similar to those on order for the Pumpfields station at £6,939 per set, less 2½ per cent.

The *Burton-on-Trent* Town Council have accepted the tender of Messrs. John Fowler and Co. (Leeds) for the supply and erection of a 250 k.w. alternator and engine at £2,965.

The Electric Lighting committee of the *South Shields* Corporation have accepted the tender of Messrs. J. and H. McLaren for the supply of a 1,000 I.H.P. steam engine at £3,900, and that of Messrs. Siemens Bros. and Co. for the supply of a 500 k.w. alternator at £2,735.

The tender of Messrs. Crompton and Co. has been accepted by the *Barrow-in-Furness* Town Council for the supply of 21 arc lamps, columns, &c., at £1,107.

Cheltenham Corporation have accepted the tender of Messrs Nalder Bros. and Thompson for the supply of an accumulator and exciter switchboard at £290.

APPOINTMENTS VACANT AND FILLED.

The Electricity Supply committee of Hull Corporation require a mains superintendent. Further particulars are given in our advertisement columns. Commencing salary £120 per annum, increasing by three annual increments to £150. Applications to the city electrical engineer (Mr. A. S. Barnard), Dagger-lane, Hull, by Wednesday, Dec. 21.

A qualified civil and mechanical engineer is required as works manager. Some particulars are given in an advertisement elsewhere, and applications have to be sent in to A. S. A., c/o Messrs. Street and Co., 30, Cornhill, London, E.C.

The Carlisle Corporation require an assistant engineer for their electricity department. Salary £130 per annum. Also a switchboard attendant and two engine drivers (accustomed to Willans' engines). Further particulars in advertisements elsewhere. Applications to the city electrical engineer (Mr. C. D. Burnett), James-street, Carlisle, by 21st inst.

A firm of electrical engineers require a shop manager, competent to manage 600 or 700 men. Address "Factor," care of J. W. Vickers, 5, Nicholas Lane, London, E C. See advertisement.

An armature winder is required for a permanent engagement. Answers to W. T., *Electrician* Office. See advertisement.

An assistant electrician is required for the outside department of an alternating current supply station. Wages 40s. per week. See advertisement.

An assistant lecturer and demonstrator in physics is required at the University College of South Wales and Monmouthshire. Salary £120 per annum. Applications to the secretary, Cardiff, by Jan. 5.

Mr. S. E. Andrew, second assistant at the Leyton electricity works, has been promoted to the position of chief assistant, vacant by the resignation of Mr. Cummins, and Mr. A. J. Abraham, of Northampton, has been appointed charge engineer.

BUSINESS NOTICES.

Messrs. James and George Battcock Fuller (trading as H. Fuller and Sons), electrical engineers, &c., Crown-street and Upper North-street, Brighton, have dissolved partnership. Mr. G. B. Fuller will continue the business at the Crown-street premises under the old title. Debts by Mr. F. G. Clark, C.A , 56, Ship-street, Brighton.

On Jan. 2 the offices of the Royal Meteorological Society will be removed to Princes Mansions, 70, Victoria-street, Westminster, London, S.W.

Mr. W. M. Mordey has removed from 66 to 82, Victoria-street, (Grosvenor Mansions), Westminster, S.W. Telegraphic address, "Biphase, London" ; telephone number, 292 Westminster.

We are asked to state that Mr. E. H. Johnson is no longer in the service of the British Blahnik Arc Light Co.

BANKRUPTCIES, LIQUIDATIONS, &c.

The summary of affairs in the failure of the Cox-Thermo Electric Co. (Limited) is published, and is a sorry statement. The gross liabilities as regards creditors amounts to £18,269. 4s. 8d., expected to rank £15,011. 15s. 8d., and this sum is an exact estimate of the deficiency, the net assets being put at *nil*. The winding-up order was made on Aug. 3, and the statement of affairs, although lodged on Sept. 29 last by the secretary, has not yet been concurred in by the directors. The company was registered on Feb. 3, 1896, capital £100,000, in £10 shares, to acquire from Mr. H. B. Cox

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certain patents relating to the direct generation of electricity and heat by means of thermopiles and thermoelectric generators, for which Mr. Cox was to receive £100,000 in fully-paid shares and £4,000 in cash. The vendor was the promoter, and he was assisted in the promotion by Mr. R. W. Wallace, Q.C., who undertook to provide £10,000 for promotion expenses and for working the patents upon the security of Six Per Cent. Debentures charging the whole of the assets of the company. The first directors, appointed by the signatories to the memorandum and articles of association, were Messrs. R. W Wallace, Q.C., J. L. Möeller, J. Brown Martin, and H. B. Cox. Mr. Brown Martin states that he resigned, but there is no record of his resignation in the company's books. The directors have advanced sums amounting to £10,000, for which debentures have been issued as under :—

Isidore Gluckstein	500	Roger William Wallace	2,000
Joseph Brown Martin.....	1,000	Francis J. Webster	500
Julius Möeller	6,000	Total.....	10,000

In addition, the directors have advanced about £625, for which they hold no security. The cash consideration to the vendor was duly paid, and the shares to which he was entitled were issued as follows :—

Signatories	7	R. W. Wallace.....	3,393
H. B. Cox.....	5,000	J. Brown Martin	300
J. Möeller.....	1,200	F. J. Webster	100

In April, 1896, the company acquired freehold premises at St. Albans, but very little actual trading appears to have been done, the company's resources being mainly expended in developing the patents. The works were destroyed by fire in February, 1897. The whole of the property was insured for £1,000 only, and it is estimated that a loss was incurred of over £5,000. In order to reinstate the works, the company borrowed from its bankers £3,000 on the security of the property, and upon the directors personal guarantee for the repayment of the loan. On March 10 last, Mr. Thomas Cooper, St. Albans, was appointed receiver and manager. It is stated that the experiments so far carried out have demonstrated that the expense of production is too great to make the invention a commercial success. The unsecured indebtedness of £5,235. 18s. includes £2,287 stated to be claimed by Mr. H. B. Cox for salary, damages, &c. The secured creditors are the company's bankers. The Official Receiver is liquidator, with the following as a committee of inspection :—Charles S. Madan, 34, Crowther-street, Salford ; Edward C. Carter, "Romeland," St. Albans, Herts ; Robert Stanton, jun., 73, Shoe-lane, London, E.C

Mr. A. H. Crump, a member of the firm of Trehearne, Son and Crump, electrical engineers, 155, Fenchurch-street, E.C., has obtained his discharge in bankruptcy, subject to judgment for £5 being entered against him.

In the bankruptcy of Edward B. Pym, electrical engineer, late of Bar Chambers, Scarborough, the first meeting of creditors will take place on 19th inst. at Bankruptcy-buildings, London, W.C., and the public examination on Jan. 20.

A first and final dividend of 2½d. is payable on 21st inst. at 2, Clement's Inn, London, W.C., in the bankruptcy of E. W. Mayner and F. J. Handford (trading as Mayner, Handford and Co.), electrical and general engineers, James-street, London, and Redhill.

It has been resolved to wind up the Electric Coal-Cutting Contract Corporation (Limited) voluntarily, and Mr. W. T. Goolden, 2, St. Nicholas-buildings, Newcastle-upon-Tyne, has been appointed liquidator.

A meeting of the Esson Motor (Limited) will be held at 8, Old Jewry, London, E.C., on Jan. 17, to receive an account of the winding up.

At a meeting of Chamberlain and Hookham (Limited) on Nov. 23, it was resolved to wind up the company voluntarily for the purpose of reconstruction, and to appoint Mr. J. Brown, of New Bartholomew-street, Birmingham, as liquidator, with authority to consent to the immediate registration of a new company. These resolutions were confirmed at a subsequent meeting on 8th inst.

Plant for Sale.—Two 250 kilowatt direct-current dynamos, particulars of which are set out in an advertisement elsewhere, are offered for sale.

As elsewhere announced, the plant, machinery and stock of electroplating and electric lighting works, in Blackburn, are for sale.

Crompton Price List.—Messrs. Crompton and Co. (Limited) notify that, in consequence of recent improvements and economies effected in the manufacture of some of their standard types of machines, a revised list of prices has been prepared, and can be obtained on application.

"The Model Engineer."—We have received from Messrs. Dawbarn and Ward (Limited) the first volume of "The Model Engineer." This is nicely got up and is very fully illustrated. The journal deals with engineering and electrical subjects, and may be commended to amateurs in these branches of study. The price of the volume is 3s. 6d. nett, and it may be well to note that already the demand is in excess of the supply.

Catalogues, &c.—Two sections of the new catalogue of the Chloride Electrical Storage Syndicate (Limited), of Clifton Junction, Manchester, are to hand, and contain some useful information on the application of electricity for power and lighting to yachts and boats. The illustrations in Section C show several yachts fitted with chloride "R" type cells, and a list of yachts so equipped is given on a subsequent page, and shows that the application of electricity to this class of vessel is slowly but surely attaining popularity. Prices of the different types of cells accompany the list. This section also deals with the application of electricity to gigs or yacht tenders, and the illustrations here include several specimens of this class of boat. Section A deals exclusively with lighting cells for various purposes. The catalogue is well got up, and will when completed (seven sections in all) be a useful volume.

Calendars, &c.—Messrs. Street and Co., 30, Cornhill, E.C., 5, Serle-street, W.C., and 164, Piccadilly, W., London, the well-known advertising contractors, forward an 1899 mounted calendar which forms a useful and ornamental office adjunct.

Railway Diary and Officials' Directory, 1899.—Messrs. McCorquodale and Co. forward the 1899 edition of a very useful Diary and Directory of Railway Officials, and also the Railway Almanac for 1899. The directory contains a list of the railway companies of the country, with the officials and other particulars, together with salaries and interest tables, &c., &c. The price is 1s.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Dec. 7 to Dec. 13, with the ports of destination :—

Argentina—Buenos Ayres, £736 (including £512 telegraph material) ; Rosario, £613. *Australasia*—Adelaide, £44 ; Auckland, £115 ; Brisbane, £12 ; Launceston, £700 ; Melbourne, £533 ; Otago, £62 ; Sydney, £291. *Belgium*—Brussels, £200 (telegraph material) ; Ostend, £51. *Canada*—Santos, £235. *Ceylon*—Colombo, £83 (including £33 telegraph material). *Denmark*—Copenhagen, £521 (telegraph cable). *France*—Boulogne, £88 ; Dunkirk, £16. *Germany*—Hamburg, £265. *Gibraltar*, £30. *Holland*—Rotterdam, £388 (telegraph material). *India*—Bombay, £140 ; Calcutta, £62 ; Madras, £64. *Japan*—Yokohama, £120. *North Atlantic*—£4,500 (telegraph cable). *Norway*—Christiania, £494 (telegraph material). *Portugal*—Lisbon, £17. *Russia*—Libau, £45 ; Reval, £426 (including £321 telegraph material). *South Africa*—Cape Town, £814 ; Durban, £1,422 (including £1,397 telegraph plant) ; Port Elizabeth, £316 ; Zanzibar, £31. *Straits Settlements*—Penang, £58. *Sweden*—Gothenburg, £308 (telegraph cable) ; Stockholm, £156 (telegraph material). Total, £13,957, against £15,063 in the corresponding week last year (Dec. 8 to Dec. 14).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

American Electrical Consolidations.—Efforts are, it is said, being made to combine the three electric light companies of Baltimore into one corporation. The companies included in the deal are the Brush Electric Co., of Baltimore City ; the Northern Electric Co. and the Edison Electric Illuminating Co.——The negotiations as to the consolidation of the City Passenger Railway Co. and the Consolidated Street Railway Co. will, it is thought, culminate in the purchase of the former by the latter. About £2,400,000 would probably be involved in the deal, and £200,000 or more would be expended in immediate improvements, including the change of some cable lines to electricity.——The certificate of incorporation of the combination of manufacturers of electric elevators and hoisting apparatus has been filed under the name of the Otis Elevator Co. This latter combination is said to include the Otis Elevator Co., the Sprague Elevator Co. and various other elevator interests. The company is capitalised at £2,200,000 ; £900,000 Preferred and £1,300,000 Common stock.

Ayr.—The Town Council on Monday considered a communication from the Drake and Gorham Electric Power and Traction Co. stating that the company might consider the advisability of withdrawing their application to the Light Railway Commissioners for power to construct a light railway from Ayr to Monkton, if the Council were disposed to grant them a lease of the tramways. It was decided not to entertain the proposal.

Bangkok.—Bangkok Electric Light Co. have disposed of the whole of their electric lighting undertaking to Capt. Andersen and Admiral de Richelieu, who, it is understood, will buy out the interest of the Siamese Government in the plant. The new owners will introduce more capital and carry out extensions of the plant and mains.

Beckenham (Kent).—The Board of Trade have deferred the consideration of the revocation of the Council's provisional order for a further period of six months.

Basingstoke.—The Board of Trade have sent a communication to the Town Council stating that "considering the advance which has now been made in electrical science, the Board are of opinion that the time has come when local bodies should apply for pro-

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visional orders rather than for licences." A provisional order is, therefore, to be applied for.

Birkenhead.—A Local Government Board inquiry was held on Thursday last into the Town Council's application for power to borrow £15,000 for electric light extension purposes. The town clerk (Mr. Alfred Gill) said that the amount would be expended in putting down additional plant at the electricity station, and also in extending the mains within the borough to meet the demand for current. Technical evidence was given by the electrical engineer (Mr. W. Bates). There was no opposition.

Bedworth.—Dissatisfaction is expressed by the Parish Council at the present gas lighting, and inquiries are being made as to cost of electric lighting.

Blackpool.—The General Purposes committee decided this week to adopt the overhead trolley system on the promenade. Mr. R. C. Quin (borough electrical engineer) presented a report in which he stated that the promenade, owing to the frequent incursions of sand and water, was exceedingly ill-adapted for the present system. On fine days the minimum leakage of the line was 45 per cent., and the maximum leakage allowed by the Board of Trade was 2½ per cent. only. The present system was of a ruinous character. The new copper conductors cost £800 a year, repairs to collectors cost £400 a year, while the cost price of leakage electricity was £700 annually. They had lost over £2,000 a year, which the overhead system would prevent.

Blairgowrie (N.B.).—Negotiations have been opened with the proprietors of the proposed source of power for the electricity works (the river Ericht), and as soon as an arrangement is arrived at a company will be formed with a capital of £8,000 or £10,000 to carry out the work. Mr. R. F. Yorke is the consulting engineer.

Canterbury.—The Town Conncil have decided to apply to the Local Government Board for sanction to borrow £12,000 for electric light extensions. The electricity works are not yet open for supply.

Carlisle.—The Town Council have expressed approval of the proposal to adopt the overhead trolley system on the local tramways.

Chelsea (London).—The Vestry have declined the Chelsea Electricity Supply Co.'s recent offer to supply electric current for public lighting.

Chiswick.—A definite agreement has now been arrived at between the Council and the Aberystwith and Chiswick Electricity Supply Co., as to the establishment of electricity supply works.

Christmas Postal Arrangements.—As Christmas Day falls on Sunday this year there will be no delivery of letters in London and its suburbs on that day. There will, however, be a parcels post delivery on Christmas Day in London and generally throughout the United Kingdom.

Death from Electric Shock.—An inquest was held at Southampton on Tuesday into the death of a man named Davies, in the employ of Messrs. W. T. Glover and Co. Deceased, who was at work on the mains being put down for the Corporation, accidentally placed his hand on a live wire and was instantaneously killed. The inquiry was adjourned.

Derby.—The Corporation decided on Wednesday to purchase the local tramways for £32,000. Opposition is to be entered against the bills by the General Power Distributing Co. and the Leicestershire and Warwickshire Electricity Supply Co.

Devonport.—The Town Council are negotiating for the purchase of the market buildings as a site for an electricity generating station.

Doncaster.—The Corporation have resolved to apply to the Light Railway Commissioners for authority to construct a system of electric tramways.

Eastbourne.—At a special meeting on Tuesday, the Town Council confirmed its decision to purchase the undertaking of the Eastbourne Electric Lighting Co., and to apply for a provisional order. The Electric Light Company are willing to sell their undertaking for £132,307. 10s., and the Corporation offer £77,564.

Falkirk.—The Falkirk Central Electric Light Association started the supply of electric current on Friday last. The association is composed of a number of shopkeepers whose premises will be lighted electrically in future. The work has been carried out by Messrs. T. Laurie and Co.

Government Purchase of the Telephones.—We have previously referred to the letters which have appeared in *The Times* from Mr. Edward Rae, who has acted as spokesman for the members of the provincial stock exchanges. Mr. Rae has suggested as the only means of improving the position of matters telephonic that the telephones should be nationalised. This suggestion has drawn from Mr. J. Staats Forbes, President of the National Co., the following letter:—

"Oxford-court, Cannon-street, E.C., Dec. 13.

"Sir: The letters from Mr. Edward Rae appearing in *The Times*, suggesting the advantages which would arise from the absorption of the business and machinery of the National Telephone Co. by the State, have naturally received the most careful consideration and attention of the Board. The Board are sensible of the deficiencies of the present system, but must remark that these are greatly attributable to the want of proper facilities for construction and maintenance of plant; to the insecurity of the present tenure of the company, and to the absence of those favourable conditions which apply to other companies conducting public services under the authority of Parliament. The Board are, and have been, only too anxious to co-operate with the Post Office (as that department can testify) in effecting improvements and development in the business, and if, as seems to be possible, the drift of public opinion should result in the desire to transfer the telephone business to the State they would feel it to be their duty, upon reasonable and fair terms, loyally to co-operate in bringing about the change, and, subject to the responsibility of consulting the shareholders, I am authorised to say, in answer to Mr. Rae's first question, that his proposal, if it should assume a practical shape—that is to say, if the Government should entertain the question of purchase—would form an acceptable basis of negotiation; and to his second, that on the assumption that the business be conducted on commercial principles the future earning capacity from year to year is not overestimated, but, on the contrary, if the restrictions and difficulties now attending the operations of the company be removed, they are largely underestimated."

Greenock.—In a report recently prepared by the burgh electrical engineer (Mr. S. E. Fedden), he estimates the cost of purchasing the tram lines from Rue End-street into Port-Glasgow at £45,000, and the conversion of lines from end of Port-Glasgow to Ashton at £150,800. Should the lines be leased to the existing company, an agreement for the supply of electric current so as to give reasonable profit to the board's electrical department is advised.

Mr. Fedden has also presented a preliminary report on the electric lighting question. The Hunter's-place site has been selected for the generating station. The low-tension continuous-current three-wire system of distribution is recommended, and the total cost of the scheme, which provides for the erection of 40 arcs for public lighting, is estimated at £30,000. If the Council decide to adopt electric traction, current could be supplied to the tramways department by incurring an extra capital expenditure of between £4,000 and £5,000.

Hanley.—The Town Council have accepted Mr. C. J. Sutherland's resignation of his appointment as joint electrical engineer of the Council's electricity department. Mr. Sutherland will commence his duties as city electrical engineer at Worcester on 1st prox.

Herne Bay—Messrs. W. C. Bersey and Co. will apply for a provisional order for this district.

Hyde.—Owing to the Town Council's decision to establish electricity supply works, the application of the Electrical Power Distribution Co. for a provisional order is to be opposed.

Ilkeston.—The Town Council are applying for provisional orders for electric lighting and traction purposes. Last week a report from Mr. Herbert Talbot, on the proposed electric lighting and traction scheme was discussed. The low pressure continuous-current three-wire system of distribution, with a pressure of 500 volts between the outers, was recommended. Mr. Talbot pointed out that by combining the plant for both supply and traction great economy would result, and less spare plant would be needed. He estimated the cost of electric lighting plant, capable of supplying current to the equivalent of 3,000 8 c.p. lamps at one time, and 50 arc lamps for street lighting, with ample reserve plant, at £15,765; and for tramways, including buildings, permanent way, power station, and plant, overhead construction, feeders, and 10 cars with necessary car shed and repairing shop, £64,749.

Infirmary Lighting.—The governors of the Dundee Royal Infirmary have decided to extend their electric lighting installation at a cost of £450. They consider "the advantage of the light was so obvious that it is unnecessary to speak of it, and, as to the annual cost, it is expected that, being large consumers, the bill would not much, if at all, exceed that for gas."

Lambeth (London).—The South London Electric Supply Corporation have submitted to the Vestry a comprehensive scheme for the lighting by arc lamp of the principal streets. The company are bound to supply current for and to maintain 25 arcs free of charge. In addition to this number the company offers to put up 225 arcs and to supply current from five circuits for £22. 10s. per lamp per annum—a total yearly expenditure of £5,062. The present cost of gas lighting is £1,800 for the same streets. The Lighting committee proposes that the company should erect 50 lamps, and charge for the 25 over those to be supplied under the agreement at £20 per lamp per annum. This proposal has been accepted by the company except that they decline to reduce the annual charge from £22. 10s. to £20. The Lighting committee have recommended the Vestry to accept the company's proposal with the lamps alight until 1 a.m., instead of only midnight, but at the last meeting an amendment was adopted adhering to the terms proposed by the Vestry, and instructing the committee to submit particulars of the cost of the arc lamp standards and a comparison of the cost of electric light supplied by meter, against the price which the Corporation or any other similar company would charge.

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Leeds.—The formal transfer of the electricity undertaking of the Yorkshire House-to-House Electricity Co. to the Corporation took place yesterday (Thursday). The whole of the staff will be taken over by the Corporation.

Leyton.—Sixty arc lamps are to be erected in High-road, Leyton, and High-road, Leytonstone, and application is to be made to the Local Government Board for sanction to borrow £1,350 for carrying out the work. Extensions of the mains for private lighting are also to be carried out.

Light Railways.—At the Board of Trade on Wednesday, Sir Courtenay Boyle, K.C.B., considered the objections to the confirmation of the order made by the Light Railway Commissioners, authorising the London United Tramways (Limited) to construct a light (electric) railway from Hanwell to Uxbridge. Mr. Pope, Q.C., for the objectors (the Great Western Railway Co.), submitted that the Board of Trade should not confirm the order. The object of Parliament when passing the Light Railways Act (which gave the Board of Trade power to confirm such an order without the intervention of Parliament) was not that the machinery should be used to enable the Board of Trade to deal with questions which ought to receive the sanction of Parliament. Mr. Pope said his point was that the effect upon the railway already existing in the district would be of such magnitude that it ought not be dealt with except by a committee of Parliament, and, further that it was not a case in which the powers of the Light Railways Act should be invoked at all —that it was, in point of fact, a tramway extension, and that it ought not to be permitted that the powers and protection which were given to the various interests under the Tramways Act should be evaded by proceeding under this particular form of legislation, which was not really applicable to the present scheme. The Great Western Railway felt that this proposal was of so much moment to their interests, and having regard to the recent adjustment of railways which had been made for the accommodation of the district by Parliament itself, that it was a case which ought to be judged of by Parliament directly and not by the Board of Trade under the Light Railways Act. Mr. Balfour Browne, for the promoters, contended that the evidence had absolutely failed to show there was any such competition as would make the undertaking one which should not be dealt with by the Board of Trade, but one which should go to Parliament. The competition was trivial to a degree, and if such competition as arose in this case was to be a bar to a light railway they would put a stop practically to the Light Railways Act. Decision was reserved.

London County Council.—At Tuesday's meeting the question of the Council allowing the National Telephone Co. to retain certain overhead wires in Islington, the spans of which are of greater length than allowed by the Council's bye-laws, was again considered. The recommendation of the Highways committee was to allow the wires to remain for a certain period. After some discussion the matter was again referred back to the committee till after the Christmas recess. The same committee recommended that the application by the National Company to lay eight additional lines of pipes underground between Northumberland-avenue and the Victoria Embankment subways be granted on certain conditions, one being that a rent of £1. 1s. per annum be paid in respect of each length of pipe. The recommendation was approved.

Mr. Benn (chairman of the Highways committee) read a letter from Mr. Young, of Glasgow, who was recently appointed chief of the Tramway Department, announcing that the duties were very different to what he anticipated, and to what he had been accustomed, and he, therefore, declined the position. It was agreed that the office be left vacant for the time being, but that Mr. Alfred Baker, manager of the Nottingham Corporation tramways, be appointed manager at a salary of £1,000 a year.

London County Council's Tramways.—As will be seen from the above report of the proceedings at Tuesday's meeting of the County Council, Mr. John Young, who was selected for the post of general manager of tramways under the Council, has declined this position. A post has been created which has been offered and, we believe, accepted by Mr. Alfred Baker, tramway engineer to the Nottingham Corporation tramways, the salary being fixed at £1,000 per annum. It is generally conceded that the Highways committee of the County Council have lost just the official who, from his previous experience, was capable of organising the tramways department, but it is to Mr. Baker's credit that he is a young man, only 35 years of age. He began his career as a tram conductor at Nottingham nearly 20 years ago, and from that time to the present has made the development of the Nottingham tramways his life's work. On the acquisition of the tramways by the Nottingham Corporation in 1897, Mr. Baker was taken over, having previously filled the post of manager to the Tramways Company for the previous seven years. At the time of his appointment by the Tramways Company, the finances of the concern were in a low state, the shares were at a heavy discount and shareholders had but little faith in the ultimate success of the Company. All this was speedily changed after Mr. Baker's appointment, and Nottingham now possesses a first-rate municipal tramway service. The original shareholders received the full par value of their holdings on the Corporation taking over the company's undertaking. Mr. Baker's experience, so far, has been confined to horse traction, but he has already advised the Nottingham Corporation on the subject of converting the horse lines into electric lines, and the Nottingham authorities have this matter at the present time under consideration. It is to be hoped that no petty differences will be created necessitating the withdrawal of Mr. Baker in a similar manner to that of Mr. Young, as, if report speaks truly, very little tact on the part of the Highways committee of the London County Council would have obviated Mr. Young's action.

Mansfield.—The Town Council are applying for a provisional order. The initial capital expenditure of electricity works is put at £15,000, but if current were taken "in bulk" from the General Power Distributing Co. the cost is put at only £5,000.

Newcastle-on-Tyne.—The Council have appointed a special committee to consider the question of electricity supply.

New Company.—A notice appeared in our last issue of the registration of the British Schuckert Electric Co. (Limited), which has been formed with a capital of £200,000, the whole of which we learn has been privately subscribed. The company has the valuable technical knowledge and experience of the Electrizitäts Aktiengesellschaft vormals Schuckert and Co., of Nuremburg.

Newport (Isle of Wight).—The Ventnor Electric Light and Power Co. are applying for a provisional order for this town, and, if satisfactory terms can be arranged for the supply of current for public and private lighting, the Town Council will probably approve of the application.

Northallerton (Yorks).—Under the terms of an agreement with the District Council the Northallerton Electric Light and Power Co. agree to erect and maintain two arc lamps in the market-place free of cost. The Council have the right to purchase the company's business, plant, goodwill, &c., upon the following terms:—(*a*) At any time between Jan. 1, 1900, and Jan. 1, 1905, on twelve months' notice, on payment of the sums expended in the erection of the works, plant, &c., and the formation and carrying on of the company, together with such a sum for each year, during which the net profits fall under 5 per cent., as shall make up the 5 per cent. (*b*) On Jan. 1, 1900 (after notice) at a valuation as a going concern and a sum not exceeding 15 per cent, on the amount of such valuation for goodwill. (*c*) On Jan. 1, 1915 (after notice), at a valuation of a going concern and a sum not exceeding 20 per cent. on the amount of such valuation for goodwill. (*d*) At any time after Jan. 1, 1915 (after notice), at a price to be settled by arbitration. So long as the company's works shall be carried on to their reasonable satisfaction the Council shall not erect or give consent to any person or company during the currency of the agreement to erect posts and carry wires overhead, or under the streets for the purpose of supplying electric current for lighting or power. There is no provisional order in this case.

Ogmore and Garw.—The District Council have entered into an agreement with the Ogmore Electric Light Co. for the electric lighting of the district for the year 1899, at £3 per 16 c.p. lamp.

Oldham.—The Electric Lighting committee have decided to consult Prof. Kennedy as to the extension of the electricity works.

The National Telephone Co. have made another unsuccessful application for permission to lay wires underground. The town clerk has expressed the opinion that the object was to enhance the value of the company's plant, which would sooner or later be taken over by the Government, and in that case they would indirectly have to pay their proportion of the cost. Singularly enough, the Finance and General Purposes Committee, at a later meeting, resolved to request the company to establish further call offices.

Police and the Telephone.—The Court of Common Council have referred to the Police committee the question of connecting several of the City police stations with the telephone service.

Power Supply.—The County of London and Brush Provincial Co. are issuing a circular calling attention to the advantages of electricity for power purposes, which calls for the careful attention of all users of mechanical power. The Company offer intending consumers desiring special information as to choice of motors and controlling apparatus therefor, the assistance of their engineering staff. The circular gives particulars as to floor space, &c.; and, in fact, will be found of service to all contemplating the use of electric motors for driving.

Redditch.—The District Council have entered into an arrangement with the National Electric Free Wiring Co. for the "free" wiring of premises in the district.

Rhyl.—The District Council have received a report from Mr. J. L. Owens on the electric lighting question. The initial capital expenditure entailed by the scheme set out would be £16,679.

Richmond (Yorks.).—The Gas and Water committee has been authorised to spend a sum not exceeding £10 for expert advice as to the establishment of electricity works.

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St. Helens.—The price of electric current has been reduced from 6d. to 4d. per unit.

St. Marylebone (London).—Last night at the Vestry meeting Mr. T. H. Brooke-Hitching moved a resolution that application should be made to Parliament for a special Act to empower the Vestry to erect and maintain electric lines and works, and to supply electricity for public and for private purposes throughout the parish. He said that in the event of the Bill being passed they would be enabled to purchase the interest of the Metropolitan Electric Supply Co. as regards their undertaking in that parish. It was hoped that they would be able to get the company to state the figure they would sell to the Vestry in an amicable manner. Sir E. Galsworthy asked how it was they had abandoned the idea of going for a provisional order. Mr. T. H. Brooke-Hitching said it was known that the Board of Trade would not grant to municipal authorities provisional orders to compete against companies who were doing their duty. Mr. E. White said there was nothing in the notice in regard to buying out the company, although they were told that such was included in the bill promoted. Mr. Brooke-Hitching had told them nothing of what this undertaking would cost. He estimated that the least the company would require for their undertaking was £600,000, which would mean their having to pay for interest, &c., £30,000. The company's profit was only £25,000, so that the Vestry, if they acquired the undertaking, would be losing £5,000. Mr. Sutherland said it was idle to think that if they had the electric lighting under their control they would lose £5,000 a year. Mr. J. Lewis hoped they would not rush this question till they had already seen what it was proposed to do by the Bill. He maintained that the Committee of the House of Commons was wrong in rejecting their application. They were told that the legal costs they had already incurred amounted to £3,000. Mr. G. B. Crook said the Vestry had entered into an agreement not to enter into competition with the Company. He contended that they were in a worse position than they were before they went to the House of Commons for the confirmation of the Board of Trade provisional order. Sir Edwin Galsworthy moved that the subject be adjourned, which was unanimously agreed to.

Sheffield.—The City Council have decided to appoint a special Electric Lighting committee.

Shirebrook (Notts.).—A committee of the District Council has been appointed to consider and report upon the proposal of the Shirebrook Colliery Co. to lay electric lighting mains in the district for the supply of current for public and private lighting.

Shrewsbury.—The Local Government Board have sanctioned the borrowing of £30,000 for the purchase of the undertaking of the Shropshire Electric Light and Power Co. and the extension of the electricity works.

Sleaford (Lincs.).—The District Council have decided to engage a consulting engineer to report upon the question of establishing electricity supply works.

Southport.—The Town Council have expressed approval of the scheme for the construction of an electric tramway between Lytham and Southport. The Council and the British Electric Traction Co. are seeking Parliamentary powers for the construction of electric tramways in the Southport district.

South Shields.—The Town Council have rejected a proposal to increase the salary of the borough electrical engineer (Mr. J. A. Jeckell) from £300 to £350 per annum.

Swansea.—The Town Council have decided to open negotiations with the Swansea and Mumbles Railway Co. with a view to acquiring the railway and introducing electric traction.

Telegraph Poles.—The poles used by the British telegraph department come chiefly from Norway and Sweden. It is stated that the terms of the specifications will be so changed as to admit of tenders from Canadian supply houses. Tenders are to be immediately invited for 25,000 poles.

Telephone Extension.—The National Company are just completing a new exchange at Newquay (Cornwall).

Walsall.—The number of customers of the electricity department on Nov. 30 was 127. The Council will oppose the Bill for the adoption of electric traction on the South Staffordshire lines.

Warwick.—The Town Council are conferring with the Leamington authorities on the proposals of the British Electric Traction Co. to introduce electric traction on the local tramways. The Council have resolved not to allow the use of the overhead trolley system.

Workhouse Lighting.—Tenders are to be invited for the electric lighting of the new Doncaster workhouse.

Wrexham.—A special meeting of the Town Council is to be called to consider the proposals of the Drake and Gorham Electric Power and Traction Co. for the construction of electric tramways in the district.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. CHAPMAN, *Fel. Chartered Inst Patent Agents, of 70, Chancery-lane, W.C., from whom all information on he subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

November 17, 1898.

24,248. E. A. THOMPSON. Parkgate. The Don electric fog alarm.
24,264. H. HIRST. London. An improved switch for incandescence or glow electric lamps in which the filament is subjected to a preliminary heating effect apart from the lighting current.
24,265. H. HIRST. London. Improvements in forming filaments or the like for incandescence or glow electric lamps.
24,270. A. P. LUNDBERG and G. C. LUNDBERG. London. Improvements in multiple wall connections for electric lighting.
24,277. W. P. THOMPSON. Liverpool. Improvements in electrical stop motions for warps. (F. E. Kip, United States.)*
24,307. J. C. FELL. London. A process for the electrolytic extraction of zinc and other metals from ores or waste containing them. (W. Strzoda, Germany.)*
24,308. H. J. HADDAN. London. Improvements in electic batteries. (Columbus Electrizitätsgesellschaft m. b. H., Germany.)

November 18, 1898.

24,357. A. T. ELLIS. London. Improvements in or connected with electric batteries.
24,371. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in alternating electric-current motors and distribution systems. (C. P. Steinmetz, United States.)
24,379. F. L. MUIRHEAD. London. Improvements in telephones.
24,382. H. L. TODD and J. DUNHAM-MASSEY. London. An electric motor for tram cars.
24,404. L. HACKETHAL. London. Improvements in insulating and equalising electric currents.*
24,417. W. LANGDON-DAVIES. London. Improvements in induction motors.
24,418. W. LANGDON-DAVIES. London. Improvements in alternating-current motors.

November 19, 1898.

24,425. H. LUTZ. Kingston-on-Thames. Improvements in combined electric wire gauges and calculating devices.
24,426. P. C. DAY and P. R. COBB. Foyers. An improved surface contact system for electric tramways, railways, or motor cars.
24,438. C. M. STEAD. Leeds. Improvements in or in connection with the construction of dry voltaic cells, accumulators, and secondary batteries.*
24,447. T. W. BARBER. London. Improvements in road conduits and appurtenances for electric traction.
24,466. W. N. STEWART. London. Improvements in connection with electric arc lamps.
24,471. F. HOLMES. Bristol. An electrical resistance for use with alternating currents in the production of X-rays.
24,487. C. STEINER. London. Improvements in or relating to contact-making devices for electric street railways with overhead conductors.*

November 21, 1898.

24,508. P. PINCKNEY. Portsmouth. Improvements in electric traction.
24,530. C. F. J. OPPERMANN. London. Improvements in and relating to electrical accumulators.
24,532. B. J. B. MILLS. London. Electric cables for high-tension currents. (La Société Française des Câbles Electriques, Système Berthoud, Borel and Cie., France.)
24,533. W. P. THOMPSON. Liverpool. Improvements in or relating to converting electrical energy into mechanical motion. (C. S. Bradley, United States.)*
24,550. O. SCHNEIDER. London. An electro-therapeutical and massage apparatus.
24,559. H. G. MORRIS and P. G. SALOM. London. Improvements in electrically propelled vehicles.*
24,563. A. C. J. GUÉNÉE. London. Improvements in dynamo armatures.
24,566. G. C. FRICKER. London. Improvements in means or apparatus for opening and closing electric circuits.

November 22, 1898.

24,570. W. S. RAWSON. London. Improvements connected with electric batteries.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1897.

25,388. PARVILLÉE. Compositions for use in the construction of electrical heating apparatus and resistances, and the processes for their manufacture.
25,581. H. M. L. CRONAN. Lighting regulator for gas and petroleum motors lighting electrically.

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COMPANIES' MEETINGS AND REPORTS.

West India and Panama Telegraph Co. (Limited).

The forty-third ordinary general meeting of this Company was held on Wednesday. Mr. WILLIAM ANDREWS presided.

Mr. R. T. BROWN (Manager and Secretary) read the notice convening the meeting.

The CHAIRMAN: Gentlemen, I suppose you will, as usual, take the report as read. Agreed. We are rather later this year than usual in presenting our accounts, and we sent to the newspapers, for the information of the shareholders, on Oct. 20th a circular, stating that the delay in holding the meeting was on account of warlike operations, the irregularity of mails and the delay in the correspondence. Well, that is not altogether cured yet. We cannot say that there is an end of these exceptional circumstances. You will have noticed, for instance, in the report that we show an increase of £6,738, but in the accounts, as far as they have since been ascertained, they only show an increase on balance of some £1,400. Of course, the first figures of the receipts is an estimated one that is sent by wire, and the last shows the state of the accounts, as far as we have been enabled to get them completed, and as they actually work out, but I may tell you they are not final. You will remember that there were large tariff reductions made on January 1st, by which the accounts have been a good deal complicated. And then there were, of course, owing to the war, censorship restrictions, messages being frequently deviated by one route or another, and the effect of that has been, of course, that the product has varied more or less. Upon the whole, however, we thought that it was the best plan to take the old figures as being the best available, and to correct, as nearly as we could, when the returns enabled us to do so. For instance, in the beginning of the half-year, the first three months showed a loss of £3,478, consequent upon the considerable reductions of tariff which you will remember we had to make. Well, subsequently that decrease of revenue was turned into an increase, by the operations consequent upon the war, and the number of telegraphic messages which were sent by the belligerents. We found in the end that with the losses on exchange, rebates which we lost or failed to get, and allowances for certain claims which must be made, and which had to be provided against, that the total that we should take credit for would be diminished, and that it would not be the increase which you see in paragraph 3 of the report, but the amount shown in paragraph 1, which is actually adopted. Now you will understand with regard to the increase, as given in the report, that the result cannot be worse than that shown, and we may find ultimately there will be a considerable margin. With regard to expenses, there is not much to state in connection with them; they amount to £21,704, against £21,426, an increase of £278, and I may say that that outlay is largely attendant upon warlike operations which have cost the Company something like £1,000, and, therefore, I think that we may look for an early diminution in the expenses, although, as I have frequently had occasion to say, you cannot expect that there will be any large diminution, because we keep them down as closely as possible in every way. Well, now, gentlemen, I think it is rather a gratifying fact that you will notice that, despite the operations of the fleets, and of the armies, in the Spanish-American war, and the disturbances which took place, the Ponce, San Juan (Porto Rico) and Santiago de Cuba cables and land lines of the Company have all been maintained in good working order, although the damage to the harbour lengths—which is more like an inland sea—at Santiago has not yet been completely repaired. I think it is satisfactory that, in spite of all this, we have been able to carry on our operations. Well now, gentlemen, I come to the receipts estimated for the current half-year, and although they are subject to correction, the same as for the half-year ended June, I think it will be found that they will show a very considerable augmentation compared with 1897. After every allowance has been made in the accounts for exchange, rebates and claims, including our outlay upon repairs consequent upon the hurricane, which has not yet been dealt with in the accounts, the nett receipts, I have every reason to believe, will be eminently satisfactory to the shareholders. I am sorry to have to tell you that during the war troubles we lost our agent and two clerks at Santiago, where they had been working under the most unexampled difficulties, as you may imagine, and I think that in these circumstances the Company may take credit for having kept its lines going under the conditions we have had to contend with. I think it is very gratifying that the Company should have been enabled to go on working well, at such an important international juncture, and that such an amount of celerity should be afforded to those desiring to use the telegraph lines, which have always been kept open by one route or another. And, therefore, under these circumstances of the half-year, I hope that the shareholders will not be altogether dissatisfied with us. Now in regard to the operations of the current half-year (because I feel I have pretty much disposed of the past half-year) I may say that our new cables, in substitution of the old chord line which had failed, have been successfully laid and are in excellent condition, and they go from Grenada to St. Lucia and thence to Ste. Croix, in addition to which we have duplicated the Trinidad-Grenada section. These duplications have greatly strengthened the Company's duplicate system. Now, the Jamaica, St. Lucia Cable touches at present at Porto Rico and Ste. Croix, and I may say to you that without detrimentally affecting the working of the system, or in any way altering its efficiency, we could by the insertion of a short additional length of cable, and the provision of some few additional clerks, have it worked as a direct all-British cable from Jamaica to St. Lucia and all the other British islands. However, we have not thought that it was worth the Company's while to spend more money and to incur increased working expenses to ensure an object for which no demand has been made. Well, now, gentlemen, we have had to contend not only with war, by fleets and by armies, but with an elemental war of a tragic character, which has been no other than the disastrous hurricane visitation that the West Indies have suffered from, causing an appalling loss of life and destruction of property, and unprecedented distress, more especially so in two of the islands. Well, gentlemen, your Directors, feeling sure of the sympathy and support of the shareholders, met together and voted a sum of 250 guineas, as the Company's mite towards the relief of the sufferers from this terrible calamity. The Cuba Company and the International Ocean Co. joined with the West India and Panama Telegraph Co. in an extension of the boon of free messages through their system in connection with the Hurricane Relief Fund for the succour of the people, and thereupon we placed ourselves in communication with the American lines, who immediately agreed to an extension of the boon over their system, and thus free messages were sent the whole distance from London to the West Indies. Here they were of advantage in meeting the circumstances of the case, and I have reason to know that the sympathy of this Company, thus manifested at the earliest possible moment, contributed very much to increasing the facilities of relief afforded. Well, gentlemen, the damage from the hurricane sustained by this Company's lines, both on land and at sea, amounts to a sum which may ultimately be estimated to reach £5,000, which is not an agreeable item; but, as previously stated, the augmented receipts owing to the war will practically prevent the shareholders from feeling the enhanced expenditure—in fact, they will not feel it at all. The British Government has come forward to the aid of the West Indies, and I have no doubt that the assistance thus afforded will enable them to surmount—or very largely assist towards enabling them to surmount—their present distress, and we trust that the assistance thus afforded to the islands which have suffered will later on eventuate in a more substantial measure of success, and enable a permanent return to be made to their former prosperity. I have no doubt that the people will do their best to support the Colonial Secretary in these efforts in regard to the West Indies at this juncture, and if something were not done for the West Indies, I imagine that there would be some odious comparisons. The shareholders are probably aware that Cuba and Porto Rico are now passing into the hands of the United States Government and people, and here I must make a public and grateful acknowledgment of the perfect loyalty with which Spain has always fulfilled her concessional obligations up to the last moment, and the fair and considerate treatment that she has always vouchsafed to this Company. It is also most gratifying to me to be able to state that upon all questions that have arisen with the American Government that the administration has taken sedulous care that the Company should be fairly treated, and they have dealt with the Company's representations, I must say, in a most conciliatory spirit. Of course, gentlemen, we cannot forecast the future. The American Government, no doubt, have great difficulties to contend with in the restoration of order, in the maintaining of good government and the organising of commerce and prosperity in a new country, but our wonderful kindred people across the sea are not given to fail. They possess a fertility, energy and determination which generally find for them a satisfactory way out. Of course, the settled prosperity of Porto Rico would be of great benefit to us, because it is one of our most important places of communication. Well, gentlemen, we owe it to our staff to draw attention to the satisfactory manner in which their duties were discharged throughout the whole system, and especially during the hostilities—when, of course, the business was very largely augmented—and also during the hurricane in the islands especially visited by those misfortunes. We have had a troublous time, and we have done our little best for your interests. I do not know, gentlemen, that there is any more with which I need trouble you upon the present occasion, and, therefore, I will move the resolution, and after it has been seconded, I shall be glad to answer any questions that any shareholder may desire to ask to the best of my ability, and I now beg to move that the report and accounts be adopted, and that the dividends recommended in the report be declared.

Mr. HENRY HOLMES: I beg to second the resolution.

Mr. COPLAND said the report stated that the revenue for the current half-year was also considerably in excess of that for the corresponding period, but was tending gradually to resume its normal limits, and he would like to ask for a little information about the actual figures. He would like also to offer the suggestion of the establishment of a dividend reserve fund, because he was of the opinion that it would enhance the value of the Company's shares in the market very much.

The CHAIRMAN said that the calculation of Mr. Copland was a very accurate one, because, during the current half-year, they had gross receipts amounting to £48,165, against £18,032 during the corresponding half of last year, or an increase of a little better than £30,000 or 166 per cent. In the report they shewed an increase of £6,700, and, of course, there would be a considerably larger sum for the current half-year available for distribution than it had been their fortune to deal with on previous occasions. There should be a big balance. He thought the suggestion of Mr. Copland for the formation of a dividend equalisation fund was a very good one, and a very sensible one.

Mr. SAUNDERS asked the Chairman whether they had any connection with the Western and Brazilian Telegraph Co.'s system, which he understood had amalgamated with the Brazilian Submarine? He would like to know whether the Directors had given any consideration to the question of this Company amalgamating or doing something of that kind. Would it be profitable to do so?

The CHAIRMAN said, in respect to the Brazilian group, the Brazilian Submarine and the Western and Brazilian Companies, which had done him the honour of making him Chairman, the West India and Panama Telegraph Co. had practically no connection in that direction at all. Their own connections were with the Cuba Company and the International Ocean Telegraph Co.

The resolution was then unanimously carried.

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Mr. JOHN NEWTON proposed a vote of thanks to the Chairman, Directors and staff.

Mr. PANNELL seconded the vote, which was unanimously carried.

Mr. HOLMES said that he would like to offer just a few remarks before the meeting separated, as he regarded that meeting as the jubilee meeting of the Company, because it was just 25 years ago that the new Board of Directors came into office, and when they did so the state of affairs of the Company was very different from that at present existing. It was reported at that time that their cables were in a very bad condition, and that the life of the Company was only worth some seven or eight years' purchase. Well, he was pleased to think that that serious prognostication had not proved to be true, and he might tell them that their original cables were good cables, both mechanically and electrically, as was proved by the fact that the first cable laid between Santiago and Jamaica—a cable which had been down now for 28 years—was still working and was in good order. There were no doubt mistakes made at first in the laying, which was over rocks and sunken reefs and banks, but that had all been rectified by the removal of the cables to a better bottom; but they had an enemy at the bottom of the Caribbean Sea, where there were copper veins, or some other substances which affected the cables, and corrosion set in and faults were developed, which entailed a great deal of trouble and heavy expense. Well, he had lived another 25 years and the Company was still alive, and he regarded its prospects as better than ever, for instead of only having a single line of cables in bad order they would see if they looked at the map that they now had a network of duplicated cables in good condition right away from Santiago to Barbadoes and Demerara. He trusted they would do much better in the future than they had done in the past.

Mr. JOHN NEWTON corroborated the remarks of Mr. Holmes, and paid a tribute to the valuable services rendered by the Board during the past 25 years.

The CHAIRMAN briefly acknowledged the vote of thanks, and the proceedings terminated.

NEW COMPANIES, STATUTORY RETURNS, &c.

CANADIAN, BRITISH COLUMBIAN AND DAWSON CITY TELEGRAPH CO. (LIMITED).—This company was registered on Dec. 9, with a capital of £300,000, in £5 shares, to acquire the whole or part of the shares, debentures, debenture stock or other securities of the Dawson City and Victoria Telegraph Co. (Limited), incorporated in Canada by Act of Parliament, to construct, build, equip and operate a telegraph line from Victoria, B.C., to Dawson City, and to carry on the business of electricians, mechanical and electrical engineers, suppliers of electricity and manufacturers and workers of electrical apparatus, instruments, cables, wires, &c.

DOWSING RADIANT HEAT COMPANY (LIMITED).—This company was registered on Dec. 8, with a capital of £12,000, in £1 shares, to acquire, develop, work and deal with any patents, inventions or licences relating to heating and lighting by electricity for hygienic, therapeutic and general purposes. The first subscribers, each with one share, are:—W. Conolly, A. C. Newstead, Herbert J. Dowsing (electrical engineer), Mrs. C. J. Newstead, Mrs. E. E. Conolly, F. W. G. Conolly and Mrs. L. Dowsing. The first Directors are:—W. Conolly, A. C. Newstead and Herbert J. Dowsing.

ELECTRIC TESTED LAMP CO. (LIMITED).—This company was registered on Dec. 10, with a capital of £2,000, in £1 shares, to acquire the business carried on under the style of the Electric Lamp Contract Renewal Co., by Mr. R. T. Godman, and to supply, sell, repair and deal in electric lamps, machinery, instruments, apparatus, &c. The first subscribers are:—C. H. Cumberland, W. J. Williams, R. T. Godman, A. W. Gattie, A. W. Seaman (electrical engineer), W. Smith and H. St. Yorke.

ENGLISH DE LAVAL STEAM TURBINE CO. (LIMITED).—This company has been registered, with a capital of £100,000, in £10 shares, to manufacture and develop De Laval's patent steam turbines, to enter into agreements with Messrs. Greenwood and Batley and the Aktie Bolaget De Lavals Angturbin, and to carry on the business of steam, air, gas and water turbine manufacturers. The subscribers are: Arthur Greenwood, Henry Greenwood and John H. Wurtzburg, engineers (with 50 shares each); Daniel Norrman, engineer (50 shares); and Major-Gen. Micklem, S. T. Batley (engineer) and George Hagger (one share each). The first Directors are: Arthur Greenwood, Henry Greenwood, John H. Wurtzburg and Daniel Norrman.

S. M. VAN HINDEN ELECTRICAL CO. (LIMITED).—This company was registered on Dec. 2, with a capital of £1,000, in £1 shares, to enter into an agreement with Mr. S. M. Van Hinden, and to carry on at Liverpool or elsewhere the business of electricians, electrical and mechanical engineers, suppliers of electricity, manufacturers of electrical apparatus, &c. The first subscribers, each with one share, are: A. J. Vickary, S. M. Van Hinden, J. Beynon, Miss G. Vickary, I. Gorfunkle, W. Gorfunkle and Mrs. E. Vickary. The first Directors are: A. J. Vickary and S. M. Van Hinden.

P. C. MIDDLETON AND CO. (LIMITED).—This company was registered in Edinburgh on Dec. 9, with a capital of £50,000, in £1 shares, to acquire and carry on the business of electric light and power engineers, now carried on under the style of P. C. Middleton and Co. The first subscribers, with one share each, are:—P. C. Middleton (electrical engineer), N. Beves (engineer), W. Smith (engineer), J. Webster, J. Packman, J. Henderson and J. Morrison. The first directors are:—W. Jackson, P. C. Middleton (managing), N. Beves, J. Webster, J. Linney and H. Skipworth.

ALDERLEY AND WILMSLOW ELECTRIC SUPPLY (LIMITED).—The 1897 return was filed on Sept. 28. The capital is £30,000, in £1 shares (of which 10,000 are Preference). Seven shares have been taken up, on each of which 2s. 6d. has been called.

CHILIAN ELECTRIC TRAMWAY AND LIGHT COMPANY (LIMITED).—The statutory return, to Sept. 8, has been filed. Seven shares have been taken up out of a capital of £1,050,000, in £1 shares, and £7 has been received.

MONTE VIDEO TELEPHONE CO. (LIMITED).—The annual return to Nov. 14 has been filed. The capital is £160,000, divided into 87,000 Preference and 73,000 Ordinary shares of £1 each; 84,000 of the former and 71,000 of the latter have been taken up and issued as fully paid.

VENEZUELA TELEPHONE AND ELECTRICAL APPLIANCES CO. (LTD.).—The annual return to Nov. 18 has been filed. The capital is £85,000, divided into 70,000 shares of £1 each and 1,500 shares of £10 each. All the former and 860 of the latter have been taken up, and 56,506 £1 shares have been issued as fully paid. The full amount has been called on the others.

WIRELESS TELEGRAPH AND SIGNAL CO. (LIMITED).—The annual return to Oct. 21 has just been filed. The capital is £100,000, in £1 shares, of which 60,000 have been issued as fully paid, and £40,000 has been paid on the others. The capital has since been increased to £200,000 by the creation of 100,000 new shares of £1 each.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Oct. 13, 1898). Price of silver 27½d. per oz. (Dec. 15). Consols (2¾ per cent.) 110¼—110⅜ for money, 110½—110⅝ for account; 2½ per cent. 104½—104⅝ (Dec. 15). Stock Exchange Settling Days: Stocks and Shares Continuation Days, Dec. 28 and Jan. 11; Ticket Days, Dec. 29 and Jan. 12; Pay Days, Dec. 30 and Jan. 13; Mining Share Carry-over Days, Dec. 27 and Jan. 10.

BRISBANE TRAMWAYS CO. (LIMITED).—This week subscriptions have been invited for £167,900 Five per Cent. First Mortgage Debentures in this company, which was formed in 1895 to acquire the tramways in Brisbane, and convert them from horse to electric traction, and to extend the lines. The company has a virtual monopoly of the tramway traffic in the city and suburbs, the municipality having the right of purchase in October, 1917, at a price to be agreed. Mr. H. S. M. Woodrow, 52, Moorgate-street, London, E.C., is secretary.

CANADIAN, BRITISH COLUMBIAN AND DAWSON CITY TELEGRAPH CO. (LIMITED).—The subscription lists closed yesterday of an issue, at £95, of £225,000 Five per Cent. First Mortgage Debenture stock of this company, which has been formed with a share capital of £300,000, for the purpose of constructing and working telegraph lines authorised to be built by the Dawson City and Victoria Telegraph Co. (Limited), a company incorporated by Act of Parliament of the Dominion of Canada. The route traversed by the company's lines includes the mining centres of the Cariboo, Omenica and Cassiar districts, where a number of large mining and trading companies are operating. Further extensions of the lines are also to be made. This line is expected to be in operation by April next. The right is reserved to redeem, subject to six months' notice after the expiry of six years, the whole or part of these debentures at 110. The secretary and offices of the company are Mr. W. Young, 64, Victoria-street, London, E.C.

CAPE ELECTRIC TRAMWAYS (LIMITED).—The transfer registers of debentures will be closed from 18th to 31st inst. inclusive.

CENTRAL LONDON RAILWAY CO.—A further call of £2 per share on the Ordinary and Preferred partly paid shares of this company has been made, and is payable on Jan. 13.

CHELSEA ELECTRICITY SUPPLY CO. (LIMITED).—The books of this company will be closed from 14th to 31st inst., preparatory to the payment of the half-year's interest on the Debenture stock.

CITY OF LONDON ELECTRIC LIGHTING CO. (LIMITED).—The transfer books of the Debenture stock will be closed from 17th to 31st inst. inclusive, preparatory to payment of the interest due on Jan. 1.

DIRECT WEST INDIA CABLE CO. (LIMITED).—The Directors' report to June 30 last was presented to a meeting of shareholders on Wednesday, and resolutions approving the proposals of the Directors therein contained were adopted unanimously. The report was as follows:—The company's cables were successfully completed and opened to the public on Jan. 31 last. The Jamaica Government have passed a law granting the company a subsidy of £2,000 a year for five years, and the Turk's Island Government have agreed to give £120 per annum for a similar period. The revenue account shows a credit balance of £15,045. 8s. 7d., of which £10,490. 12s. 10d. has been applied to the discharge of all expenses incurred prior to the opening of the cable for traffic, including the discount at which the debentures were issued (£6,000), leaving available £4,554. 15s. 9d. It is proposed to pay a dividend for the half-year to June 30 at the rate of 5 per cent. per annum, absorbing £750, leaving £3,804. 15s. 9d. to be carried forward. A Stock Exchange quotation has been obtained for the debentures. Mr. Geo. G. Ward and Mr. Fred. Ward have been elected to seats at the board. Mr. T. G. H. Glynn and Mr. Joseph Rippon retire and offer themselves for re-election as Directors, as do Messrs. Gribbon, Holroyd and West as auditors.

DOULTON AND CO. (LIMITED).—The applications for the Five per Cent. Preference shares of this company amounted to nearly four millions and a quarter, and those for the Debenture stock to upwards of £2,500,000.

EDMUNDSONS' ELECTRICITY CORPORATION (LIMITED).—Applications are invited for £75,000 4½ per cent. First Mortgage Debenture Stock of this Corporation at par, £25,600 of which amount has been applied for by the directors and shareholders and is to be allotted in full. The prospectus (which is given on another page) announces that this stock will be secured by a trust deed creating a first charge upon debentures to which this

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Company is entitled in various electricity supply companies, and by a floating charge upon the undertaking of the Corporation. This debenture stock is redeemable at the option of the Corporation after the 1st of January, 1913, on six months' notice at 105. The prospectus sets out the companies in which the Corporation is already interested, and gives some particulars of further contracts to which the present debenture issue is to be devoted. Application forms and further particulars can be obtained at the offices of the Corporation or from the solicitors or brokers. The list opens to-morrow (Saturday) and closes on or before Tuesday next, December 20th, at 4 p.m.

ELECTRIC CONSTRUCTION CO. (LIMITED).—A meeting of the Second Mortgage Debenture-holders will be held at Winchester House, E.C., on 21st inst., to consider a recommendation by the trustees (the Electric and General Investment Co.) to accept an offer to pay off, on Jan. 1, 1899, the outstanding balance of Electric Construction Co's. Six per Cent. Mortgage Debentures at 103 per cent.

ELECTRO CHEMICAL CO. (LIMITED).—This company are making an issue of £40,000, in Six per Cent. First Mortgage Debentures.

GREAT NORTHERN TELEGRAPH CO. (LIMITED).—The coupons falling due on Jan. 1 should be presented for payment at the office of Messrs. C. J. Hambro and Son, 70, Old Broad-street, E.C.

HALIFAX AND BERMUDAS CABLE CO. (LIMITED).—The report of the Directors of this company for the year to June 30 last, submitted to the shareholders on Wednesday, states that the delay in presenting the statements of account is due to the pressure arising from the accession of business during the Spanish-American war. Since last report the company contracted with the British Treasury to lay a cable to connect Bermuda with Jamaica, *via* Turk's Islands, and the Direct West India Cable Co. (Limited) was formed to undertake the work. The contract was signed on Aug. 2, 1897, and the cable was opened for traffic on Jan. 31, 1898. This extension greatly improves the position of the Halifax and Bermudas Company by giving it through traffic. The receipts in the past year were £10,154. 7s. 4d., compared with £3,742. 8s. 4d. in 1896-7. This increase is due to the opening of the Jamaica cable and to the interruption of other routes during the Spanish-American war. The net result is a profit of £6,655. 0s. 8d., compared with £951. 15s. 11d., an increase of £5,703. 4s. 9d. It is proposed to declare a dividend of 5 per cent., amounting to £2,500, leaving £4,155. 0s. 8d. to be carried forward. Offers for the sale of debentures to the trustees were invited in December and June last, and £4,989. 7s. 6d. was paid for £5,100 of debentures, which amount has been written off capital expenditure. A Stock Exchange quotation has been obtained for the debentures. Mr. Geo. G. Ward and Mr. Fred. Ward have been elected to seats at the board of the company. Mr. Charles R. Hosmer and Mr. Joseph Rippon retire, and offer themselves for re-election. At the meeting resolutions adopting the report, the dividend, the re-election of retiring Directors and auditors were carried unanimously.

NATIONAL TELEPHONE CO. (LIMITED).—The transfer books of the Three and a-Half per Cent. Debenture stock of this company will be closed from the 19th to 31st inst. inclusive, preparatory to the payment of the half-year's interim dividend due Jan. 1.

ROLLER-BEARINGS CO. (LIMITED).—The Directors' report for the year to Sept. 30 states that during this period much further experience has been gained in the practical application of this company's bearings, and several important improvements have been made, having for their object greater efficiency without adding materially to the cost. There has been a considerable development in the adoption of line shafting and heavy bearings, whilst their introduction for tramway work has increased to an extent which justifies the Directors in claiming that they are now in use in most of the principal cities and towns of the United Kingdom. The company's bearings are also in successful operation upon furnace cars, dynamos, broughams, motor-cars, heavy ventilating fans for collieries, and a variety of other machines. The number of bearings supplied in the year shows a considerable increase, the gross value of the trade done showing an increase of over 100 per cent. The Directors have made strenuous efforts to bring roller bearings prominently to the front. This has necessitated considerable expenditure of capital, which they believe will be remunerative, and will prove by future results to have been fully justified. Considerable progress has been made in the introduction of the bearings into France and Germany, and in the former country negotiations are still proceeding for the acquisition of the patent rights on remunerative terms to the company.

SHEFFIELD ELECTRIC LIGHT AND POWER CO. (LIMITED).—A dividend of 10 per cent. is announced. A meeting is called to wind up the company, consequent upon the purchase of its undertaking by the Sheffield Corporation.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has appointed Wednesday, Dec. 21, a special settling day in £100,000 Five per Cent. Perpetual Debenture stock of the *British Electric Traction Co. (Limited)* and 13,400 fully paid Ordinary shares of £5 each (Nos. 6,601 to 20,000) and 13,400 fully paid Five per Cent. Cumulative Preference shares of £5 each (Nos. 6,601 to 20,000) of the *Telegraph Manufacturing Co. (Limited)*, both securities to be quoted in the Official List. The committee has been requested to appoint a special settling-day in and to grant a quotation to 10,000 £5 Ordinary shares of the *Folkestone Electricity Supply Co. (Limited)*, and also to allow 15,000 Seven per Cent. £10 fully paid Cumulative Preference shares of the *British Aluminium Co. (Limited)*, and £100,000 Four per Cent. First Mortgage Debenture stock of the *London Electric Supply Corporation (Limited)*, to be quoted in the Official List.

WESTERN AND BRAZILIAN TELEGRAPH CO. (LIMITED).—This company's traffic receipts for the week ended Dec. 7 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Co., Limited) were £2,973.

WESTERN UNION TELEPHONE CO.—This company has declared a quarterly dividend of 1¼ per cent.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
*Birmingham Tramways.	Dec. 10	3,867	+ 431	...	...	...
Blackpool Corporation...	„ 8	127	+ 38	36	15,942	+ 2,345
Blackpool and Fleetwood Co.	„ 10	137	...	22	13,987	...
*Bristol Trams & Carriage	„ 9	2,558	+ 302	23	69,208	+ 8,213
City & South London Ry.	„ 11	1,117	+ 16	24	23,754	+ 772
Dover Corporation	„ 10	142	+ 61	36	6,718	...
Dublin United (Southern)	„ 9	652	+ 265	49	21,646	+ 7,017
Liverpool Overhead Rly.	„ 11	1,383	+ 87	24	37,055	+ 3,177
*Sheffield Tramways.....	„ 11	1,228	+ 277	49	50,157	+ 2,251
*South Staffs. Trams.....	„ 9	600	+ 49	49	30,950	− 26

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Dec. 7.		Price Wednesday, Dec. 14.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Week Ending Dec. 14. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.					£ s. d.			
6,000	10	...	Bournemouth and Poole Electricity Supply Ord.	11	11½	11	11½	—	—	..	..
6,000	10	£3 5s.	Do. 4½ per Cent. Cumulative Pref.	10⅝	11⅛	10⅝	11⅛	4 4 0	—	..	..
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	11½	12⅛	11½	12⅛	2 16 0	February & August	..	..
20,000	5	2/5	Do. 4½ per Cent. Preference	6	6⅛	6	6⅛	3 9 3	" "	—	..
£34,000	5	2/6	Chelsea Electricity Supply Ordinary	8	9	8½	9½	3 3 2	March	8½	—
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	114	116	115	117	3 18 5	June and December	—	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red)	103	105	103	105	4 15 3	..	..	..
50,000	10	5/0	City of London Elec. Lighting Ord. 40,001 to 90,000	24½	25½	24	25	5 0 0	February & August	25	24½
10,000	10	1/9	Do. Ordinary 90,001 to 100,000	24	25	23½	24½	..	..	..	..
40,000	10	6%	Do. 6% Cumulative Pref.	15½	16½	16½	16½	7 11 9	January and July ..	16½	16
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	127	131	127	131	3 15 1	June and December	..	..
30,000	10	—	County of London & Brush Prov. Ord. (fully paid	12½	13½	12½	13½	—	—	..	—
10,000	10	...	Do. (£8 paid)	10	11	10	11	..	..	—	—
20,000	10	6/0	Do. 6% Cumulative Preference	14½	15½	14½	15½	4 0 0	March & September	—	—
15,660	5	2/6	House-to-House Electric Lighting Supply Ord.	9	10	9	10	2 0 0	..	9⅞	—
17,000	5	3/6	Do. 7 per Cent. Preference	9½	10½	9½	10½	3 6 8	March & September	9½	—
15,000	5	10%	Kensington and Knightsbridge Ord.	13	14	13	14	3 18 7	..	..	—
10,000	5	6%	Do. 6% 1st Pref.	7½	8½	7½	8½	3 12 9	January and July ..	..	—
110,000	3	—	London Electric Supply Ordinary	3½	4	3½	4	—	—	—	—
48,050	5	...	Do. Preference	6	6½	6	6⅝	—	—	6⅞	..
62,400	10	5/0	Metropolitan Electric Supply Ordinary	17	18	17½	18½	3 4 10	April and October ..	17⅛	16⅝
£230,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	121	117	121	3 14 9	June and December	—	—
6,452	10	6/0	Notting Hill Electric Ordinary	16	17	16½	17½	3 8 7	March	17	16⅝
275,000	1	—	Rand Electric	⅜	1⅛	⅜	1⅛	—	—	—	..
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'c't'n, Ltd., 5% 1st Mor. Deb	88	93	83	93	5 8 1	—	—	—
150,000	$100	$2	Royal Electric Company of Montreal Shares ...	155	160	155	160	5 0 0	—	—	—
130,900	100	4½%	* Do. 4½% 1st Mort. Debs.	104	106	104	106	4 6 0	April and October	..	..
31,980	5	5/0	St. James and Pall Mall Electric Ordinary	17	18	16	17	4 14 2	February & August	17⅛	16½
20,000	5	2/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	" "	9⅝	9½
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.)	105	108	105	108	3 15 6	June and December	..	—
66,000	5	...	South London Electric Supply Ordinary (£3 paid).	2⅞	3⅛	2⅞	3⅛	..	..	..	..
79,900	5	5/0	Westminster Electric Supply Ordinary	16	17	16	17	3 16 6	March & September	16⅞	16⅝
18,848	5	5%	Yorkshire House-to-House	7⅞	8	7⅞	8	3 2 6	February and July ..	—	—
18,626	5	5%	Do. (£4 paid)	5½	6½	5½	6½	3 18 5	February and July ..	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Dec. 7.		Price Wednesday, Dec. 14.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 14.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS								
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	101	105	101	105	3 17 0	January and July	101	..
25,000	10	..	Amazon Telegraph	3	4	3	4	—	—	—	—
£125,000	100	5%	Do. 5 per Cent. Debentures	92	95	92	95	5 5 3	—	—	—
£905,560	Stock	15/0	Anglo-American	64	67	64	67	4 10 5	Feb., May, Aug., Nov.	6¾	..
£3,047,220	Stock	30/0	Do. Preferred	114½	115½	115	116	5 4 4	" "	116⅛	114¾
£3,047,220	Stock	5/0	Do. Deferred	16½	16¾	16½	17	—	—	16 15/16	16⅝
130,000	10	5/0	Brazilian Submarine	15½	15¾	15¾	15¾	4 15 3	Mar., June, Oct., Dec.	15 9/16	15¼
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	111	115	111	115	4 8 0	June and December	..	..
10,000,000	$100	$12½	Commercial Cable Capital Stock	180	190	180	190	4 4 3	Jan., Apr., July, Oct.	..	..
£1,332,523	Stock	4%	* Do. 4 per Cent. Debenture Stock	104	106	104	106	3 15 6	" "	105½	105¼
16,000	10	8/0	Cuba Submarine Ordinary (Deferred)	10	11	10	11	6 7 3	February and August	10½	..
6,000	10	10/0	Do. Preference 10 per Cent.	16½	17½	16½	17½	5 14 3	" "	—	..
12,931	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October	..	—
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	..	—
£30,000	50	4½%	Do. 4½ per Cent. Debentures	105⅞	108⅞	105⅞	108⅞	4 5 0	January and July	—	—
60,710	20	3/0	Direct United States Cable	11½	12	11½	12	5 8 4	Jan., Apr., July, Oct.	11⅞	11⅝
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	103	106	103	106	4 6 8	..	..	..
£4,000,000	Stock	..	Eastern Ordinary	172	177	172	177	3 19 2	Jan., Apr., July, Oct.	176	173½
£1,295,000	Stock	17/6	Do. 3½ per Cent. Pref. Stock	104	107	104	107	3 5 5	" "	105⅝	104
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	124	123	124	128	3 2 6	May and November	125	124
£89,900	100	5%	* Do. 5 per Cent. Debentures, 1899	101	104	101	104	4 17 0	February & August	..	..
£500,000	Stock	8/9	Do. Provisional Certificates 50% paid	£4	57	54	57	..	..	—	..
250,000	10	2/6	Eastern Extension	17½	17¾	17½	17¾	3 18 11	Jan., Apr., July, Oct.	17¾	17 3/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	129	125	129	3 2 4	February & August	126	..
£16,200	100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900 (reg.)	101	105	101	105	4 17 1	January and July	..	..
£64,400	100	5%	Do. (Bearer)	102	105	103	105	4 17 1	" "	102⅝	—
£35,100	100	5%	*Eastern and S. African 5 p. c. Mor. Deb., 1900 (reg.)	101	105	101	105	4 17 1	" "	—	—
£46,500	100	5%	Do, (Bearer)	102	105	102	105	4 17 1	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	103	106	103	106	3 16 4	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	103⅞	106⅞	103⅞	103⅞	3 15 9	May and November	103⅛	—
180,227	10	1/9	Globe Telegraph and Trust	12½	12¾	12½	12¾	4 0 9	Jan., Apr., July, Oct	12⅜	12½
180,042	10	6%	Do. 6 per Cent. Preference	16½	17	16¾	17½	3 9 7	" "	17	16⅝
150,000	10	5/0	Great Northern of Copenhagen	28½	29½	28½	29½	3 7 10	January, April, July	..	—
£150,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B"	100	103	100	103	4 17 10	March & September	—	—
£97,800	100	4½%	Halifax and Bermuda Cable 4½% 1st Mort. Deb. (red)	101	104	101	104	4 7 0	June and December	..	—
17,000	25	12/6	Indo-European	54	57	54	57	4 7 9	May and November	—	—
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	109	112	109	112	5 7 7	March & September	..	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red)	105	108	105	108	3 14 3	June and December	—	—
11,889	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October	—	—
3,881	£100 Cert.	6%	Submarine Cables Trust	134	139	134	139	4 6 9	" "	139	..
15,609	10	—	West African Telegraph	—	—	..	..	..	—	—	—
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	4 18 0	March & September	..	—
30,008	2½	—	West Coast of America	¼	¾	¼	¾	..	—	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	103	106	103	106	3 16 6	June and December	..	..
88,321	10	0/6	West India and Panama	1½	1⅝	1½	1½	—	May and November	1⅝	1 5/16
34,568	10	6/0	Do. 6 per Cent. 1st Preference	9½	10	9¾	10½	5 17 1	" "	10⅛	9½
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	7	9	7	9	6 13 4	" "	..	—
£80,000	100	5%	* Do. 5 per Cent. Debentures	106	109	106	109	4 12 10	January and July	..	—
64,269	15	5/0	Western and Brazilian Ordinary	12½	12¾	12½	12¾	4 13 2	May and November	..	—
33,129	7½	3/9	Do. 5 per Cent. Preferred Ordinary	8	8½	8	8½	4 8 2	" "	..	—
33,129	7½	1/3	Do. Deferred Ordinary	4	4½	4	4½	—	" "	..	—
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	107	110	107	110	3 13 1	June and December	107	..
1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	..		—		6 7 10	Feb., May, Aug., Nov.	—	—
£158,100	100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	98	103	98	103	5 16 6	March & September	—	—
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	2¼	3½	2¾	3½	6 8 1	August	—	—
224,850	10/0	1¼d.	Consolidated Telephone Const. & Manufacturing	1/16	3/16	1/16	3/16	6 7 0	July	—	—
28,000	5	4/0	Monte Video Telephone 6 per Cent. Preference	..	—	—		7 5 6	October	—	—
£84,597	5	3/0	National	5½	5¾	5½	5¾	5 4 4	February & August	5¾	5⅝
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	12	14	12	14	4 5 9	" "	13⅝	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	12	14	12	14	4 5 9	" "	—	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	5½	5¾	5½	5¾	4 10 11	" "	5 7/16	..
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	100	103	100	103	3 6 8	June and December	103¼	101⅝
171,504	1	0/4	Oriental	⅜	½	⅜	½	6 13 4	April and October	—	—
58,000	5	6/0	United River Plate	4½	4¾	4¼	4¾	6 6 5	July	4⅝	..
£151,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	104	107	104	107	4 15 5	June and December	106¼	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	2	1/2⅜	Brush Electrical Engineering	1⅞	2	1⅞	2	3 0 0	—	—	—
90,000	2	1/2⅜	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	—	—	—
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	111	115	111	115	3 19 0	February & August	—	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102	105	104	105	4 7 0	June and December	103	..
£20,000	5	5/0	Callender's Cable Construction	9½	10½	9½	10½	6 8 7	" "	—	—
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	111	114	111	114	4 0 4	November and May	..	—
300,000	1	9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	—	1½	—
50,000	1	..	Chadburn's Ship Telegraph Ordinary	1⅛	1⅜	1⅛	1⅜	—	—	—	—
50,000	1	7½	Do. 6 per Cent. Cumulative Pref.	1	1⅛	1	1⅛	4 16 0	—	—	—
32,098	3	—	Crompton and Co. (Nos. 1 to 32,098)	1½	2	1⅝	2⅛	..	—	—	—
£82,850	100	5%	* Do. 5% First Mort. Deb. (red.)	91	96	91	96	5 5 10	January and July	—	—
99,261	5	2/1½	Edison and Swan United ("A" Shares) (£3 paid)	2	2⅛	2	2⅛	7 4 0	February & August	2 1/16	—
17,139	5	3/1½	Do. (£5 paid)	4	5	4	5	6 0 0	" "	..	—
£194,023	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	99	101	99	101	4 0 5	June and December	..	—
17,400	5	5%	Edmundson's Electric Corporation Ord (fully paid)	5	5⅛	5	5⅛	4 10 11	Half-yearly	5⅛	—
110,000	2	1/2⅜	Electric Construction Co. (Limited)	2⅛	2⅜	2⅛	2⅜	4 12 0	February & August	2 1/16	2 1/16
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Pref.	2⅜	3⅛	2⅜	3⅛	4 6 2	August	..	—
£111,100	Stock	4%	Do. 4% First Mortgage Deb. (red.)	105	107	105	107	3 16 2	..	..	—
21,196	1	—	Elmore's Patent Copper Depositing	⅛	⅜	⅛	⅜	..	—	—	—
12,500	10	8/0	Henley's Telegraph Works Ordinary	20½	21½	20½	21½	6 0 11	February & August	21½	21½
78,000	10	7/0	Do. 7 per Cent. Preference	18	19	18	19	3 13 8	" "	..	—
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 8	" "	..	—
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	4 8 11	" "	22¾	—
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	102	106	102	106	3 15 6	March & September	104	..
37,350	12	12/0	Telegraph Construction and Maintenance	37	41	37	41	4 6 2	March and July	38½	..
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	104	107	104	107	4 14 9	January and July	—	—
£50,000	5	4/0	Willans and Robinson Ordinary	7¾	8½	7¾	8½	4 17 0	April and October	8½	—
£30,000	5	3/0	Do. 6% Cumulative Preference	6¾	7½	6¾	7½	4 2 9	" "	—	—
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	106	108	106	108	3 18 8	May and November	—	—
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	..	Blackpool and Fleetwood Tramways	19	21	19	20	..	—	19¾	19½
25,000	10	6%	Bristol Tramways and Carriage	21½	22	21½	22	2 14 7	—	—	—
25,000	10	6%	Do. (£7. 10s. paid)	18⅜	18⅞	18⅜	18⅞	1 14 1	—	—	—
£90,410	Stock	4%	Do. 4% Debenture	121	123	121	123	3 5 1	—	—	—
80,000	10	..	British Electric Traction Ordinary	16	17	16	17	..	—	—	—
10,000	10	2/4 7/16	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm.pd.)	12½	13½	13	13½	4 8 11	—	13⅜	13 1/16
£35,250	10	3/0	Central London Ordinary	9½	10½	9½	10½	2 18 6	June and December	10	..
178 303	10	1/9⅜	Do. (£6 paid)	5½	6½	5½	6½	2 16 6	" "	6	5⅞
£630,000	Stock	2½%	City and South London Railway Con. Ordy.	65	68	65	68	2 19 4	January and July	68½	—
22,500	10	..	Do. Ordinary (£4 paid)	3½	4	3½	4	..	..	..	..
9,251	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	3 4 6	January and July	—	—
£137,701	Stock	4%	Do. 4% Perpetual Debenture	134	136	134	136	2 18 10	May and November	..	—
20,000	10	6%	Imperial Tramways Ordinary (old £6 shares)	16½	16⅞	16½	17	3 10 7	March & September	17	16½
10,000	10	6%	Do. 6% Preference	15	15⅞	15⅛	15⅝	3 18 1	" "	—	—
£70,000	Stock	4%	Do. 4% Debenture	116	118	116	118	3 16 3	..	..	..
37,500	10	3/4	Liverpool Overhead Railway Ordinary	10 3/16	10 5/16	10 3/16	10 5/16	3 3 9	February & August	—	—
10,000	10	5%	Do. 5% Preference	15	15½	14¾	15½	3 5 7	" "	—	—
125 000	Stock	4%	Do 4% Debenture	1 8	110	108	110	3 13 1	January and July	—	—
20,000	5	3/3½	New General Traction 6% Cumulative Pref	4⅜	5½	4⅜	5½	—	—	—	—
£540,000	Stock	3%	Waterloo and City Ordinary	113	116	112	115	2 13 6	June and December	113½	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

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CONTENTS OF THE CURRENT NUMBER.

NOTES	285	Carbons for Electric Lighting and Other Purposes. By F. Jehl. Illus. Continued	301
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe	288	A Direct Reading System for Measuring Current Leakage. By Dr. M. Kallmann. Illus.	303
Cork Combined Electric Lighting and Traction System. Illustrated	289	Improvements in Magnetic Space Telegraphy. By Dr. O. Lodge, F.R.S. Illus. Continued	305
Carlisle Electricity Supply Station. Illustrated	294	Legal Intelligence	310
An Imperial Cable Service	298	Trade Notes and Notices	312
Electricity Works Accounts	298	Companies' Meetings & Reports	317
COMBINED ELECTRIC TRACTION AND SUPPLY STATION	300	City Notes	318

NOTES.

THE letter addressed to the Colonial Secretary by Sir SANDFORD FLEMING in advocacy of his all-British, and State-owned submarine cables scheme is receiving a quite unusual amount of attention in the daily press, more by reason of its fitting in with the Imperial sentiment just now than because of its intrinsic merits. The novelty of the present suggestion is that the State—or more precisely the British, Canadian, Australian and New Zealand Governments—shall jointly lay down cables at their own expense from Western Canada *viâ* the Pacific to Australasia and round by way of India, Ceylon, the Cape, and thence to Bermuda and Halifax. The cost is estimated at from £5,000,000 to £6,000,000; and the one pertinent criticism by *The Times* in the course of a friendly leader is summed up in the question "Is the game worth the candle?" All the rest is a mere string of platitudes about coaling stations, concentration of fleets, duplication of lines of communication, and immunity from interruption, most of which is more or less erroneous, and the rest of no practical account.

SIR SANDFORD FLEMING'S arguments, if they are worth anything, go to show that the whole British cable system of the world should be owned by the State; but instead of suggesting their transfer from the Companies he advises the State to lay down cables of its own in competition—for that is what the scheme really amounts to. We cannot believe that it will ever be adopted in that shape, or on the scale recommended by its advocates. If there are strategical reasons for additional cables, these cables will be laid, no doubt, when and where necessity for them is proved; but it would surprise us very much did Mr. CHAMBERLAIN give his consent to the expenditure of so large a sum chiefly, if the truth be told, to reduce the by no means inordinate profits earned by the existing great cable companies, who have done all the hard work and accepted all its risks.

ACCORDING to the *Times* Ottawa correspondent, the Dominion has offered to contribute an equal share with the Imperial Government of the cost of a Pacific cable, the joint obligation not to exceed five-ninths of the whole cost, the Australasian colonies having undertaken to contribute the balance. This scheme, it should be observed, is not that recommended by Sir SANDFORD FLEMING, and stands probably as little chance of acceptance by the British Government.

PUBLIC interest in the telephone question is this month represented by the *Fortnightly Review* with an article from the pen of Mr. A. H. HASTIE, entitled "The Telephone Tangle and the Way to Untie it." With the tangle he is on sure ground, and appears to be in agreement with most writers on the subject, except perhaps in his personal leaning towards ceding the trunk wires to the National Company, and giving it all the powers needed for an effective monopoly. Failing this, his mode of untying the tangle is extremely simple. He values the shares and stock of the Company at about six and a-half millions; add 10 per cent. for compulsory purchase, and the whole thing will be in the hands of the State for, say, seven and a quarter millions—a capital sum to be borrowed at 2½ per cent. and the earnings from which will be doubled and trebled in no time.

MR. HASTIE is not in love with the Post Office, and he wants the telephone service to be placed under a separate and independent department whose duty it will be, among other things, to enable any gentleman shooting in the north of Scotland to have his London letters read out to him every morning *viâ* the trunk telephone wires. This is Mr. HASTIE'S ideal system; unfortunately it is not the ideal of sporting gentlemen, nor of a vast number of other persons who desire to be let alone in their privacy and their recreation. Telephone enthusiasts like the *Fortnightly Review's* contributor need to be reminded that the telephone was made for man, not man for the telephone.

WE publish in another column a full report of a case decided in the City of London Court on Monday. From the evidence it appears that a workman—who has at any rate since

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the accident made up his mind that he is unskilled—while replacing a broken portion of a fuse-holder caused a short-circuit with a screw-driver and burnt his hand. The short-circuit was no doubt an accident directly attributable to the negligence of the workman, but probably the fact that the man was left in ignorance as to whether the fuse on which he was working carried current or not was one of the factors which influenced the judge in giving his verdict. It is evident that there was a distinct possibility of causing a short circuit unless care was taken in doing the job, and, whether the man was skilled or unskilled in the manipulation of screw-drivers, this should have been made quite clear to him.

An amusing example of the lay newspaper reporter's appreciation of technicalities is the *Standard's* account of the case, from which we quote below:—

> From the evidence for the plaintiff it seemed that . . . he was told . . . to do certain electrical work in connection with high-tension mains. While there an explosion of electricity occurred, and the plaintiff was very severely hurt on the left arm and hand. Had he been a little taller, the electricity would have struck his head, and he must have been killed instantaneously. As it was, he went to St. Bartholomew's Hospital, and was away from work for ten weeks. . . . The defence was that the plaintiff brought the accident about by not wearing india-rubber gloves, as provided by the rules. He himself caused the explosion by applying a screw-driver to an arc. . . .

Dr. Kallmann, the city electrician of Berlin, has always paid considerable attention to the problem of testing supply networks under working conditions, and a Paper by him, describing the systems of fault-signalling networks employed in the German capital, aroused considerable interest a few years ago. In another column we publish the substance of a further contribution of his to the subject of testing for earth leakages. The particular way he applies the double bridge is, we believe, new, although Mr. Quin has used a differential ammeter in a somewhat similar way for the purpose of detecting faults, and Dr. V. Krempelhuber has also recently proposed the employment of this instrument for observing the leakage from a three-wire network.

Of the various applications of Dr. Kallmann's system, the measurement of leakage from single feeders appears to be the most valuable. As we mentioned in a leading article a few weeks ago, the periodical testing of feeders is most important, and if Dr. Kallmann's method of continuous testing at the expense of a trifling C^2R loss proves as practical as it appears on paper it ought to be extensively employed. On the other hand, the system described for measuring stray currents from rail returns will, we think, hardly be found serviceable in practice, for if there are cars between the two pairs of test points (which the author says must be placed some kilometres apart) the current passing through the rails at the two ends of this section will not be the same even if there is no appreciable leakage from the rails to earth. The method for taking a continuous reading of the condition of house wiring is ingenious, but it must be borne in mind that the reading can only be considered an indication, and not a measurement, for it is not dependent merely on the insulation resistance of the installation under test. This fact is, however, alluded to by the author. The whole article merits careful perusal by the electricity supply engineer.

We give an account in another column of the inquest on the unfortunate workman who lost his life in Southampton. Work on "live" high-pressure mains and machinery is always attended with danger, whether the workman insulates himself or puts on rubber gloves, and such work should be avoided as much as possible. So many accidents, fatal and otherwise, have occurred in transformer pits and junction boxes that, except in cases of emergency, no work should be done in those places while the connections therein are charged. In Southampton no very serious inconvenience could have been caused by leaving the work over until the mains had been disconnected.

Cable Interruptions.—	Date of Interruption.
Para—Maranham	Nov. 15. 1898

David Salomons Scholarship.—The David Salomons scholarship for 1899 has been awarded by the Institution of Electrical Engineers to T. R. Renfree, student in the Siemens engineering laboratory of King's College.

Trunk Telephone Line.—A telephone line between Paris and Brest was opened on Saturday last, and it will probably be extended to Cherbourg in the near future. A line to Luxembourg, *vid* Longwy and Nancy, is projected.

The British Association and the Academie des Sciences.—It is now definitely announced that the next annual Congress of the Academie des Sciences will take place at Boulogne from Sept. 14 to Sept. 22, 1899, which is simultaneous with the meeting of the British Association at Dover.

Telegraphy in Egypt.—Instructions have been issued for a detachment of Royal Engineers to be made ready at once for service in Egypt and the Soudan. On arrival in Egypt the detachment will be told off for duty in connection with a scheme for developing the telegraph system in the Soudan.

Personal.—The order of knighthood has been conferred upon Mr. W. S. McDonald, the generous donor of many gifts to the McGill University of Montreal. Mr. Joseph Chamberlain has cabled to Mr. McDonald his thanks for the magnificent gifts to the university.——We hear that Prof. Röntgen has declined the offer of the appointment to the University of Leipsic.

New Electricity Supply Station.—The Salisbury Electric Light and Supply Co.'s works were formally opened by the Earl of Pembroke on Monday last. Messrs. Edmundson were the contractors for the complete works, which have been erected on an old mill site and are driven partly by a turbine and partly by steam. We reserve for a future issue a full description of the station.

Electric Traction in New York.—The Third Avenue Railway Co. of New York, having decided to abandon its cable equipment for electric power, has awarded the contract for the steam and electrical equipment of its power house, which will contain machinery capable of developing 64,000 H.P., and for its street railway lines, to the Westinghouse Electric and Manufacturing Co. of Pittsburgh. The undertaking involves the expenditure of rather more than a million sterling.

Royal Institution.—Among the lectures announced before Easter is a course of seven, by Lord Rayleigh, on the mechanical properties of bodies. The Friday evening meetings will begin on January 20th, when a Discourse will be delivered by Prof. Dewar on "Liquid Hydrogen"; succeeding Discourses will probably be given by, among others, Prof. H. S. Hele-Shaw, Prof. H. L. Callendar, and Lord Rayleigh. The year 1899 is the Centenary Year of the Royal Institution, and arrangements are being made with a view to its celebration in a fitting matter. Details will be announced at a later period.

Wireless Telegraphy.—During the present week the Wireless Telegraph Co. have been occupied in equipping a lighthouse and a lightship on the south coast with instruments to enable wireless telegraphic communication to be established

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between the ship and the shore. The Trinity House authorities have placed at the Company's disposal a room in the South Foreland Lighthouse, and have allowed a choice of one of the three lightships of this part of the English coast, between which two points the experiments are to be made. It is expected that these stations will shortly be in full working order on the Marconi system.

Cost of Electric Cooking.—In a Paper on "The Practical Applications of Electrical Power," read by Mr. H. R. J. Burstall before the Royal Institution of British Architects on Monday night, the following table, compiled by Mr. C. O. Grimshaw, of the Westminster Company, was given:—

Cost of Running Cooking Apparatus at 4d. per Unit.

Description.	Capacity.	Cost per hour.	Cost for one operation from all cold.
Kettle	1½ pints	... 1·28d. ...	0·45d.
Griller...	2 chops	... 2·24d. ...	0·53d.
Saucepan.....	2 quarts.	... 1·6d. ...	0·8d.
Fish kettle	16 quarts	... 4·56d. ...	—
Domestic iron...	Scorching paper	... 0·8d. ...	Cost to heat up, 0·13d.

Scientific Nomenclature.—During the course of an address to the members of the Yorkshire Naturalist Union at Scarborough, on Saturday, Prof. Michael Foster, the retiring president of the union, said that a great drawback to the spread of science was the fact that every day the English language was being enlarged by the introduction of new words to which science, in its different branches, contributed the largest proportion. The meaning of those new words became known only to those who had to make frequent use of them, and new terms were often forced on those utterly ignorant of their meaning. To carry on the work of science it was necessary, as far as possible, to use words which were in touch with the modern development of science.

"La Poste Electrique Internationale."—A company bearing this name is being promoted in Brussels, having a capital of £320,000, with the object of erecting charging stations for motor-cars at distances of 10 or 12 miles apart on the main roads in France and Belgium. The stations are to be equipped with machinery for charging accumulators and also to be provided with the necessaries for charging oil-motors and repairing all classes of motor-cars and cycles. It is also intended to have a restaurant or bar, and, in addition, to provide for medical attendance, so that the travellers can be recharged and repaired as well. The roads on which the company propose to start operations are on the main route from Brussels to Paris by way of the Meuse valley.

Obituary.—With much regret we record the death, after a short illness, of Mr. James Brown, superintendent of the Direct United States Cable Co.'s station at New York, at the age of 47. Mr. Brown was originally in the postal telegraph. service in Aberdeen, and joined the Direct Company in 1874, being sent to the Rye Beach, New Hampshire, Station. When Mr. G. G. Ward was appointed representative of the company in New York, Mr. Brown was transferred to that station as clerk-in-charge, and occupied that position until 1884, when he succeeded to the superintendency on the resignation of Mr. Ward. Mr. Brown filled his post to the satisfaction of the company as well as with credit to himself, and the company loses in him a hard-working, conscientious and painstaking official. His interment took place on the 20th inst. at Kensico Cemetery, near New York, several prominent officials of the Western Union and other telegraph companies acting as pall-bearers. Mr. Brown leaves a wife and family and a large circle of friends to deplore his early death.

An Addition to the French Telephone System.—An article has been going the round of the New York papers, to the effect that important improvements are to be introduced in the French telephone service, which will extend it considerably. We believe that the only alteration contemplated is the establishment of a system by means of which any subscriber or non-subscriber will be enabled to make an appointment with any other individual (who need not either be a telephone subscriber), to be in attendance at the latter's instrument or at a call office at a stated time. These appointment messages will be transmitted for 2½d. within a distance of 15 miles, and for greater distances a higher charge will be made, but not exceeding 5d. The message making the appointment will be delivered at the recipient's house just as a telegram, and will be in the form: Mr....., of ....., requests you to be at call office no....., at ..... o'clock. Such a system would be of great value for trunk conversations in this country—in fact, this was suggested by Mr. Campbell Swinton in the discussion on Mr. Gavey's telephone Paper at the Institution in 1896.

A Severe Snowstorm visited a wide area of the eastern part of the United States on November 26 and 27. The fall of snow was very heavy, and the accompanying wind caused the snow to drift badly in the streets of the cities and towns, and prostrated telephone and telegraph wires in the suburban districts. The street-railway service of New York was badly impaired in consequence of the storm. This was the first real test of the ability of the open-slot system to meet the severe conditions of wintry weather. This system, together with all others, excepting the elevated railroads, was paralysed for 24 hours or more, being entirely shut down from Saturday evening until Sunday evening. The stalled cars were bunched in groups around the city, impeding all efforts to clear the tracks by sweepers or ploughs. The fault is not entirely that of the electrical conduit, however, as the Metropolitan Street Railway Co., owing to the recent expansion of its system, has not provided itself with sufficient electrical ploughs and sweepers. The cleaning of the tracks had to be done mainly by horse power, and the heavy double-truck electric cars stalled along the line greatly impeded the work. The cable roads fared better than any other of the surface lines, especially as the cable sweepers do not lose their tractive effort, no matter how heavy the ice or snow, but pull right through with a force that no drift can resist. Such storms, however, very rarely visit New York, and it is not likely that this last experience will be repeated. With a sufficient battery of sweepers to keep the track free of snow as it falls, such a general tie-up will probably never occur again. Throughout the eastern section of the country overhead trolley lines were blocked to such an extent that traffic was greatly impeded for the time being.

Accidents and Interruptions.—*Bristol.*—A curious accident occurred at Kingswood, near Bristol, on Monday. The accident was caused by a runaway trolley—not an electric trolley-car, but a horse-driven railway trolley. This came into collision with a wooden lamp-post, which it broke. The lighting here is on the Parfitt overhead series system, from the Western Counties Electric Light and Power Syndicate's station, and the overhead lighting wires, falling across the wires of the electric tramway, caused a startling display of fireworks and a few slight shocks. The tram system was, however, not damaged in any way, and the service was resumed as soon as the wire could be disentangled.

Norwich.—Another serious interruption occurred in the supply at Norwich on Friday last week. A short-circuit occurred between the negative and neutral mains on one of the principal feeders, and in attempting to burn it out other short circuits were set up elsewhere and affected all three mains. In disconnecting to set matters right, the neutral main was unfortunately cut in one part, with the result that one side of the three-wire system in part of the town acquired too high a pressure, and some lamps and fittings burst, as at Wickham a short time ago. The Norwich company has now issued the following circular letter to its consumers:—

Dear Sir: I am instructed to state that in consequence of the extraordinary demand for electric light, the Company has experienced great difficulty in sustaining a full supply, the regrettable failure of last Friday being due to this cause and to the anxiety of the directors to meet the requirements of all their consumers.

As the demand during Christmas week (commencing Dec. 19) will be greater than ever, the Board appeals to its customers asking them not to turn on more lights than are actually required during the maximum load viz., between the hours of 4 and 6 o'clock.

The directors need hardly assure the public that they are doing everything possible to provide against the recurrence of such an accident in the future, whilst they greatly regret the inconvenience caused by last night's failure.

Manchester.—Owing to the failure of a rubber cable last Sunday, the electric light in some of the churches went out. The gravity of the mishap has been greatly exaggerated in the local press.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Loud Transmission of Sound.—M. Dussaud has studied the best means of intensifying the sound transmitted by a microphone to a telephone receiver. He produced a steady sound by means of an electrically-driven tuning fork placed in front of an extremely sensitive microphone. At the receiver end the circuit divided into four branches, each actuating a separate telephone membrane. M. Dussaud tried various combinations of the four receivers, and found that the more numerous they were the louder was the sound. It was also found advantageous to collect the vibrations from both sides of the membranes. He employed a set of collecting tubes all leading into a resonator of the shape and size of a human mouth. He thus was enabled to reproduce the sound of wind instruments and the human voice in a large hall accommodating 1,000 persons and with such loudness that they could be heard in every part of the hall. On the State Telephone system of Geneva communication was established between two subscribers in such a manner that ordinary speech could be heard in every part of the room. As only two Leclanchés were used, the increased efficiency was solely due to the new arrangement for transmission.

[Dussaud, *Comptes Rendus*, Dec. 5, 1898.]

Resistance between Steel Spheres.—If the effect of the pressure between two conductors in contact upon their electric resistance could be accurately determined, some light would probably be cast upon the nature of metallic conduction. F. Auerbach reports upon some valuable experiments made with this object by A. Meyer, of Stockholm, who pressed two geometrically true and perfectly polished steel spheres together and determined their resistance when the pressure was varied. The effect of the pressure is, of course, to flatten both spheres to an extent depending upon their elasticity. The flattened contact surfaces offer a freer passage to the current than is offered by a mere point of contact. Now it is conceivable that the conductivity of the contact surface is simply proportional to its area. On the other hand, it might also depend upon the pressure. Meyer's spheres showed that both these elements enter into action. They varied from 4cm. to 10cm. in diameter, and were pressed together with forces of 85gr. to 1,000gr. To ensure comparable results they had to be exposed to the vibration of a tuning fork before every measurement. The results show that the conductivity varies directly as the area of contact, and as the integral of the pressure. This means that the relation is not a geometrical one, but also an electrical one. Any theory of metallic conduction must therefore be able to account for the proportionality between conductivity and pressure before it is accepted.

[Auerbach, *Wied. Ann.*, No. 12, 1898.]

Electric Dispersion.—E. Marx has extended Drude's work with Blondlot exciter and short-wire waves by loosening the coupling between the primary and the secondary system. This has the effect of allowing the proper oscillations of the primary to develop themselves independently of the influence of the secondary, and the author thus shortened Drude's smallest waves of 12cm. to 4cm. The smallness of the waves allows of measurements of electric refractive indices of solutions by Drude's method even when the conductivity is as high as 4×10^{-6}. Such measurements were carried out for wide ranges of the electric spectrum with regard to water, benzol, and ethyl alcohol. The study of benzol yielded the interesting result that substance has, in the whole region from the ultra-violet to waves of infinite length, only one absorption band of any size. This fact makes it possible to estimate the inductance of the benzol molecule. But, on the other hand, benzol does not obey the Ketteler-Helmholtz dispersion formula, whereas ethyl alcohol does. In water the maxima and minima of the refractive index follow each other in double octaves, with decreasing intensity. Hence there are many absorption bands in the infra-red. This, according to the electromagnetic theory of light, implies an increasing divergence between the dielectric constant and the optical refractive index, and thus accounts for the unusually high value of the refractive index of water for infinitely long waves.

[Marx, *Wied. Ann.*, Nos. 11 and 12, 1898.]

Magnetic Susceptibilities.—J. Koenigsberger has accumulated a large mass of material from which to draw a number of more or less well-founded conclusions. The field of magnetic susceptibilities is almost virgin ground for the ambitious pioneer, as the quantities involved are, as a rule, extremely small, and an error of 200 per cent. is nothing out of the way. There are, however, a few solid facts brought out by the author which embody a good deal of careful work. The susceptibility of water, determined by several methods, was found consistently to be $-0{\cdot}8 \times 10^{-6}$ at 20deg. as against air. H. du Bois's theorem, according to which the susceptibility of ferric chloride solutions and other solutions is constant in various fields, so long as they contain no free iron, was confirmed. The susceptibility of aqueous solutions of paramagnetic and diamagnetic salts may be determined from that of the solvent, from the concentration, and from the susceptibility of the solid substance itself. The susceptibility of diamagnetic solids is independent of the strength of field. The author has traced some probable connection between atomic volume and atomic magnetism. He finds that bodies which have the smallest atomic volume are also most strongly paramagnetic. This analogy is worth following up, as it may help us to a clearer insight into the nature of magnetisation.

[Koenigsberger, *Wied. Ann.*, No. 12, 1898.]

Becquerel Rays.—What is the origin of uranium rays? This question is one of the most puzzling problems of modern physics. Uranium and thorium and some of their compounds have the property of sending out rays, called Becquerel rays after their discoverer, which exert photographic effects through opaque substances and impart a temporary conductivity to gases which they traverse. These properties are the same as those possessed by Röntgen rays, but whereas the origin of the energy of the latter is well known, and their nature is in a fair way of being explained, the energy displayed by uranium appears to be an open defiance of the law of the conservation of energy. Three more or less daring hypotheses have been put forward to account for it. Madame Curie supposes that all space is pervaded by rays somewhat of the nature of Röntgen Rays, but more subtle, which are only absorbed by bodies of specially high atomic weights, like uranium and thorium. Crookes surmises that these substances have what Maxwell would have called the demoniac power of absorbing some of the kinetic energy of gaseous molecules impinging upon them and emitting it in the form of Becquerel rays. A third hypothesis supposes that uranium and similar substances combine with some unknown constituent of the atmosphere by an exothermic reaction. J. Elster and H. Geitel have endeavoured to discriminate between those hypotheses, using the highly efficient uranium pitch ore of Joachimsthal for the purpose. They first tried it in a vacuum, but without noting any difference. This is a serious blow to the chemical hypothesis and to Crookes's assumption. Then they tried to shield uranium from Madame Curie's rays by taking it to the bottom of a mine, 850m. below the surface. But that expedient failed to affect the uranium. So unless those hypothetical rays are capable of penetrating 3,000ft. of rock with ease, the Becquerel rays are still completely unaccounted for.

[Elster and Geitel, *Wied. Ann.*, No. 12, 1898.]

An Electrical Exhibition Next Year.—It is evident that the Electrical Exhibition which was held at Madison Square Garden this year was successful, as a commercial enterprise, inasmuch as the managers have decided to hold another affair of this character next year. The Exhibition will be held in this city, but just where and at what time it has not yet been decided.

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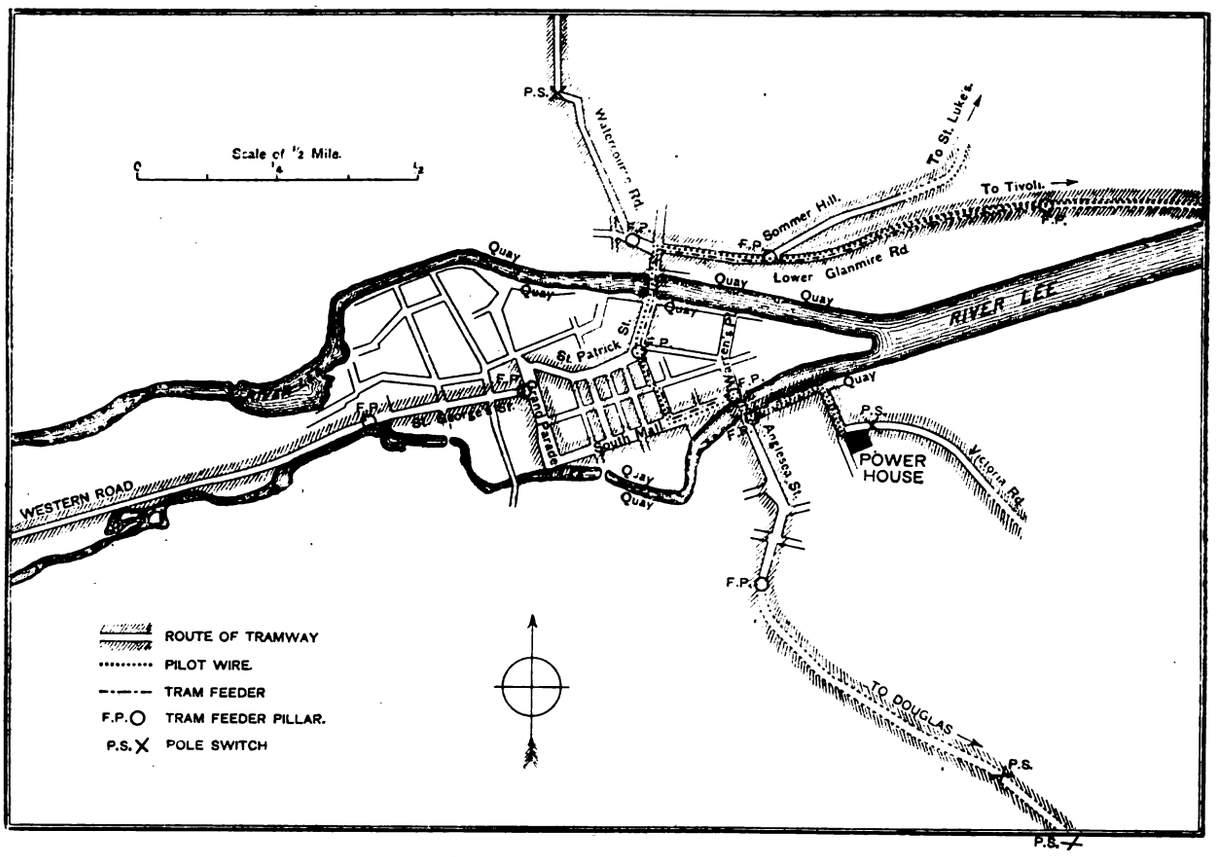
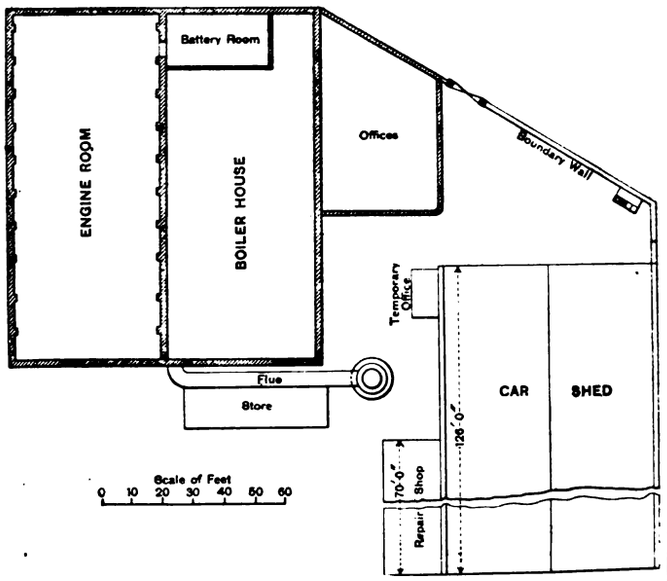
CORK COMBINED ELECTRIC LIGHTING AND TRACTION SYSTEM.

The current for the electric lighting of Cork and for the propulsion of the tramways in that town is generated from one station. The extent of the lighting district and the route of the tramways are shown in the two maps below. It will be seen that the power-house is situated at a corner of both the lighting and tramway networks, but that it is situated at no very great distance (220ft.) from the River Lee. It is built on piles, and is a brick-built building faced with Ruabon bricks.



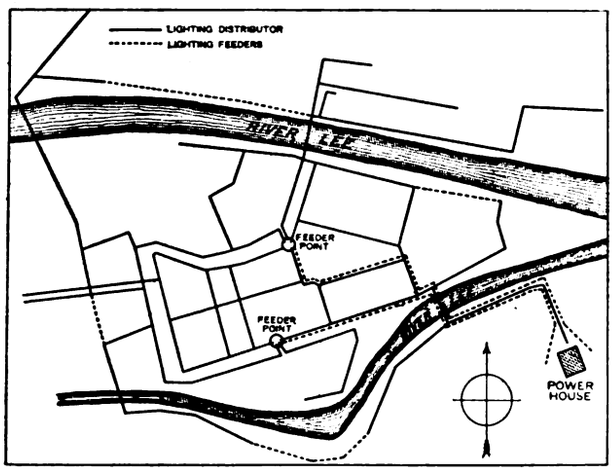
Map Showing Route of Tramway, Feeders, &c.

We give a view of the boiler-room. The three boilers are of the Babcock-Wilcox type, each with 2,531 sq. ft. heating surface and capable of evaporating 8,000lb. of water per hour. Their normal working pressure is 150lb. per square inch. The chimney stack is of steel, erected on concrete foundations, and self-supporting. It is 180ft. high, 7ft. internal diameter, and lined with firebrick. The thickness of the plates at the base is $\frac{7}{16}$in., and the size of each plate is 4ft. by 6ft., there being three plates to the ring.



Plan of Generating Station.

A feed heater of simple construction is used, made by the Wheeler Condensing and Engineering Co., the feed water being heated by the exhaust from the feed pumps and condenser pumps. The feed pumps are of the Blake and Knowles type, arranged compound. The diameter of the high-pressure cylinder is 6in., low pressure 9in., water cylinder 4in., and the stroke is 8in. The steam cylinders of these pumps are



Plan of Lighting Network at Cork.

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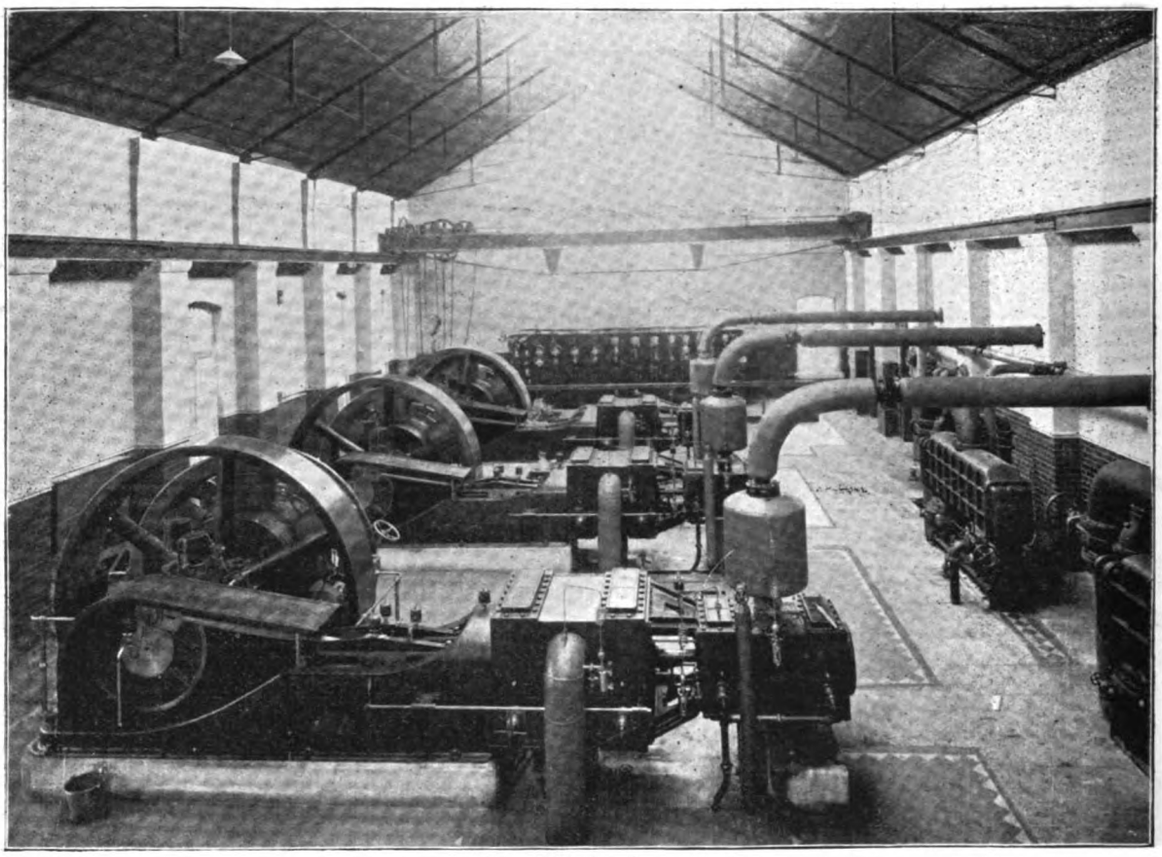
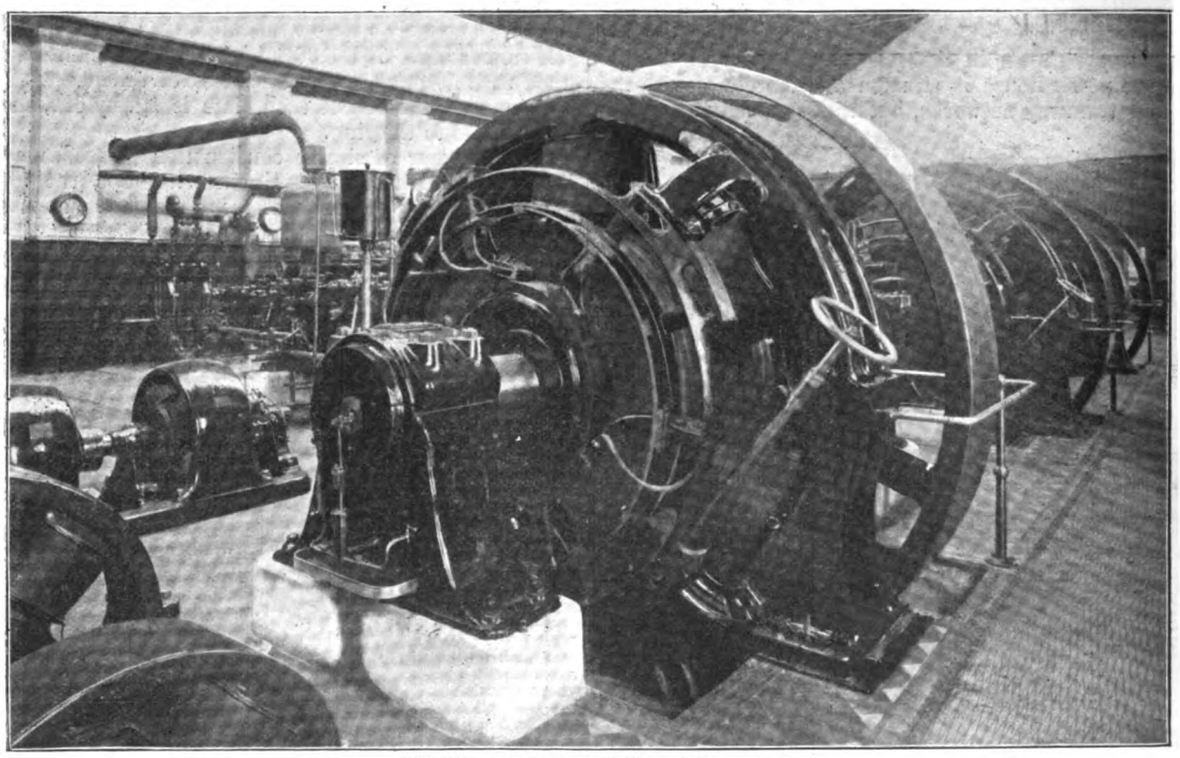
fitted with an outside valve gear, so arranged that it can be adjusted to all conditions of speed. The arrangement of the steam connections is such that, in case of any repair being required, either pump can work independently of the other.

tank, the oil, which will be floating on the surface, can be run off. Edmiston filters are used to filter the feed water before it enters the boiler. The two filters are capable of filtering 16,000lb. of water per hour. They are arranged on the twin



View of Engine Room.



200-Kilowatt Compound-Wound Generator.

The hot well is situated in the boiler house; it is fitted with baffle plates, and the divisions of it can be filled with coke and straw if desired, for the purpose of intercepting any oil that may be discharged into it. By opening the valve and filling the system, fitted with valves to enable the filters to be used on either range of feed pipes.

The steam pipes are of steel, fitted with heavy steel screwed flanges, and any engine can be fitted directly from the boiler

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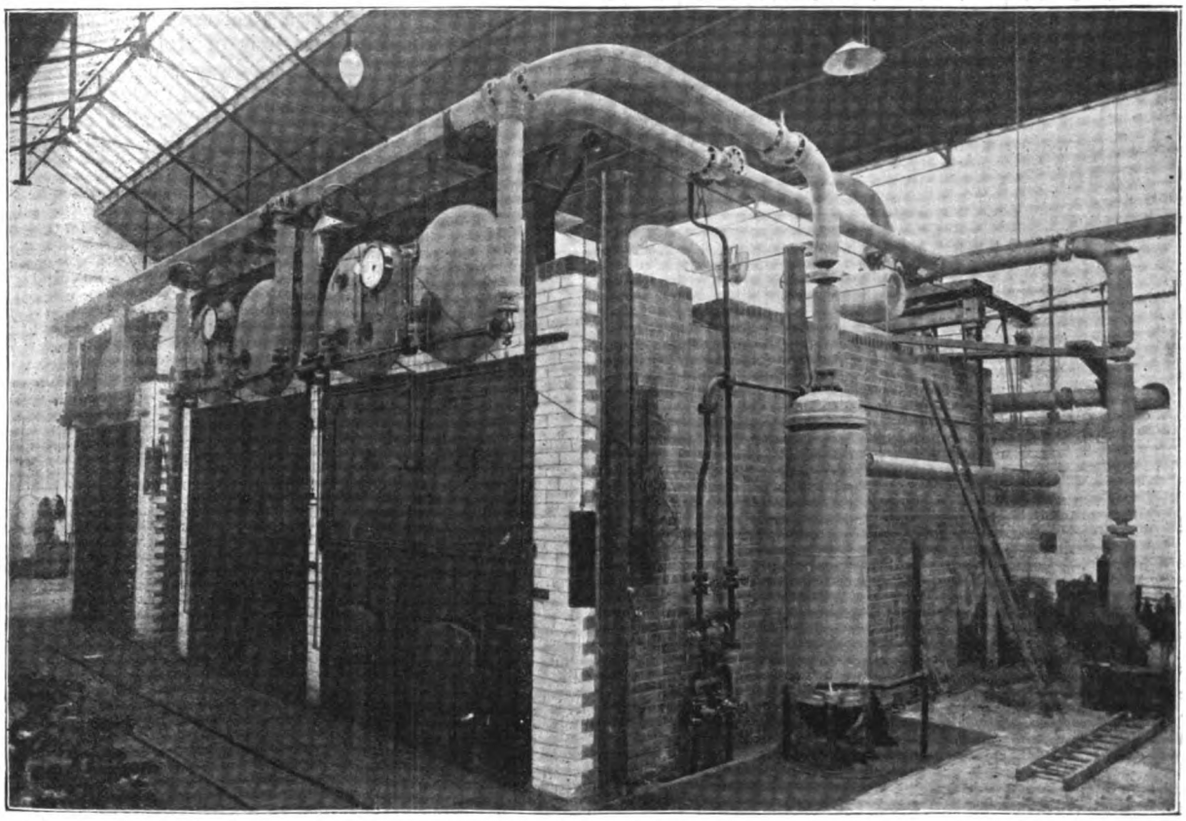
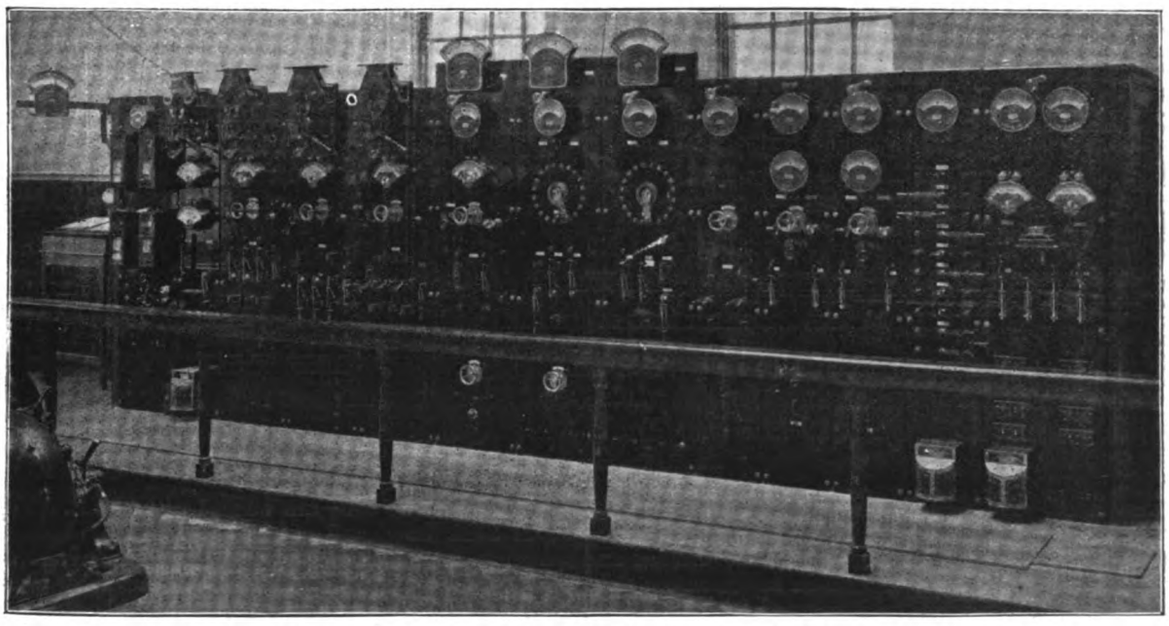
immediately behind it (*see* plan of station). Valves are, of course, inserted to enable any faulty section in the piping to be cut out. An automatic atmospheric valve is also fitted, which will slow the engines to exhaust directly into the atmosphere in the event of there being any pressure due to the failure of the condensing plant. The pipe on the atmosphere side of this valve is of thin steel, rivetted in spirals.



View of Boiler Room.



Combined Traction and Lighting Switchboard.

The engine room, a view of which is given on another page, contains three Macintosh and Seymour side-crank, tandem, compound, condensing engines. These run at 135 revolutions per minute, and are fitted with expansion governors and separate exhaust valves on both high and low-pressure cylinders. The high-pressure cylinder is steam-jacketed and exhausts into a reservoir in the interior of which are three copper coils which can be heated with live steam. Condensers of the Wheeler Admiralty type are used, the engines being arranged in the centre, the air pump at one end and the circulating water pump at the other end. Each of these condensers is capable of dealing with 12,000lb. of steam per hour. The condensing water is taken directly from the river through 12in. cast-iron pipes, there being an auxiliary supply from the waterworks, which can be laid on to start the pumps if the suction pipe is empty owing to the retaining valve not being perfectly watertight.

Each of the engines is coupled directly to a 6-polar 200 kilowatt compound-wound generator, giving 500 volts at 135 revolutions per minute. These dynamos are of the usual British Thomson-Houston railway generator type (*see* illustration) and do not merit any special description. A battery is provided which can be charged either from the traction or

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lighting 'bus-bars, a booster being employed to supply the necessary extra voltage. The booster can also be driven from either pair of 'bus bars.

The 256 Tudor cells in the battery room are mounted in three tiers. Each cell contains six positive and seven negative plates. The capacity of the battery is 770 ampere hours for a normal seven hour discharge, and its maximum rate is 210 amperes. Pitch pine, painted with acid-proof paint, is used for the battery stands, which are insulated on large oil insulators.

The switchboard, of which we give both a photographic and diagrammatic view, is situated at the end of the engine room. It contains three generator panels, fitted with automatic circuit breakers with magnetic blow-outs and change-over switches, so that the generators can be connected either directly to the lighting or traction 'bus-bars. Besides the generator panels, there are two feeder panels, two balancer panels and one panel fitted with the testing instruments required by the Board of Trade. The former pair of panels is fitted with the necessary regulating switches and magnetic blow-outs, arranged so that the battery can either be charged or discharged from either the lighting or traction 'bus-bars, as already mentioned. By a suitable arrangement on the balancer panels, this machine can be driven from the traction bars, if so desired, in the day-time; or it can be used as an ordinary balancer with the two motors in series across the outers of the lighting 'bus-bars, the junction being connected to the neutral. In the latter case, the set is run up to give its correct voltage by means of a motor placed in the centre, which is then disconnected as soon as the balancer sets are reconnected to the network. There is a large repair shop, containing the machine-tools and forge likely to be required for the maintenance of the machinery and cars.

Sixteen double-deck cars built by the Brush Electrical Engineering Co., and capable of seating 44 persons, have been provided. They are mounted on single Peckham trucks, and equipped with two "G.E. 60" motors and series-parallel controllers. Except in respect of the motors, which have had to be specially designed, on account of the very narrow gauge (2ft. 11½in.), the car equipment follows the usual standard practice of the British Thomson-Houston Co. The line is double track through all the principal streets, with some branches, as shown in the map. The longest part is to Douglas, a village about two miles south of Cork. As seen in the map, the line crosses the river twice—first, over the Parnell Bridge, which is a steel swing bridge, and, secondly, over Patrick's Bridge, which is of stone. The rails are laid on a bed of concrete, the roadway being paved between the rails and for 18in. outside the rails. Our illustration shows a part of the track where double bracket centre poles are used. In some places double bracket side poles are used instead, in which case the distance between the two tracks is reduced by 2ft. Outside the city boundaries the rails are laid on creosoted sleepers, 6ft. by 4½in. by 9in. Ordinary girder rails are used, weighing 83lb. per yard, with steel fish-plates 26in. long, weighing 56lb. per pair. The tie-bars are of wrought iron, 2in. by ⅜in. They are double screwed at the ends, and weigh 10½lb. each. The rails are fixed to the sleepers by 80 dog-spikes and 14 fang bolts, and chips to each rail length. The rails are bonded with 000 B. & S. Chicago bonds 35in. long, and at the points long bonds are used spanning the steel castings. At each crossing there are four 000 B. & S. 35in. bonds, and the rails are also cross-bonded every 240ft. Where the tracks are double they are cross-bonded at intervals of 240ft., these bonds being placed halfway between the rail cross-bonds. To prevent any interruption in the return circuit when the Parnell Bridge is swung open, four ½in. cables connect the rails on either side of the water, these being fastened to the rails by bonds.

Span wires are only used in a few places; in the principal streets centre poles with double bracket arms are employed, and on the remainder of the line side poles, as illustrated. The trolley wire is of hard-drawn copper, and is double throughout. Where it crosses the swing part of the Parnell

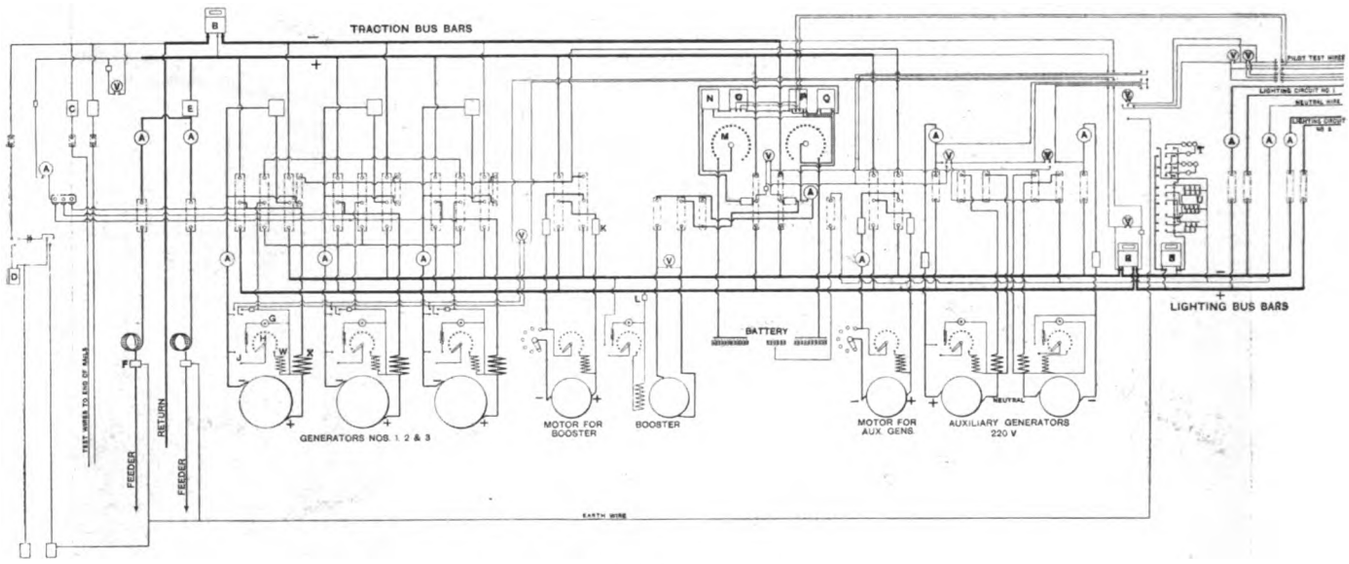
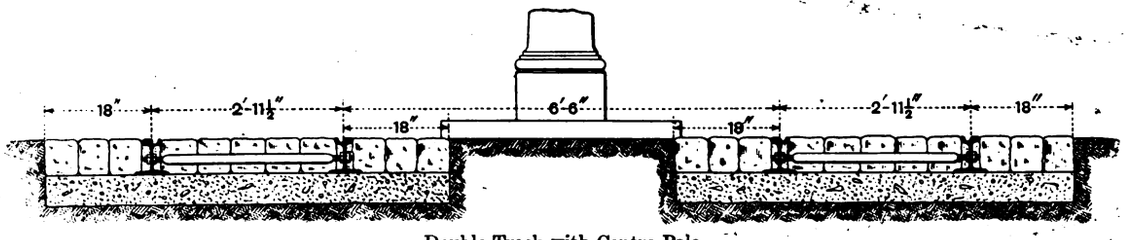


Diagram of Switchboard Connections.

A, Ammeters
V, Voltmeters
B, Traction 'Bus Bar Recording Voltmeter
C, Recording Voltmeters
D, Recording Ammeters
E, Circuit Breaker
F, Lightning Arrester
G, Pilot Lamp
H, Field Rheostat
J, Field Switch
K, 100-amp. Cut-out
L, 4-amp. Switch Cut-out
M, Battery Regulating Switch
N, Recording Wattmeter (charge)
O, Recording Amp.-hour Meter (charge)
P, Recording Amp.-hour Meter (discharge)
Q, Recording Wattmeter (discharge)
R, Lighting Bus Bar Recording Wattmeter
S, Station Lighting Recording Wattmeter
T, Arc Circuit
U, Incandescent Circuit
W, Shunt Coil of Dynamo
X, Series Coil ,, ,,



Double Track with Centre Pole.

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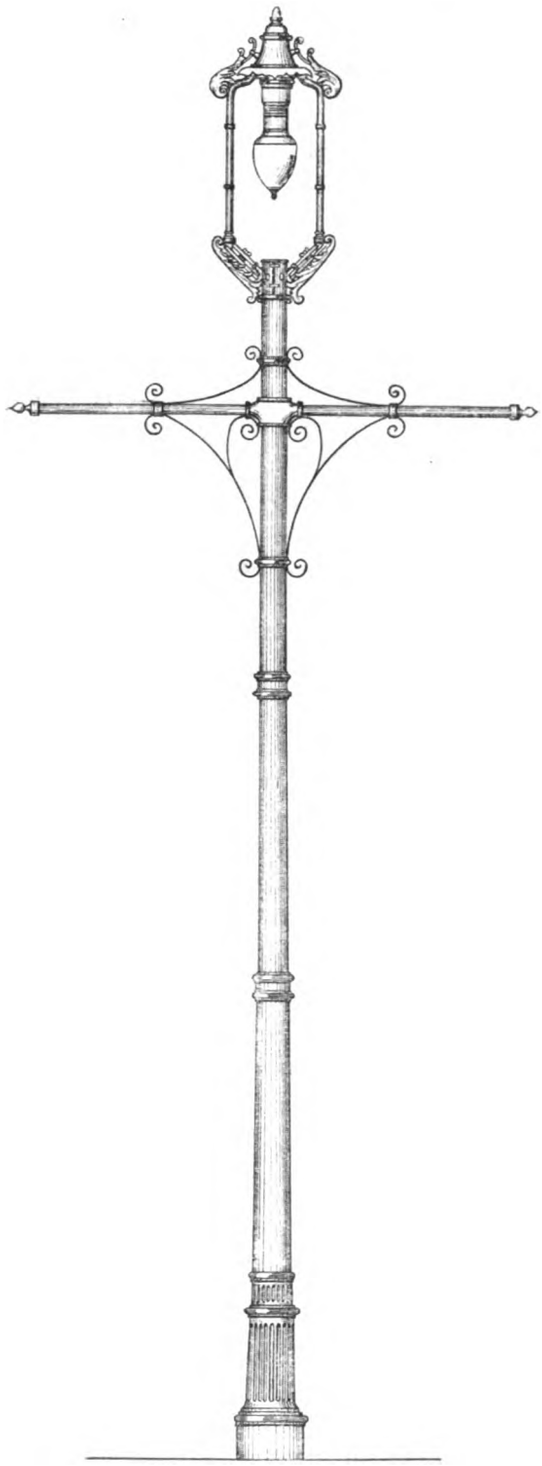
Bridge, it is supported on special poles and brackets fastened to the movable part of the bridge, with heavy spring clips, which allow the bridge to be moved in either direction.

The lighting network is on the three-wire system, with 460 volts between the outers. Over 20 miles of cable have been laid for lighting and traction, the cable in the majority of cases consisting of Callender's lead-covered steel-tapered armoured cable laid directly in the ground. There are at present



Double Bracket Trolley and Arc Lamp Post at Cork.

only two feeding points on the lighting system distant from the station by about half a mile. The feeders cross the River Lee, and here they are laid in a trench excavated in the bed of the river. Four additional feeder cables have been laid as spare, to allow for future extensions. The feeders are of 0·7 sq. in. section, and the distributors of various sizes, the largest having a sectional area of 0·15 sq. in. In the centre of the city three-core distributors are used, and in the outlying districts three single distributing cables which are protected by a covering of bricks in addition to their armouring. Nineteen Callender's disconnecting boxes are fitted at various junctions of the network.

Street lighting has not been permanently started yet, but will be shortly. In the principal streets an arc lamp is fixed on every alternate centre pole, as shown in the illustration. Enclosed arcs are used, connected five in series, and so arranged that alternate lamps are on different circuits. The switches and resistances are contained in the bases of the poles, and, as usual, a compensating resistance can be switched in circuit with any lamp.

The supply of current on the lighting network was started about the beginning of September, and since then about 130 consumers have been connected to the mains. In all, 217 intending consumers have now applied for connections, these representing an equivalent of 14,447 8 c.p. lamps, including 113 H.P. in motors. The price charged for the light is 5d. per unit for the first two hours on the maximum demand system, and 1d. afterwards. For power the present tariff is 4½d. for the first two hours, and also 1d. afterwards.

Side-Pole and Car.

The British Thomson-Houston Company were the contractors to the Cork Electric Tramways and Lighting Co. for the work as a whole and themselves supplied the complete electrical equipment. The following were the chief sub-contractors to the British Thomson-Houston Company :—

Permanent way, power house buildings, &c.	Mr. W. M. Murphy, Dublin.
Engines	Messrs. R. W. Blackwell and Co., London.
Boilers	Messrs. Babcock & Wilcox (Ltd.), London.
Auxiliary apparatus, pumps, condensers, &c.	The Wheeler Condenser and Engineering Co. and the Blake and Knowles Steam Pump Works (Limited), London.
Battery	The Tudor Accumulator Co. (Ltd.), London.
Traveller	Messrs. Jessop and Appleby, Leicester.
Cars	The Brush Electrical Engineering Co. (Limited), Loughborough.
Peckham trucks	Messrs. R. W. Blackwell and Co., London.
Overhead line construction	Messrs. R. W. Blackwell and Co., London.
Lighting, network and cables.	Callender's Cable and Construction Co. (Limited), London.
Arc lamps and hoods	The General Electric Co. (Ltd.), London.

Alderman Fitzgerald, of Cork, was sub-contractor to Mr. W. M. Murphy for the buildings in connection with the power house.

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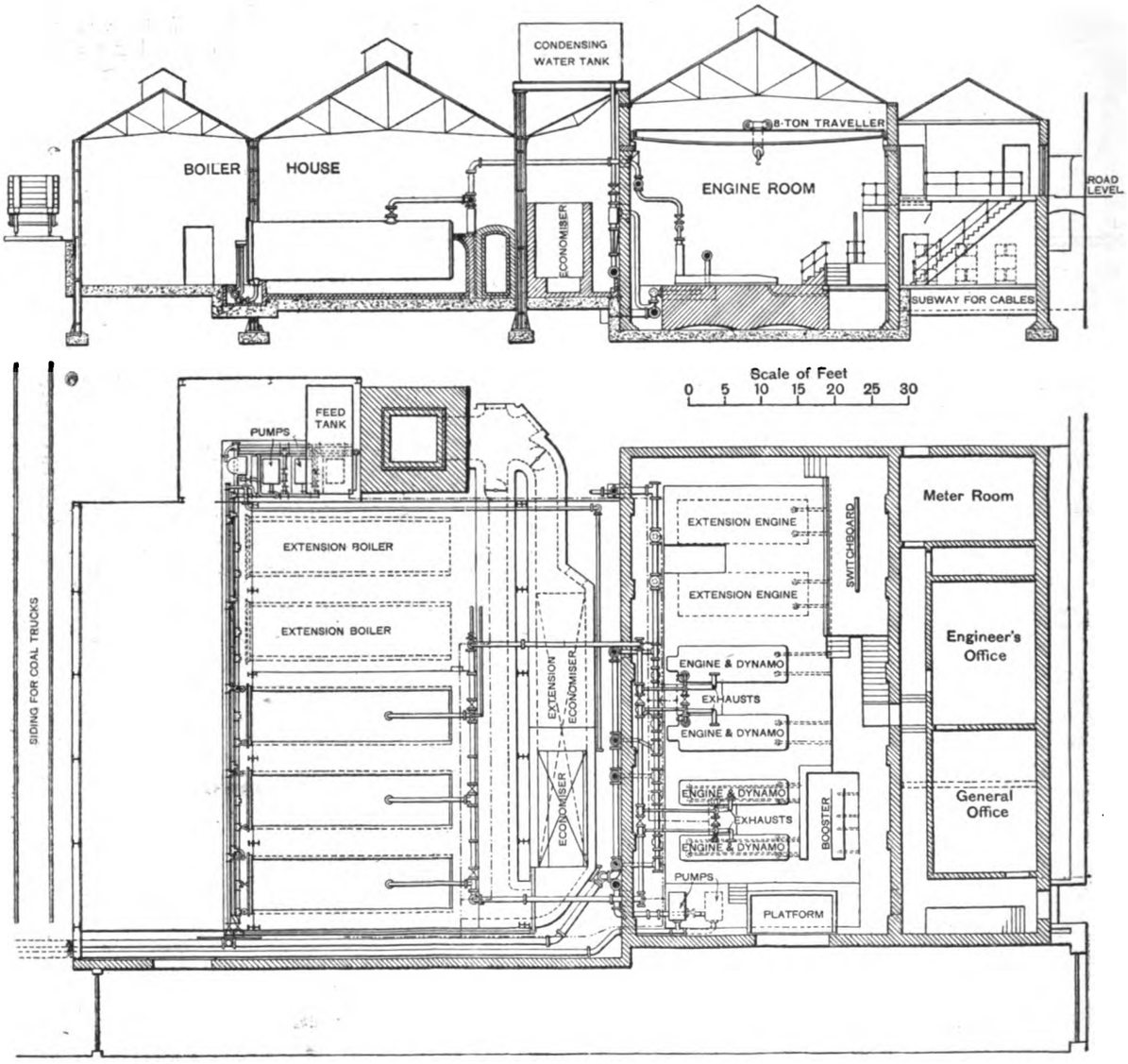
CARLISLE ELECTRICITY SUPPLY STATION.

The Carlisle central station, which will shortly be put into operation, is of Prof. A. B. W. Kennedy's design. At present it will only serve for the lighting of the town, but it is proposed to erect an electric tramway system which will be fed from the same station. The system adopted is the three-wire system, with an earthed middle wire and 460 volts between the outers. Steam-driven balancing dynamos are used, and a battery. The boosters are arranged so that they can be used in series with the cells, and add to the voltage of the dynamo during charge and to the voltage of the cells during discharge.



Plan and Sectional Elevation of Carlisle Central Station.

During light loads the voltage is regulated by cutting cells in or out, and the cell-regulating switch is interlocked with the booster reversing-switch by a special arrangement designed by Prof. Kennedy, which facilitates the switchboard attendant's duties and ensures against error. This is one new feature of the Carlisle station; another exceptional feature is the provision to be made for utilising the dynamos either for the 460 volts lighting network or the contemplated 500 volts tramway system. For the former purpose they are used as shunt machines; for the latter a series-winding is added, and they run compound. The arcs used for public lighting are connected 10 in series across the 460 volt mains.

The station is situated at the corner of James-street and the Victoria Viaduct, and has the advantage of a siding from the Caledonian Railway. The plan and sectional elevation show the general arrangement of the station and the disposition of the machinery and plant.

The boilers are of the Lancashire type, 28ft. by 8ft., manufactured by the Oldham Boiler Works Co., each with two internal furnaces, 3ft. 8in. external diameter. A working pressure of 160lb. per square inch will be employed. The steam-pipe connections are shown in the illustration; it may be mentioned that in their erection this arrangement was departed from, but to a very slight extent only. The main lines of pipe are 8in., and are of steel, while all the bends and all the pipes of 4in or less in diameter are of copper. A Green's economiser is employed.

The condensing water pumps are electrically driven, the water being obtained from the river. Four Ledward ejector condensers are used, two capable of dealing each with 4,000lb. of steam per hour, and two dealing with half that quantity. In these condensers Messrs. Ledward have not departed from their standard pattern.

The two main steam dynamos are of the Willans-Siemens type, running as shunt machines at 330 revolutions per minute, and generating 255 amperes at 490 volts (maximum), or as compound machines at 350 revolutions when they are capable of giving 227 amperes at 550 volts. These are supplemented by two pairs of balancing dynamos, each pair being coupled to a Willans engine. Each dynamo of these

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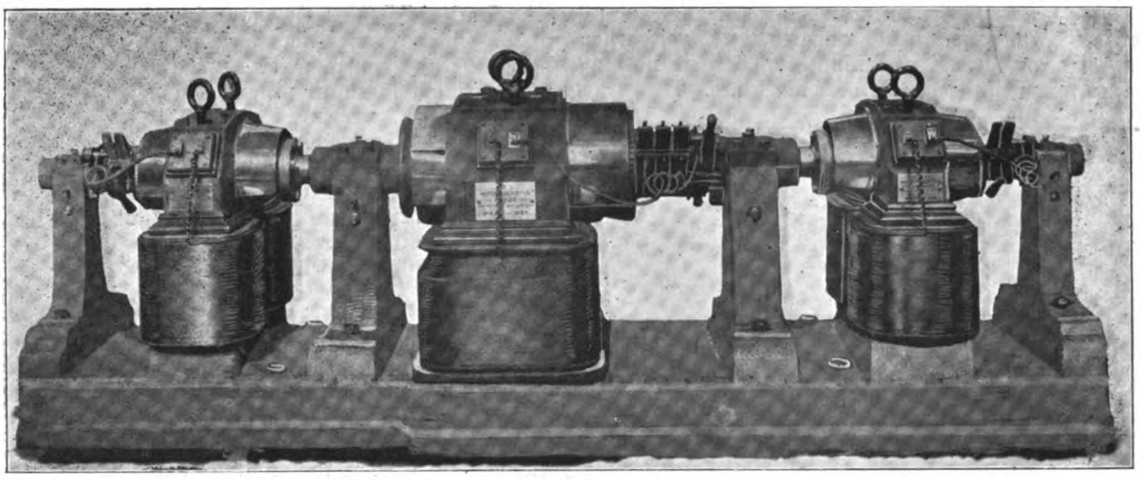


Motor-driven Booster, manufactured by the Electric Construction Co.

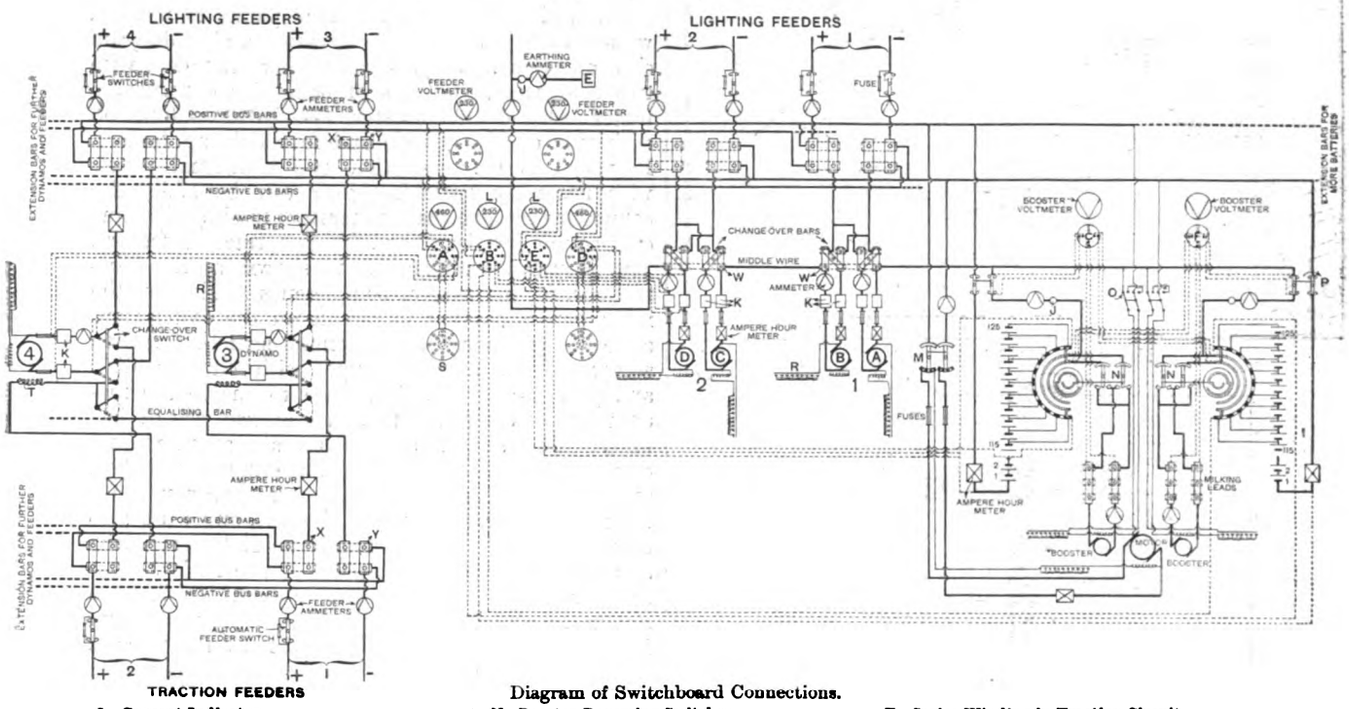
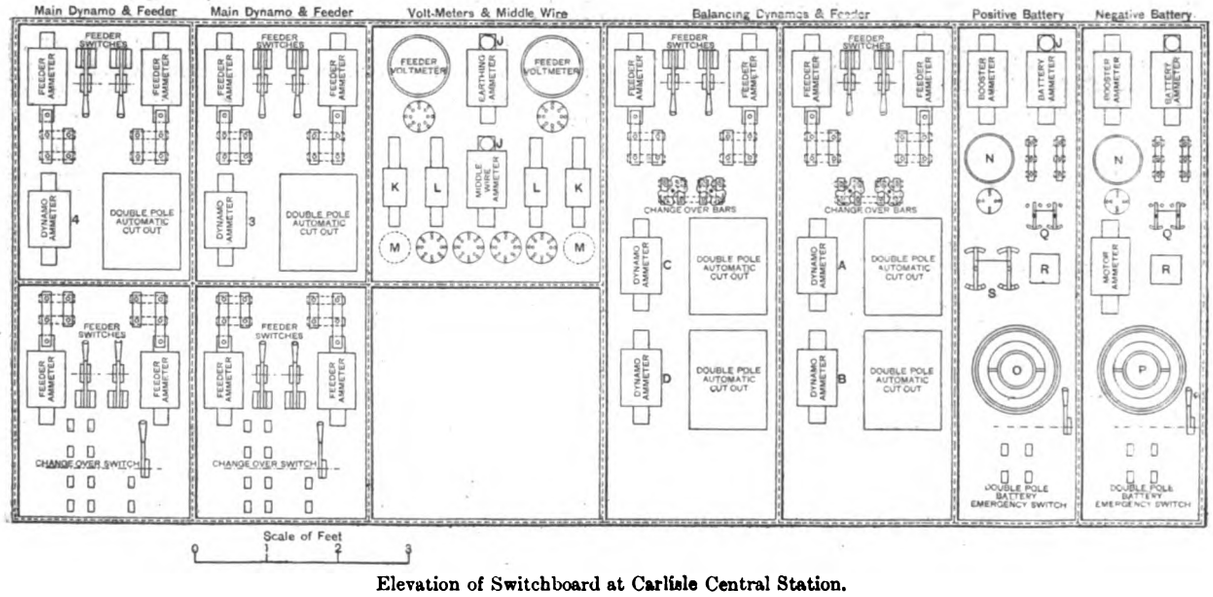


Diagram of Switchboard Connections.

J, Current Indicator
K, Double-Pole Automatic Cut-outs
L, Dynamo and Bar Voltmeter
M, Motor Double-Pole Starting Switch
N, Booster Reversing Switches
O, Booster Field Switches
P, Double-Pole Battery Emergency Switch
R, Field Regulating Resistance
S, Extension Voltmeter Switch
T, Series Winding in Traction Circuit
W, Middle Wire, Bus Bars
X, Dynamo Bar
Y, Feeder Bar



Elevation of Switchboard at Carlisle Central Station.

J, Current Indicator
K, Dynamo and Bar Voltmeter
L, Balancing Dynamo and Bar Voltmeter
M, Extension Switch
N, Booster Voltmeter
O, Positive Battery
P, Negative Battery
Q, Booster Field Switch
R, Booster Reversing Switch
S, Double-Pole Motor Starting Switch

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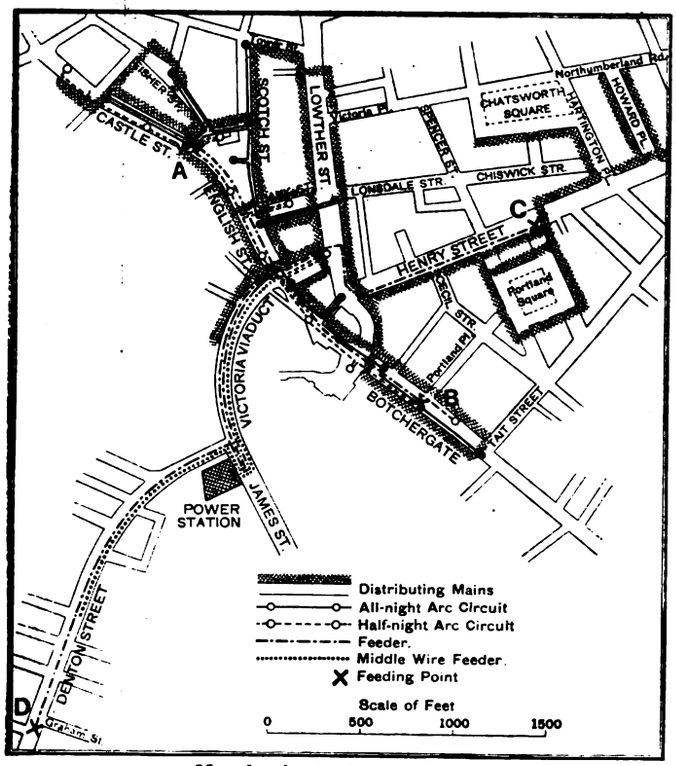
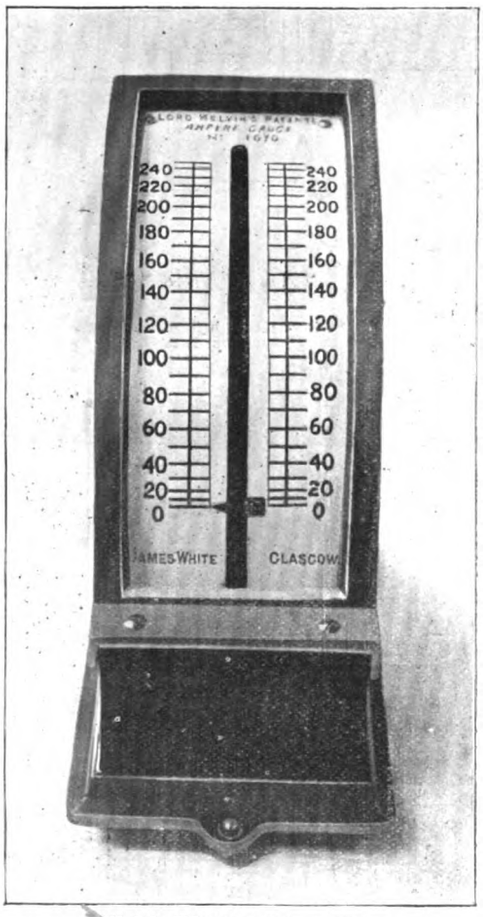
"double-enders" will generate 128 amperes at 245 volts when running at 450 revolutions per minute. There is nothing exceptional to remark in either of these machines.



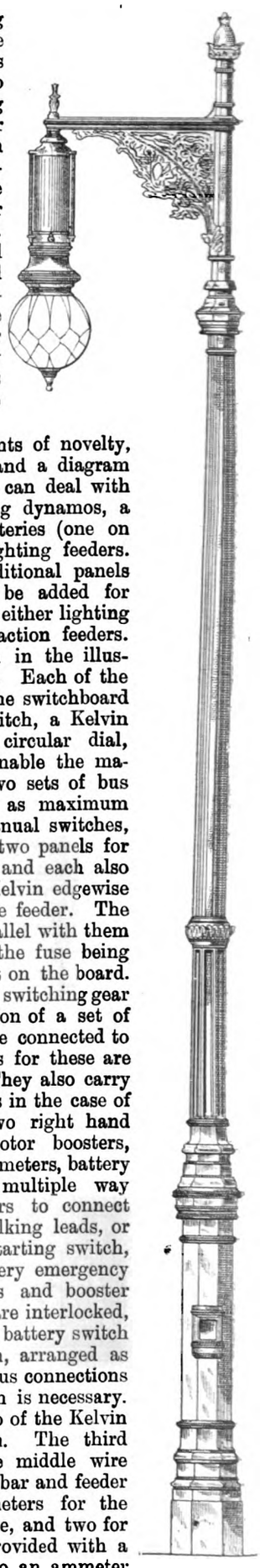
Map showing Positions of Mains.



Kelvin Edgewise Ampere Gauge.

The booster, shown in the illustration, consists of three upright bipolar machines, of the Electric Construction Co.'s standard type, mounted together in line on a substantial bedplate, which carries four self-oiling bearings; the centre machine is the motor which is shunt wound and is for an E.M.F. varying from 460 to 520 volts; it provides the driving power for the two outer machines or boosters proper. These are each capable of giving any current between 0 and 60 amperes at any voltage from 10 to 70 volts, with capacity for a maximum load of 120 amperes. The dynamo armatures are connected to the motor armature by flanged couplings for easy separation and removal. As already mentioned, the booster will be used principally for charging and discharging the battery when the E.M.F. at the omnibus bars is either lower or higher than the E.M.F. of the battery.

The switchboard, having some points of novelty, we illustrate it by both an elevation and a diagram of connections. At present the board can deal with two generators, two sets of balancing dynamos, a motor with double booster, two batteries (one on each side of the system) and four lighting feeders. Provision is made so that two additional panels with necessary switching gear can be added for connecting the two main generators to either lighting or traction bus bars, and for two traction feeders. The proposed arrangement is shown in the illustrations, for the sake of completeness. Each of the main generators has in circuit on the switchboard a double pole automatic magnetic switch, a Kelvin sector pattern ampere gauge with circular dial, and plug bars. The latter are to enable the machines to be connected to either of two sets of bus bars. The automatic switches act as maximum or minimum cut-outs, and also as manual switches, and they have carbon breaks. The two panels for the main generators are on the left, and each also carries two feeder switches and two Kelvin edgewise ampere gauges on the two poles of one feeder. The feeder switches have connected in parallel with them a light fuse for breaking the circuit, the fuse being fixed in a convenient position, but not on the board. The balancing dynamos have the same switching gear as the main dynamos with the addition of a set of change over bars, so that they can be connected to either side of the system. The panels for these are the fourth and fifth from the left. They also carry feeder switches and ampere-gauges, as in the case of the main generator panels. The two right hand panels are for the batteries and motor boosters, and have mounted on them booster ammeters, battery ammeters, booster voltmeters and multiple way switches, motor ammeter, plug bars to connect the booster either to the battery, milking leads, or to a meter-testing circuit, a motor starting switch, booster field breaking switches, battery emergency switches, battery regulating switches and booster reversing switches. These latter two are interlocked, as has already been mentioned. The battery switch has 11 contacts and a double brush, arranged as in the diagram. From this the various connections are evident, and no further description is necessary. The ammeters on these panels are also of the Kelvin type, and the voltmeters are Weston. The third panel from the left is devoted to the middle wire instruments, and to the dynamo, 'bus-bar and feeder voltmeters. There are four voltmeters for the dynamos and bars, of the Kelvin type, and two for feeders of the Weston type, each provided with a double-pole multiple way switch; also an ammeter for the middle wire and one for the earth connection. The panels are of slate, 2in. thick, enamelled back



Arc Lamp Post for Carlisle Public Lighting.

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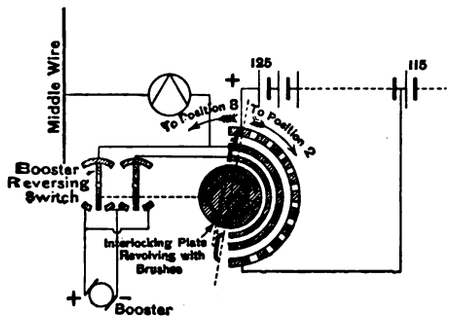
and front. The frame work is built up of steel tees and angles; it is 17ft. long, 7ft. 3in. high, and is surmounted by an eight-day clock.

All the feeder ampere-gauges are of Lord Kelvin's edgewise sector pattern, with scales, as shown in the illustration. The principle of this instrument is the same as that of Lord Kelvin's ordinary sector pattern ampere-gauge. These contain a solenoid giving an exceedingly intense and uniform field, this solenoid being so constructed that the axis of the field passes through the axis of the solenoid. Into the solenoid is entered a soft iron plunger suspended from an aluminium sector which, together with the pointer and suspension bar, forms the movable system. The current passing in the solenoid attracts into it the soft iron plunger, and this movement is indicated by the pointer on the scale. The zero is at the bottom of the scale; and an increase of current is shown by a rise of the pointer. These instruments are fitted in strong cast cases with nickelled facing, forming a thoroughly substantial piece of apparatus, and at the same time having the accuracy of reading of a high-class instrument. The Kelvin voltmeters are of the small dial engine-room type, a special feature in which is a short scale giving only the part of range that is required, and consequently very large divisions.

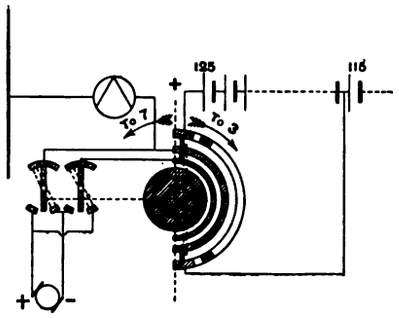
To avoid crowding the diagram, all the connections to the voltmeter switches A, B, C, D, E and F are not shown in the plan of connections. A and D can connect their voltmeters to either of the main generators, 3 and 4, A on the dynamo side of the cut-out and B on the 'bus bar side. They can also be connected between the top and bottom 'bus bars respectively. B and E can be connected in the same way to the balancing dynamos, A, B, C and D, B on the dynamo side of the cut-out and E on the 'bus bar side. B can also be connected between either positive 'bus bar and the middle wire, while E in a similar way on the negative side. Lastly, B and E will also give the voltage between cell 125 or cell 115 and the top negative and positive 'bus bar respectively, inside the battery switch. C and F in their lower positions connect their voltmeters between the booster terminals, in their left-hand positions between the terminals of the positive battery and emergency and regulating switches respectively, and in their right-hand positions between the terminals of the negative battery and the regulating and emergency switches respectively.

There are two batteries, each of 125 Chloride cells, at the station itself. The minimum capacity for a five-hour discharge was specified to be 800 ampere hours, and the cell was to give without derioration 90 amperes for three hours, or 120 amperes for 30 minutes, in each case without a lower E.M.F. than 1·86 volts per cell being attained. The cells are in glass boxes and supported, as usual, on oil insulators.

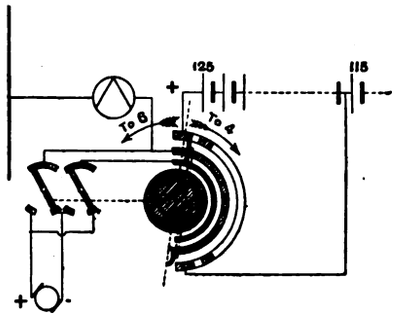
The map given shows the course of the mains, the situation of the feeding points, arc lamps, &c. All the cable is of the Callender lead-covered and armoured type, laid direct in the ground. The distributors are of uniform size, viz., triple concentric with conductors 0·12, 0·12 and 0·06 sq. in. in section. The latter is, of course, for the neutral wire, which forms the



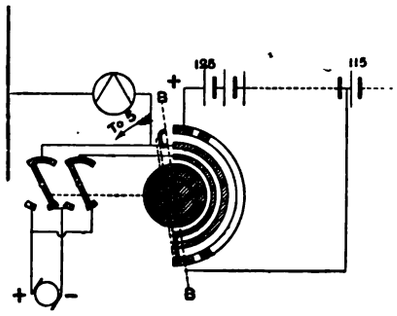
POSITION 1.—End of Discharge; beginning of Charge.
POSITION 7.—Discharge direct from Battery; all Cells in circuit.



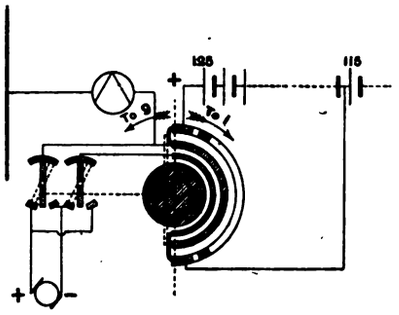
POSITION 2.—Charge continued as far back on Regulator as possible; ready to switch in Booster.
POSITION 6.—Beginning of Discharge direct from Battery; Booster taken off.



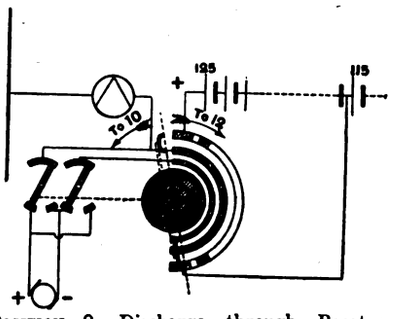
POSITION 3.—Charge continued through Booster; all Cells in circuit.
POSITION 5.—End of Charge; Volts on Booster reduced and Booster put on top Cell.



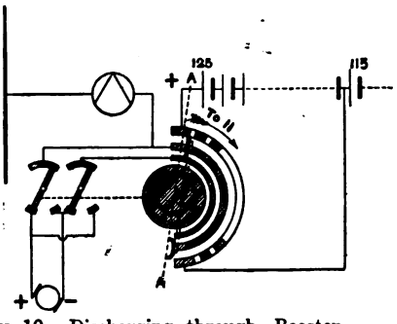
POSITION 4.—Charge continued; Booster brought back so as not to overcharge end Cells. This is the limiting position B B.



POSITION 8.—Discharging all Cells direct; ready to put Booster in to help discharge.
POSITION 12.—Discharge direct from Battery; all Cells in and Booster taken out.



POSITION 9.—Discharge through Booster; helping Battery.
POSITION 11.—Reducing Volts on Discharge; cutting out Cells and reducing Booster volts.



POSITION 10.—Discharging through Booster with all Cells in circuit. This is the limiting position A A.

DIAGRAM OF BATTERY REGULATING SWITCH (NEGATIVE SIDE).
Showing Method of using Booster in Charging and Discharging the Battery.

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outer conductor of the cable. The feeders are ordinary concentric, all of 0·25 sq. in. section, and the neutral wire feeders, two in number, are single armoured cable with a similar conductor section.

There are in all 25 arc lamps, erected on cast-iron bracket pillars of the design shown in the illustration. The pillars are placed along the edge of the footpaths with the brackets and lamps overhanging the roadway. The lamps are run in three circuits, two consisting of eight lamps in series and the other one of seven. Current is taken from the outside conductors of the three-wire network at a pressure of 460 volts. They are constructed so as to burn 10 in series on this pressure, as is done at Edinburgh. Consequently, it will be possible to introduce five more lamps into these three circuits at a later date. The lamps are of the Crompton-Pochin type, with single carbons, and they will burn for 18 hours without retrimming. The current is 10 amperes. The pillars were supplied by Messrs. Mackenzie Bros., and the lamps, &c., by Messrs. Crompton.

In the base of each pillar is fixed an automatic cut-out and substitutional resistance, so arranged that, in the event of a lamp "hanging up," or the carbons burning out, the remainder of the circuit is not interfered with. A single-pole switch and fuse is provided at each end of each circuit. These, with the line steadying resistances and other fittings, are fixed inside the base of the poles.

In concluding, we wish to acknowledge our indebtedness to Prof. A. B. W. Kennedy, and some of the contractors, who have afforded us material assistance in the preparation of this article.

AN IMPERIAL CABLE SERVICE.

Sir Sandford Fleming has addressed a communication to Mr. Chamberlain urging the adoption of a system of State-owned cables for the empire.

Sir Sandford Fleming instances in support of his arguments the success which has attended the change from a telegraph service managed by private companies to a telegraph service owned by the State and administered under the Post Office department. Before the transfer complaints were frequent and well founded as to the inefficiency of the telegraph service, and the business done was much restricted. After the transfer and the reorganisation of the service by which it was accompanied, the public gained the advantage of cheap messages, and business developed to such an extent that receipts progressively increased. We can as yet (he points out) but faintly appreciate the extent to which the telegraph may be employed, because its use heretofore has been restricted, on long-distance messages, by almost prohibitory charges. If messages be exchanged between places not far apart, let us say between London and Edinburgh, or Toronto and Montreal, the gain in time by the use of the telegraph is inconsiderable. But if the points of connection be far separated, such as London and Melbourne, or Ottawa and Cape Town, the comparison between a postal and a telegraph service brings out the distinct value of the latter. Were the cables owned by the State large profits would not be the main object, and, precisely as in the case of the land lines of the United Kingdom, it would be possible to reduce charges so as to remove restrictions on trade and bring the service within reach of many now debarred from using it.

When the Government assumed control of the inland telegraphs of the United Kingdom it was found possible to greatly reduce charges. In 1869, the year before the transfer, less than seven million messages were carried. At the transfer the rate was reduced to 1s. per message; the traffic immediately increased nearly 50 per cent. and continued increasing until, in the tenth year, 29 million messages were transmitted, with a surplus of revenue over expenditure of £354,060.

The system of Imperial cable construction put forward for adoption by Sir Sandford Fleming would have for its object to complete the telegraphic circuit of the globe and to "constitute a base for connecting every one of her Majesty's possessions and naval coaling stations (Gibraltar and Malta excepted) by the most perfect means of conveying intelligence at our disposal." He divides the proposed cable system into three sections, one of which would be composed of cables in the Pacific Ocean, one of cables in the Indian Ocean, and one of cables in the Atlantic Ocean. The cables in the Pacific Ocean would start from Vancouver and find a first mid-ocean station at Fanning Island, a second at Fiji, and a third at Norfolk Island. From Norfolk Island it would bifurcate, one branch extending to New Zealand and one to the eastern coast of Australia. Telegraphic communication across the continent would put it in touch with King George's Sound. The cables in the Indian Ocean would start from King George's Sound and find mid-ocean stations at Cocos Island and Mauritius, extending thence to Natal or Cape Town. From Cocos Island connection would be made with Ceylon, Singapore, and Hong Kong. From Mauritius connection would be made to Seychelles, Aden, and Bombay. The cables in the Atlantic should extend from Cape Town to Bermuda, finding mid-ocean stations at St. Helena, Ascension and Barbados. From Bermuda connection would be made with Halifax and the existing Canadian and Trans-Atlantic lines. The total distance for which under such a scheme new cables would be required is estimated by Sir Sandford at 23,000 knots, and the approximate cost of construction at from £5,000,000 to £6,000,000. One advantage of completing the circuit of the Empire by a round-the-world system of British cables, upon which Sir Sandford Fleming lays special stress, is that each point touched "would be in connection with every other point by two routes, extending in opposite directions," thus practically constituting a double connection in each case.

ELECTRICITY WORKS ACCOUNTS.

Southport Municipal Electric Supply Works.

Inaugurated November 17, 1894, the electric supply undertaking at Southport is maintaining steady progress, and stands in a satisfactory position as regards economy of working in relation to undertakings of similar magnitude. The authorised capital is £58,822, all of which has been borrowed at 3 per cent., while £3,010 has been repaid. At March 31 last the total expended capital amounted to £63,057, representing £93·8 per kilowatt of generating capacity of plant.

Comparing the business of 1897-8 with that of the preceding year we find that with an increase in the number of consumers of from 225 to 338 the equivalent 8 c.p. lamp connection has risen from 16,671 to 26,012, or 56 per cent. The total output for the year 1897-8 being 876,490 shows an increase over that of 1896-7 of 53·4 per cent., while the supply to private consumers indicates an increase of no less than 93 per cent.

In consequence of a reduction in the price charged the average revenue received per unit has dropped from 4·813d. to 4·268d. The total costs per unit have been substantially reduced through all the items of cost except establishment charges and repairs and renewals of mains and at the station. The year's working shows a decreased ratio of costs to revenue and a working profit of £3,523, representing 6·24 per cent. of the mean capital. This profit has been disposed of by a payment of £1,416 in interest on loans, £1,488 to the sinking fund, and £195 in wiping out the previous year's adverse balance, leaving a balance for 1897-8 of £475 to be carried forward.

The Local Government Board have sanctioned a further loan of £21,178 for electric lighting extensions.

Whitehaven Municipal Electric Supply Works.

Whitehaven, even to a greater extent than Southport, enjoys the effect of a relatively high proportion of public and contract lighting, and moreover the use of batteries tends further towards giving the high "plant load factor" (as measured by the ratio of the units sold to the plant capacity) of 28·8 which has obtained during 1897-8.

Supply having started in September, 1893, our analysis includes the fourth completed year of working. The whole of the authorised capital of £19,004 has been borrowed—£4,213 at 3½ per cent. and £14,791 at 3 per cent. interest, while £1,263 has been repaid (at 3½ per cent.). The expended capital has amounted to £18,667, being at the rate of £88·9 per kilowatt of generating plant. So far as the accounts rendered to us are concerned, Whitehaven appears to have lost the three opening months of 1897 without a record of existence during that period.

The increase in the total output sold has been barely 6 per cent., while the average revenue per unit and the total costs have both risen. The works costs have, however, been slightly reduced, and the figures for the costs are very satisfactory for the output, being below the average.

Out of the working profit of £1,647 which has been made, representing 8·96 per cent. of the mean capital, £792 has been paid into the sinking fund, and £538 as interest on loans, leaving a balance to the good, carried forward, of £316.

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	SOUTHPORT.		WHITEHAVEN.	
Undertaking Worked by	Southport Corporation.		Whitehaven Corporation.	
Date of Commencement of Supply	1894.		1893.	
System of Supply	Alternate-current transformers in sub-stations.		3-wire continuous-current.	
Chief Engineer	C. D. Taite.		J. S. Brodie.	
YEAR ENDED	MAR. 31, **1897.**	MAR. 31, **1898.**	DEC. 31, **1896.**	MAR. 31, **1898.**
QUANTITIES—				
Units generated	335,864	532,862	199,051	207,284
„ SOLD (TOTAL)	245,515	376,490	178,378	188,709
„ sold to consumers	151,095	291,277	66,491	83,738
„ sold for public lighting, &c.	94,420	85,213	111,887[a]	104,971[a]
„ used on works	7,797	10,162	3,000	6,000
UNITS SOLD PER 8 C.P. LAMP CAPACITY	21	17·8	27·2	28·8
Maximum supply demanded	257	404	156	170
Number of public lamps	42 arc	42 arc	437 street (glow)[b] 124 harbour „ [b]	6 arc, 446 street (glow)[b] 126 harbour (glow)[b]
Number of consumers	225	338	—	124
Connections to mains in 8-c.p. lamps	16,671	26,012	5,564	6,464
CAPACITY OF PLANT IN 8-C.P. LAMPS	11,700	21,100	6,560	6,560
CAPACITY OF PLANT IN KILOWATTS	375	675	210	210
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£58,822 / £157	£58,822 / £87·1	£19,004 / £90·4	£19,004 / £90·4
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	58,822 / 157	58,822 / 87·1	19,004 / 90·4	19,004 / 90·4
RECEIVED (TOTAL)	48,973[a] / 131	60,973[a] / 90·3	19,004 / 90·4	19,004 / 90·4
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	46,820 / 125	58,820 / 87·1	19,004 / 90·4	19,004 / 90·4
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	9,922 / 26·5	— / —	— / —	— / —
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	9,922 / 26·5	— / —	— / —	— / —
REPAID (TOTAL)	1,500 / 4·00	3,010 / 4·46	1,263 / 6·01	1,263 / 6·01
RESERVE OR SINKING FUND	98 / 0·261	74 / 0·110	— / —	9 / 0·043
DEPRECIATION FUND	— / —	— / —	— / —	— / —
EXPENDED (TOTAL)	49,232 / 131	63,057 / 93·8	18,079 / 86·0	18,667 / 88·9
Lands and buildings	11,276 / 30·1	12,701 / 18·8	733 / 3·49	570 / 2·71
Plant	20,430[b] / 54·5	28,551[b] / 42·8	7,201 / 34·3	7,189 / 34·2
Mains	16,047 / 42·8	20,325 / 30·1	9,088 / 43·3	9,261 / 44·1
Miscellaneous	1,479 / 3·94	1,479 / 2·19	1,057 / 5·03	1,647 / 7·84
BALANCE OF CAPITAL ACCOUNT	−259[c] / −0·691	−2,084[c] / −3·09	924 / 4·40	337 / 1·61
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£4,925 / 4·813d.	£6,687 / 4·263d.	£2,791 / 3·755d.	£3,335 / 4·240d.
Revenue from supply	3,671 / 3·587d.	5,663 / 3·610d.	1,339 / 1·801d.	1,988 / 2·528d.
„ meters, &c.	133 / 0·130d.	130 / 0·083d.	40 / 0·054d.	58 / 0·074d.
„ public lighting	840 / 0·821d.	840 / 0·536d.	1,137 / 1·530d.	1,274 / 1·620d.
„ sale of lamps, &c.	— / —	12 / 0·008d.	3 / 0·004d.	8 / 0·010d.
„ miscellaneous sources	282 / 0·276d.	42 / 0·027d.	273 / 0·367d.	6 / 0·008d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£2,635 / 2·575d.	£3,164 / 2·017d.	£1,573 / 2·116d.	£1,688 / 2·146d.
WORKS COSTS	1,965 / 1·921d.	2,337 / 1·490d.	1,336 / 1·798d.	1,380 / 1·755d.
Generation of electricity	*1,583* / *1·547d.*	*1,887* / *1·203d.*	*1,006* / *1·354d.*	*898* / *1·142d.*
Fuel (including cartage, &c.)	486 / 0·475d.	626 / 0·399d.	367 / 0·494d.	439 / 0·558d.
Oil, waste, water, stores	103 / 0·101d.	141 / 0·090d.	89 / 0·120d.	72 / 0·092d.
Wages at station	887 / 0·867d.	946 / 0·603d.	406[c] / 0·546d.	282 / 0·359d.
Repairs and maintenance at station	107 / 0·105d.	173 / 0·110d.	145 / 0·195d.	105 / 0·134d.
Distribution of electricity	*115* / *0·112d.*	*189* / *0·121d.*	*70* / *0·094d.*	*101* / *0·129d.*
Wages, &c.	44 / 0·043d.	40 / 0·026d.	18 / 0·024d.	56 / 0·071d.
Repairs, renewals of mains, &c.	71 / 0·069d.	149 / 0·095d.	52 / 0·070d.	45 / 0·057d.
Public lighting	*267* / *0·261d.*	*261* / *0·166d.*	*260* / *0·350d.*	*381* / *0·485d.*
Attendance	179 / 0·175d.	219 / 0·140d.	129 / 0·174d.	244 / 0·310d.
Renewals	88 / 0·086d.	42 / 0·027d.	131 / 0·176d.	138 / 0·176d.
MANAGEMENT AND PROPERTY CHARGES	670 / 0·655d.	827 / 0·527d.	237 / 0·319d.	308 / 0·392d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*142* / *0·139d.*	*187* / *0·119d.*	*69* / *0·093d.*	*87* / *0·111d.*
Management	*528* / *0·516d.*	*640* / *0·408d.*	*168* / *0·226d.*	*221* / *0·281d.*
Salaries	316 / 0·309d.	360 / 0·230d.	110 / 0·148d.	135 / 0·172d.
Stationery, &c.	101 / 0·098d.	82 / 0·052d.	5 / 0·007d.	5 / 0·006d.
Establishment charges	86 / 0·084d.	186 / 0·119d.	42 / 0·057d.	52 / 0·066d.
Law charges, &c.	25[d] / 0·024d.	12[d] / 0·008d.	11[d] / 0·015d.	29[d] / 0·037d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£2,290 / 5·36%	£3,523 / 6·24%	£1,218 / 6·98%	£1,647 / 8·96%
Sum carried to Depreciation Fund	— / —	— / —	— / —	— / —
Sum carried to Reserve or Sinking Fund	1,175 / 2·75%	1,438 / 2·55%	634 / 3·63%	792 / 4·31%
Net interest on loans (incl. Debenture charges)	1,285 / 3·01%	1,416 / 2·51%	584 / 3·35%	538 / 2·93%
BALANCE FROM LAST ACCOUNT	— / —	−195 / 0·345%	— / —	— / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	475 / 0·841%	— / —	316 / 1·72%
Deficit	*169* / *0·395%*	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	53·5%	47·4%	56·4%	50·6%
Expenditure per kilowatt capacity	£7. 0s. 7d.	£4. 13s. 10d.	£7. 9s. 10d.	£8. 0s. 10d.
REVENUE PER KILOWATT CAPACITY	£13. 2s. 7d.	£9. 18s. 2d.	£13. 5s. 10d.	£15. 17s. 6d.
Expenditure per 8-c. lamp capacity	4s. 6d.	3s. 0d.	4s. 9½d.	5s. 1¾d.
REVENUE PER 8-C.P. LAMP CAPACITY	8s. 5d.	6s. 4d.	8s. 6¼d.	10s. 2d.
REVENUE PER 8-C.P. LAMP CONNECTED	5s. 11d.	5s. 1⅜d.	10s. 0½d.	11s. 11¾d.
Price charged for lighting, per unit	7d. to 4d.	7d. to 2d.[e]	5d.	5d.
Price charged for power, per unit	4d.	4d.[f]	—	—
Price charged for public lighting	£20 per arc per ann.	£20 per arc per ann.	4d.	4d.[e]

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COMBINED ELECTRIC TRACTION AND SUPPLY STATIONS.

We publish in our issue this week descriptions of the electric power stations at Cork and Carlisle, the first named of which has recently commenced working, while the other will shortly be put in operation. These two power stations may, in some respects, be regarded as being each the converse of the other, inasmuch as the station at Cork is primarily a tramway station equipped so that it can also generate current for electric lighting, while the Carlisle station is essentially an electric supply station with arrangements for working tramways at some future date in the event of electric traction being adopted in that town. Though at first sight the difference between these two conditions might appear to be more of a distinction than a real difference, yet from an engineering as well as from a commercial point of view there is an essential difference. It has been boldly asserted that it will pay an electric lighting concern to undertake electric traction, but that it will *not* pay an electric traction undertaking to supply current for lighting. The reason is to be found in the fact that an ordinary town tramway load is fairly uniform over very many hours in each day, and is, therefore, highly remunerative, whereas the characteristic peak of an electric lighting supply load tends to rob the electric supply undertaking of much of the profit that it would make if it could have a uniform load over many hours. A combination of the two, generally speaking, is, therefore, an advantage to an electric supply undertaking, though it might be, and, in some cases, is, a disadvantage to a tramway concern. Widely different views have been expressed in the electrical profession in regard to the advisability of imposing a lighting load on a tramway station, and as to the converse case of imposing a tramway load on a lighting station. It has been said, for example, that the ordinary town traffic puts a tramway peak on to the station at about the same time that the lighting peak occurs, and that

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therefore the combination produces no advantageous results. This view is, in our opinion, largely imaginary, as the tramway peak, where it exists at all, is by no means as large in proportion to the average load as is the case with a lighting peak; and in the vast majority of cases the effect of an ordinary tramway load from early morning till late at night is to improve considerably the load factor of a lighting station. With regard to the converse case, of a lighting load being put upon a station primarily and essentially designed for tramway work, there are several aspects to be considered. It is probable that a tramway company with a very extensive network of lines over which a frequent service of cars is running, would generally find the hours sufficiently long and the load sufficiently uniform to produce the best paying results; and for such a company the burden of supplying current for lighting during the evening would certainly be no advantage; indeed, it would be a positive disadvantage. On the other hand, there are many places where the tramway service puts a maximum load on the system during the hours of daylight, and where the load appreciably falls after dark. In such circumstances the addition of a lighting load would extend the hours of useful work in the power station, and would therefore increase both the turn-over and net profit of the undertaking. There is another case that merits consideration, viz., where instead of a limited liability company the local authority owns and works the lighting and tramway business. When this is the case, in the vast majority of instances, it would be far more advantageous in all respects for the authority to erect one combined station rather than to have two independent stations, one for the tramway and the other for the supply business.

Having decided upon a combined station, there remains to be settled many questions of detail as to the manner in which the combined plant is to be arranged. In not a few large power stations the load on the generators at any one moment is of a mixed character, consisting of lighting, tramway motors and ordinary consumers' motors. But this practice has not found favour in England. Indeed it is probable that the small magnitude of the loads on combined stations in this country would render it inadvisable to combine the loads on actually the same generators. Going to the opposite extreme some combined stations have been designed with two sets of plant, one exclusively for the supply, and the other exclusively for the tramway current. The more recently designed stations, however, have been provided with generators, each of which may be switched on to either the lighting or the tramway circuits, two separate sections of the switchboard controlling the feeders for these two departments. This is, in our opinion, the best arrangement in average circumstances, providing, of course, that the supply is to be from low-pressure continuous-current generators. Where alternate currents or polyphase currents are concerned, the problem is more complicated. In both Cork and Carlisle the arrangements are for continuous-current generators supplying direct either to the tramway or lighting circuits. A point which presents some little difficulty at the outset is the pressure,—the pressure required for tramway generators being somewhat higher than what would be necessary to produce the Board of Trade limit of low pressure in the consumers' network. This difficulty, however, is very satisfactorily surmounted by means of the extra excitation which the series windings give to the railway generators, these windings not being used when the generators are employed for the ordinary supply. Thus, when working on the lighting circuit the generators are regulated exclusively on the shunt magnet coils, but when used for running the tramcars the shunt excitation is brought up to a higher pitch and the series windings are thrown in so as to over-compound the generators for about 10 per cent. fall on the feeders at maximum load. For instance, at Carlisle the ordinary pressure on the consumers' mains is 460 volts between the outers, while for the tramway supply at top load a generator pressure of about 550 volts would be required. The difference in generator pressure is well produced by means of the change from shunt to compound excitation, as just explained.

With the rapid extension of electric traction and electric supply in the United Kingdom which is noticeable at present, and with the marked disposition of local authorities to acquire and exercise powers to work both these classes of undertakings, the problems associated with the combined electric traction and power station will come more and more prominently to the fore. As these problems present themselves to manufacturers and consulting engineers engaged in designing stations, they are bound to influence and modify the practice in the design of power station plant and details. Generators capable of undertaking both classes of load, even better than those now on the market, will certainly be evolved ere long; and it would seem that the multiplication of this class of station will ultimately lead to the abandonment of the two-pole form of continuous-current generators, so popular in stations a few years ago, and the substitution for them of the large multipolar generator, approximating in character to the railway generators now so extensively employed on the Continent and in America.

CARBONS FOR ELECTRIC LIGHTING AND OTHER PURPOSES.*

BY FRANCIS JEHL.

(*Continued from page 219.*)

Fig. 33 shows the construction of a modern gas generator (as given by Prof. A. Ledebur.)†

It is largely used also in connection with Siemens furnaces, and is adapted for small coal, especially for brown or mineral coal, which gives plenty of gas. Fig. 34 is a vertical section and plan. It will be noticed that two of the sides of the generator are vertical, while the front and back sides are inclined. The inclination depends upon the material used as fuel, and may be from 50deg. to 70deg., according as the latter is compact or loose. The fuel is thrown into the generator at *a* by raising the covers, and *b* are openings that serve for stoking and keeping the fuel evenly divided on the grates. One of the grates, as will be seen from the figure, is a plain one, while the other is of the "step" form, thus insuring a large surface, which is necessary when small coal is used. The air arrives from the blower at *c*, while *d* is a door which is kept closed when the blower is in action, and serves also for taking the ashes away. The gas that is generated goes into the passage *h*, when the valve *e* is raised by means of the wheel *f*. It will also be noticed that the whole generator is built below the surface of the ground, with only a space open at the front in order to get at the ashes, &c. This affords a convenient way of supplying fuel to the generator as the openings *a* are on the ground level, while there is little heat dissipated through the sides, as they are banked with the earth, which is a bad conductor. The dimensions marked in the drawing are in metres.

Fig. 34 shows the construction of a gas generator that H. Stegmann says is adapted for nearly all kinds of solid fuel with the exception of earthy brown coal. A noticeable feature of this generator is the grate, seen in the illustration. Of course, when using a blower, it is necessary to have a door in

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† "Gasfeurungen," A. Ledebur.

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front of the grate. The advantages of such a form of grating is that there is a constant tendency of the fuel as it gets consumed to shift downward, while the ashes, &c., get pushed towards the opening between the grate and the back of the generator, from whence they can be easily dislodged. A small

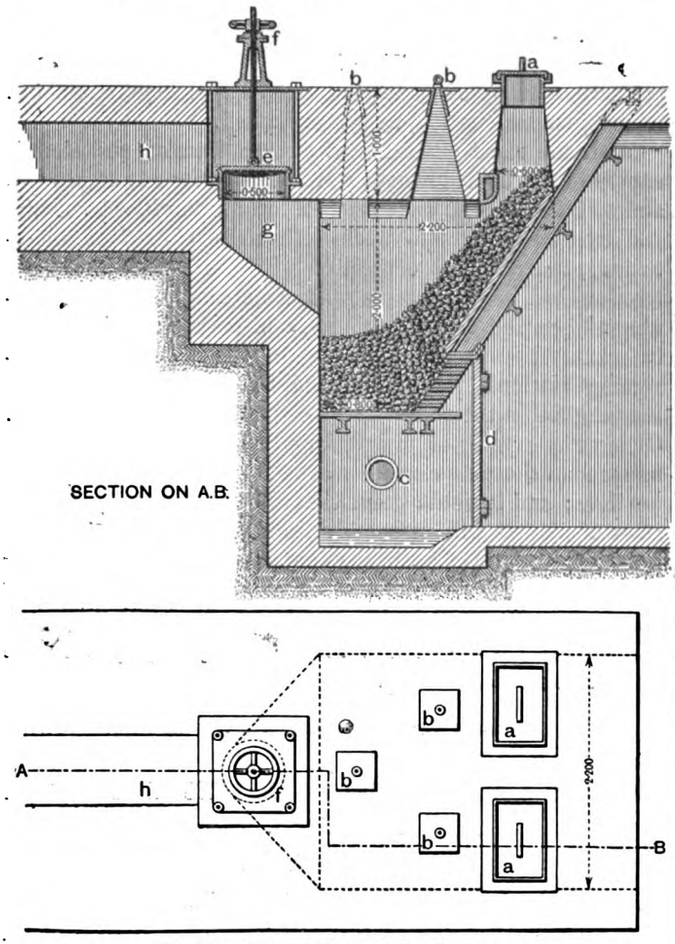

FIG. 33.—General Form of Gas Generator.

opening at the top of the generator (not shown in the illustration) serves for stoking purposes when necessary.

It has, however, been found in practice that fuel which cakes and swells up a great deal does not give general satisfaction when used in the generators that have been so far described. The generators that are built especially for such kind of fuel have generally the form shown in Fig. 35. It will be noticed that the lower portion of the generator is of a plain, cylindrical form, while the upper part tapers inwards, as

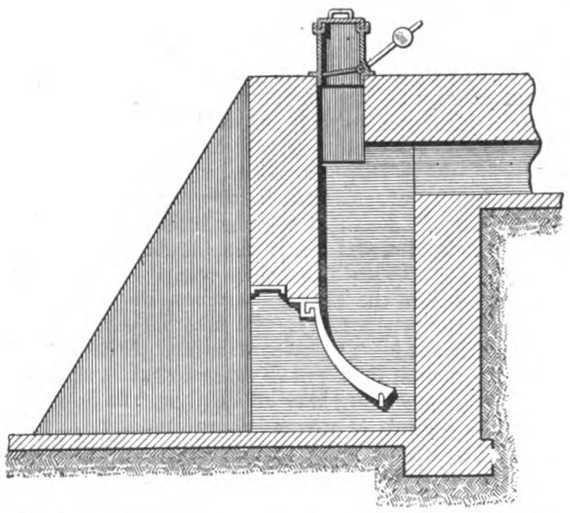

FIG. 34.—Gas Generator adapted for different kinds of Fuel.

shown. Such generators were built by Sailler for the Witkowitz works, where they use coal that cakes very much, and have given satisfaction with the fuel used. As seen, the generator has no grate; but there are simply two openings, *a a*, at the bottom, which are stopped up with plugs of earth when the generator is in action. From time to time these plugs are withdrawn, and the fused slag is allowed to run out. Around the lower part of the generator there are two grooves, *b b*, in which water circulates for cooling purposes, as that part of the generator gets very hot. The air which is supplied from blowers is led into the generator at two sides by the nozzles *c c*, which are also placed in a cooling box, shown by the shaded portion at the lower part of the generator. At the top there are a couple of stoking holes, *d d*, while *e* is the passage into which the gases generated flow, and *f* is a device for supplying fuel, similar to that already explained. It is said that, with an air pressure of about 10cm. to 20cm. on a water manometer, the gas generated does not contain more than 1 to 2 per cent. of carbonic acid gas, while the tempera-

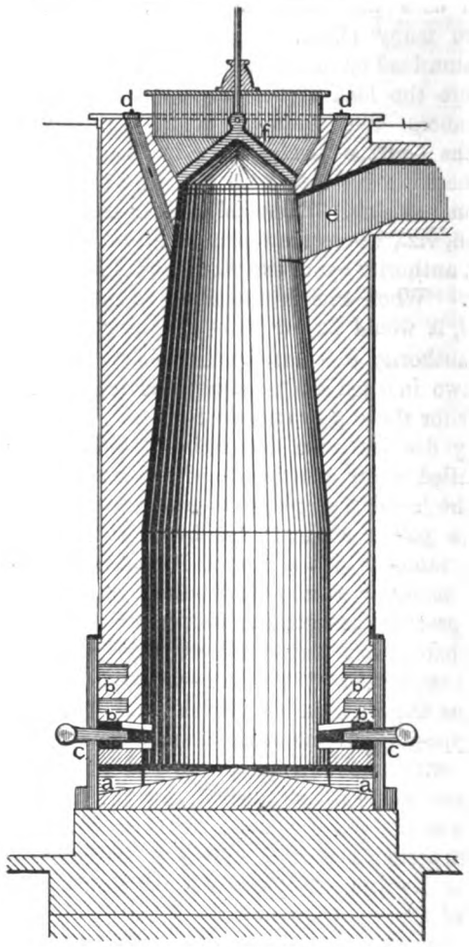

FIG. 35.—Gas Generator for Caking Fuel.

ture at which it leaves the generator is from 700°C. to 900°C. Nor is there any distilled matter obtained, as the gases are so hot when they reach the furnaces that the volatile matter cannot condense.

According to Steinmann, the total grate surface of a generator should not exceed two square metres, and if more gas is wanted than one generator can produce, two should be used, as large generators do not work well. The space between the grates should be about $\frac{1}{4}$ to $\frac{1}{3}$ the total grate surface in a plain grate, and $\frac{1}{2}$ to $\frac{3}{4}$ in those of the step form. Prof. Ledebur states that upon one square metre of grate surface about the following amount of fuel should be supplied per hour: mineral coal about 40 to 50 kilogrammes, and if there is a strong draught about 60 kilogrammes, coke 60 to 80 and peat 100 kilogrammes.

The height of the fuel in a generator may be about 0·6 metre with small brown coal, 0·7 metre with large brown

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coal, 0·75—0·8 metres with mineral coal and coke, while 1—1·5 metres with peat and wood. It is almost needless to state that every generator should be supplied with some safety device, so that in case of an explosion the expanded gases may find an easy path for egress.

In concluding this chapter on generators the writer wishes to point out what an advantage over other countries the United States and Russia possess, as they have enormous wells of natural gas, and gas generators are, of course, not necessary where natural gas can be obtained. There is thus a saving in attendance, while at the same time the flow of gas is far more regular than can be obtained from a generator which depends upon cautious manual management. Natural gas has another important advantage. That obtained in the United States contains much less inert gases than that generated in a generator, and, therefore, per weight or volume it will give more thermal units than the gases produced in a generator, so that the natural gas is better adapted for obtaining the high temperature necessary in baking carbons. The gases generated in a gas generator may have, under good conditions, 35 parts in volume of fuel gases, the remaining 65 parts consisting of nitrogen, carbonic acid gas, &c., while natural gas contains more than 80 per cent. of fuel gas. The components of natural gas are: Methane (CH_4), hydrogen (H), ethylene (C_2H_4), ethane (C_2H_6), carbonic acid gas (CO_2), and nitrogen (N).

VII. The Furnace.

In considering the furnace or oven in which the gas is burnt, it may be remarked that the same is, in reality, nothing more than a simple chamber or part of one, in which the gases and air meet, get mixed, and then burn, while the resulting gases that are produced by the combustion leave at the opposite end. The principal object to be attained in such a combustion chamber is to effect a complete burning of the combustible gases, that is, the combustible hydrocarbon gases should all be transformed into carbonic acid gas. To obtain complete combustion, we must have a sufficient and well distributed supply of air, also a high temperature which facilitates the chemical action resulting from the mixture of oxygen and the combustible gases. One of the most important objects to attain is to get the gases and air well and proportionately mixed, as otherwise we obtain an incomplete combustion. The writer may cite the two cases of an illuminating gas jet, and a Bunsen burner, both of which, let us suppose, consume the same quantity of gas. The heat given out by a gas jet in such a case is considerably less than that of the Bunsen burner, where the gas and air get well mixed before burning, whereas, in a gas jet, there is only a sort of lateral mixing of air and gas. We see also that a much better mixing of air and gases can be obtained, when the gases are supplied from a generator or gas well, than when using an ordinary grate furnace where the fuel is directly burned and converted into heat.

From these facts we conclude that an ideal furnace, especially for the carbon industry, would be one in which the gases issue from a large number of jets, which permits a better and more perfect mixing with air, while at the same when only one or a few jets are used. In fact, it has been time the heat produced will be more evenly distributed than demonstrated that when a certain quantity of gas is consumed, a better thermal efficiency is obtained when using many jets than when using a few. Another important thing to attain when burning gases in an oven or furnace is regulation, that is, to regulate the quantity of gas so that it flows out of the jet or burner in proper proportion. By using the word "jets or burners" the writer refers to the openings in furnaces from which the gases or air issue.

It may be mentioned that Frederick Siemens maintains that it is necessary for each flame to have a certain space in which it can expand, as otherwise there will not be a complete combustion. His assertions are based upon the theory, that combustion depends upon a sort of molecular motion, and that this motion is rendered difficult when gas and air come into contact with fixed bodies, where either attractional or frictional resistance is experienced. Practice has confirmed the above, as it is found that furnaces with a very small combustion space, in which the flames always strike or come in contact with the sides, do not give as much satisfaction as those furnaces having a correspondingly larger space.

To obtain a high temperature in a furnace it is necessary to have the air heated before it is mixed with the combustible gases. It is evident that when cold air is supplied a large quantity of heat is absorbed and taken from the fire, which heat would have otherwise been used for a more direct purpose. Mr. Neilson, of Glasgow, was no doubt the first to propose the hot blast—that is, to heat the air used for combustion before it reaches the furnace. His contrivance consisted of a series of pipes that were maintained at a high temperature either by means of a separate furnace, or by using a portion of the waste heat of the blast furnace itself. It was, however, in this direction that William and Frederick Siemens in 1860 made their epoch-making invention of what is known as the "regenerator." This invention consists simply of a chamber that is filled up with fire bricks so piled upon each other as to allow the heated gases of combustion to circulate freely around them before passing into the flue and out at the chimney. Generally, in practice two such chambers are provided; as soon as the bricks in a chamber are red-hot the combustion gases are switched over to the cold chamber in order to heat it. The air necessary for combustion is allowed to pass into the furnace by way of the hot chamber, and thus its temperature is raised to about 600°C. or 700°C. before it mixes with the combustible gases, thereby making it possible to obtain a very high temperature. As soon as this chamber is cooled down somewhat, the other chamber, which in the meanwhile was heated, is switched on to the air passage again. Thus, by forcing the air always to pass through one or the other hot chamber, a constant supply of hot air is obtained for combustion. In certain cases in practice the combustible gases are also forced to pass through such hot chambers, and thus air and gases arrive at the furnace with a very high temperature.

In such cases four chambers are necessary—that is, two pairs, each pair consisting of two chambers: one for the air and the other for the gases. These chambers are heated by allowing a portion of the waste heat to pass through each chamber. By this means it will be seen that a larger portion of the waste heat can be advantageously utilised again, and thus not only is a considerable economy in fuel obtained, but also a higher and steadier temperature. However, even when using a regenerator the waste heat escaping from a furnace may still be considerable, as tests have shown that the gases coming out at the chimney have sometimes a temperature from 400°C. to 600°C.

(To be continued.)

A DIRECT READING SYSTEM FOR MEASURING CURRENT LEAKAGE.*

BY DR. M. KALLMANN.

This system is based on the idea shown diagrammatically in Fig. 1. Suppose that ammeters A_I and A_{II} are placed in series with the positive and negative mains respectively; the number of lamps L burning will determine the current of J amperes which is flowing. If there is no leakage from either conductor the ammeters A_I and A_{II} would indicate J amperes. But if there is a leakage, owing, say, to faulty insulation of the negative conductor at the point y, and if we assume that the positive conductor in the remaining part of the network has an earth, x, of greater or less value—(an ideally high insulation is unattainable in practice)—an earth current, j, will flow from y to x, as shown in the dotted line. The readings of the two ammeters will then differ by j, the leakage current from the portion of the network under test. Now it would be impossible to observe such a small current as j by the difference between the two large currents J_I and J_{II}. It is, therefore, necessary to combine the two instruments in one, or, in other words, to use an ammeter with a differential winding. If this instrument shows no deflection, the insulation is faultless, but as soon as a leakage occurs its amount is indicated.

This method differs in the following important points from the other methods of measuring the insulation of light and power net-

* Abstract of a Paper read before the Verband Deutscher Elektrotechniker; *Elektrotechnische Zeitschrift*, October 13 and 20, 1898.

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works :—(1) The leakage is shown directly as the actual loss of current that has taken place ; (2) it is independent of the earth potential ; (3) it is independent of the working pressure ; (4) it is independent of the load at the time of the measurement ; and (5) it is uninfluenced by leakage or earths on other parts of the system. The simplest way of applying this method is shown diagrammatically in Fig. 2. The resistance W is inserted in series with the conductor or system of conductors, the condition of whose insulation is to be tested, between the points 1 and 2 and between the points 3 and 4. Each of these points is connected through resistances e to one winding of the differential galvanometer g. This instrument may be a milli-voltmeter with two windings. In this

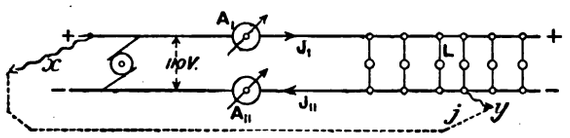

Fig. 1.

way, the readings of g will correspond to the difference of the two main currents i_1 and i_I. In place of a differential instrument, the connections of a Thomson's double bridge may be used as shown in Fig. 3, in which case the instrument g need only have a single winding. This combination requires no further explanation ; the reference letters and numbers in figures are the same as those used in Fig. 2. If the current i_I is equal to the current i_1, g will not deflect, as the points 5 and 6 will have the same potential, and the

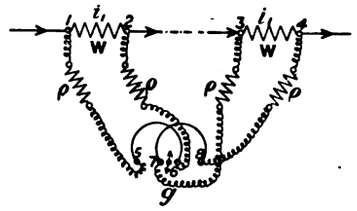

Fig. 2.

deflection g of the galvanometer again corresponds to the amount of current leakage between the points 2 and 3. In my system, therefore, the double bridge serves to compare currents and not to compare resistances. Instead of the convenient direct reading of G, one can, of course, bring the needle of the galvanometer back to zero by adjusting the resistance e. W,W need not either have the same value so long as W,W and e e on each side of the bridge have the same proportion to one another. These variations in the method are, however, not convenient in practice.

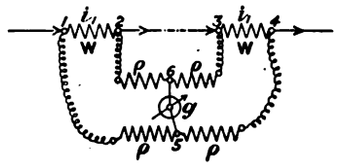

Fig. 3.

I will now enumerate the most important applications of my system. It may be used :—(*a*) to measure the leakage from a single feeder (Fig. 4) ; (*b*) to indicate the currents returning through earth from the rails of electric railways (Fig. 5) ; (*c*) to show the whole leakage current from a two-wire system (Fig. 6) ; (*d*) ditto from a three-wire system (Fig. 7) ; and (*e*) to measure the leakage currents from transmission lines to sub-stations.

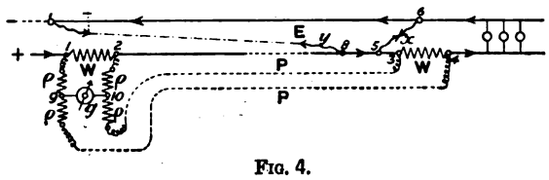

Fig. 4.

(*a*) The resistance W is inserted at the station end of the conductor to be tested between 1 and 2 (Fig. 4) and a resistance of exactly the same magnitude is inserted at the other end between 3 and 4. Assuming the conductor under test to be a feeder, from which no current is tapped between the points 2 and 3, the currents flowing from 1 to 2, and 2 to 3 will be equal if there is no leakage, and the galvanometer g will show no deflection. If there are a number of leakage currents, x, y, &c., their sum $x+y+\ldots$ will be indicated by the deflection of the galvanometer. Instead of a galvanometer or milli-voltmeter a signalling relay may be used by means of which the occurrence of a fault will be automatically announced. The resistance e e may be very small, so long as it suffices to compensate for the differences in resistance between the test wires P P.

(*b*) Fig. 5 shows the system applied to the rail returns conductors of electric railways. Lengths of rail, otherwise quite intact, must be used as substitutes for the resistances (*Hauptstromabzweigewiderstände*) W in the previous figures. In Fig. 5 the return current flows in the direction of the arrowheads through the length of rail S, and passes through the section 1, 2 (say 30 metres long), with a value of i_1 ampere. At a distance of some kilometres will be

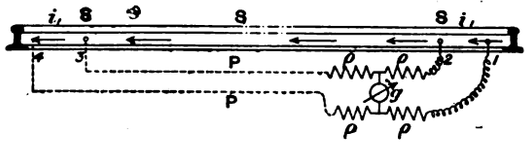

Fig. 5.

another length of rail, 3, 4, of the same profile, &c., through which the current will be i_I. A current of $i_1 - i_I$ amperes will, in fact, have branched from the rail circuit to earth between the points 2 and 3. This current will be indicated by the galvanometer g in the manner already referred to.

To give a numerical example, suppose, as the result of tests, the electrical resistance of a kilometre of heavy double rail to be 0·007 ohm. A length of 30 metres will have a resistance of 0·00021 ohm. A current, i_1 of 100 amperes (corresponding to six large cars) will cause a difference of potential of 0 021 volt between

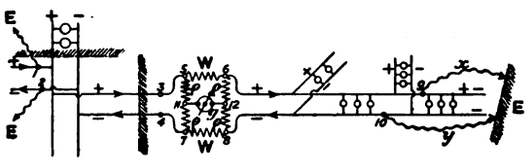

Fig. 6.

the points 1 and 2. If 20 amperes have left the rails between the points 2 and 3, the current i_I will only amount to 80 amperes, and the difference of potential between the points 3 and 4 will be 0 0168 volt. The leakage current to be indicated on the instrument g will, therefore, correspond to 0·0042 volt. Assuming 100 ohms for the resistance of the test-wires P and the compensating

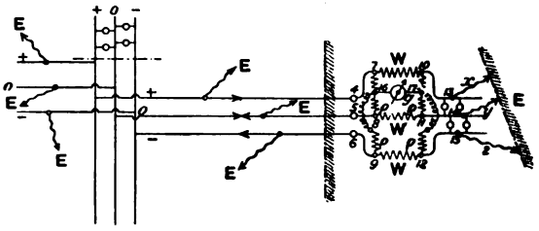

Fig. 7.

resistance e, and another 100 ohms for the resistance of the galvanometer itself, the current flowing through the galvanometer will be $\frac{0{\cdot}0042}{200+2} = 0{\cdot}0000105 =$ approx. 10^{-5} ampere. A Weston galvanometer with a pointer will give 1deg. deflection for 2^{-6} ampere, so

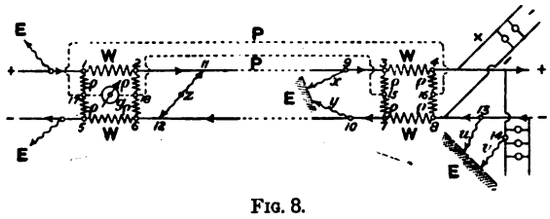

Fig. 8.

that in this case with 20 amperes earth-current 5deg. deflection will be obtained. With a mirror d'Arsonval more than ten times the deflection will be obtained. P.P may be the test-wires contained in the feeders, and their ends are to be connected to all four rails, preferably by means of the cross bonds.

(*c*) I now come to the method of connection to both poles of a network. Fig. 6 takes the case of a two-wire house installation connected to a supply network. The apparatus is connected where the service line is led in, resistances W being connected in series with it at 5, 6 and 7, 8, as shown. In the other parts of the net-

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work there may be any earths 1, 2; let us assume that the earth on the negative pole is the more important. If in the house the positive pole at 9 has a lower insulation resistance than the negative pole 10, there will be a greater currrent flowing from the point 9 by way of x to the negative pole, and the current through 5, 6 will be greater than that through 7, 8. A sensibility of 1deg. per 10,000 ohms fault was obtained with a Weston galvanometer, and this can easily be increased by using a mirror instrument. However, the above sensibility is quite sufficient, as the apparatus is not intended for the insulation test, which must be made before the house is connected, but is meant to give a direct indication of the state of the insulation at any time afterwards, without disconnecting the house from the supply. Thus an indication is only required if the insulation has dropped to a given value; for instance, to some hundreds or thousands of ohms. The apparatus can either be continuously in circuit, and connected if required to an automatic signalling arrangement, or the two resistances W can be normally short-circuited by a double-pole switch.

The details of the apparatus (Fig. 9) will be referred to later, but it may here be mentioned that in the case of equality of the fault resistance of the + and − poles of the network, as well as of the installation, no deflection of the instrument g would be obtained. Although this coincidence is only to be expected on rare occasions, a test for it is easily possible by connecting a resistance of a few hundred ohms momentarily between each pole alternately and earth while taking the reading; the highest deflection obtained is then the determinative one. For even if, for instance, the leakage from the main network is not so intense at the time of the measurement, or if it is principally from the same pole which has a bad

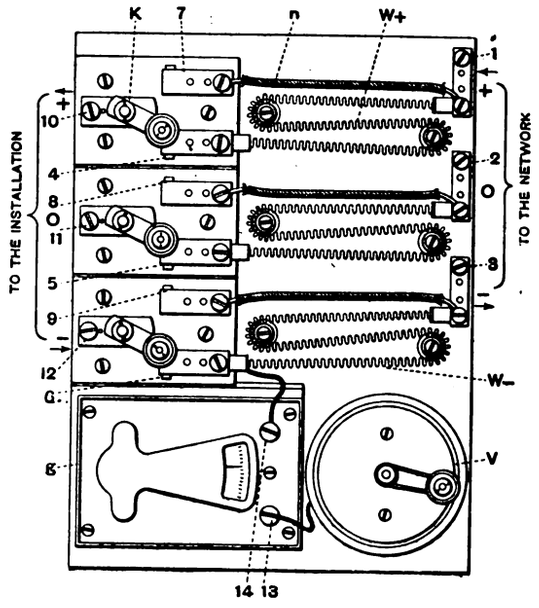

Fig. 9.

insulation in the installation, that is to say, if under the conditions the leakage current is quite small for want of large potential differences, the leakage is not inconsiderable in *every* case. Thus, if the leakage from the network changed in amount, or, above all, in polarity, a fault in an installation which was formerly quite harmless, can become dangerous. The leakage indicator described, when used in combination with an earthed resistance, shows clearly all these unavoidable fluctuations and changes in the condition of the insulation resistance of the whole network, as well as of the individual installation, which must always interact. As a particular case in point, consider a three-wire network whose middle wire is not earthed. A fault on the + wire of an installation, when the prevailing fault on the network is also on the + pole, is quite harmless; but if the latter fault be on the neutral wire, the fault in the house becomes serious, and if a bad fault on the negative pole of the network were to occur, the danger would be again considerably increased.

(*d*) The connections for a three-wire system, shown in Fig. 7, make it clear that the double-bridge arrangement can be extended to a system of any number of wires, without more than one instrument being necessary. The galvanometer g is connected to each of the three main resistances W in exactly the same way, and the system rests on the following:—If the current in the positive wire be i_+, that in the negative wire i_-, the current through the middle wire will be $i_+ - i_- = i_0$ amperes. The current i_0 passing through W on the middle wire at the points 8, 11, would, if there were no faults in the insulation be equal to the difference $i_+ - i_-$; and the galvanometer g which is connected equally across the points 7 and 10, 9 and 12, and 8 and 11 would show no current. But if an earth of x amperes occur, *e.g.*, at the point 13, this current x will also flow through the + resistance W from 7 to 10, but not through the other two resistances. The instrument g will thereupon show a reading corresponding to the difference $i_+ + x i_- - i_0 = x$ amperes.*

(*e*) The connections for many wire systems show how the apparatus is arranged for many sections in parallel; Fig. 8 is for a number in series. This diagram may be taken, for instance, to represent a case of long distance transmission with a sub-station. The generating station is to the left of the points 1, 2, where the transmission line begins, and the current passes in the customary manner through the resistances W at 1, 2 and 5, 6. A galvanometer g connected between 17 and 18 would, as in Fig. 6, indicate the leakage from the whole network to the right of the points 2 and 6, *i.e.*, from the transmission line and distributing network. It is not this test, however, but a separate test of the parts of the system that is needed. For this purpose a resistance, W, is inserted at the end of the transmission line at 3, 4, and at 7, 8. To the right of the points 4 and 8 is the distributing network or the sub-station. The points 15, 16 are connected to test-wires, P P, and, by joining a galvanometer, g, to their ends, the leakage u and v (points 13 and 14) in the part of the network alone beyond the points 4, 8 can be observed. By connecting g simultaneously to 17, 18 and 15, 16 gives, on the other hand, the difference between the total leakage and that from the distributing network, and, consequently, the leakage x and y on the transmission line (points 9 and 10) The difference of potential between the wires P P is only a fraction of a volt, and their absolute potential lies half-way between the potentials of the main wires—two circumstances which are of value, as they render the test-wires harmless. This method can be extended to any number of sub-stations or distributing networks.

The apparatus (Fig. 9) employed for my tests was made by the European Weston Electrical Instrument Co., and I must not fail to express my thanks to the manager, Herr R O. Heinrich. Three main resistances W_+, W_0 and W_- are fixed on a common base, their resistances being each about 0·8 ohm and their dimensions such that they can carry a current of 25 amperes for a short time. They are fixed between the terminals 1, 4, 2, 5 and 3, 6 respectively. If the arms K of the switches are on the contacts 4, 5, 6, the current passes to the installation through the resistances W. The galvanometer g is connected to the ends of these resistances through other resistances e (not seen in Fig. 9 as they are within the base of the instrument), according to the arrangement in Fig. 7. If no measurement is being made, the arms K are placed on the contacts 7, 8 and 9, and the resistances W are short-circuited by the copper shunts n. In this case also the galvanometer remains connected across the house-terminals, but no deflection should take place as, owing to the resistances W carrying no current. To compensate any inequality in the resistances e, and in order to adjust the zero exactly, a small adjustable resistance wrie v is included in the galvanometer circuit. The galvanometer is a portable Weston needle instrument of about 250 ohms resistance and a sensibility of 1deg. = 0 0000025 ampere. The six resistances e (Fig. 7) are each about 900 ohms. Under these conditions a fault to earth of 10,000 ohms resistance or a leakage of 1,100 ampere (at a pressure of 105 volts on each side of the three-wire system) gave a deflection of 1deg. The instrument can, of course, be made more compact; the above is only an experimental form.

* A very similar system was described by Dr. V. Krempelhuber in the *Elektrotechnischer Anzeiger*, 1897, p. 730.

IMPROVEMENTS IN MAGNETIC SPACE TELEGRAPHY.†

BY DR. OLIVER LODGE, F.R.S.

(Continued from page 271.)

Induction *v.* Conduction.

As to the question between space induction and earth conduction, and the relative part each plays in any given case, it is a question which can be answered either by experiment or by calculation. In some cases experiment would be absurd, as, for instance, when either sending or receiving circuit is not earthed anywhere; in other cases, as at Lavernock, it can be answered either way. Now Mr. Gavey tells me that he has tried an experiment on this very point, by taking an insulated wire outstretched between two boats and "earthed" in the sea at either end. Signals being sent from the land, they could be heard out at sea to a certain distance when the wire was above water, but when it was immersed they disappeared at a smaller distance. The argument, of course, is that, regarded as the tapping electrodes of a conductive receiver, the ends of the wire acted similarly both times; but regarded as an inductive receiver responding to magnetic influences, the submerged wire was protected, be-

† Paper read at the Institution of Electrical Engineers, Dec. 8, 1898.

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cause, let us say, the direct and return portions of the circuit, when the wire was immersed in the sea, were more or less coincident. And the moral is that induction contributed the greater part of the effect. It is not quite conclusive, however, because induction and conduction may aid each other anyhow, and, when either is stopped, the residual disturbance may be too faint to hear. A trial with a continuous current might, I think, conclusively measure the part due to conduction. So far as I know no attempt has been made to dispense with earth conduction altogether, by the use of a return wire along the beach; but calculation shows sufficiently that, if this were done, signalling would practically cease. It is a mistake to suppose that the negative result with the submerged wire depends on the reflection of electromagnetic waves at the surface of water, because true electromagnetic waves have in this installation nothing to do with the case. The water may and does to some extent act as a conducting screen, but it is sufficient to consider the immersion of the wire as resulting in simply closing up the receiving circuit until it is a long thin rectangle of inappreciable area, so that the direct and return circuits almost coincide. The experiment proves distinctly that induction has something to do with the result, and that it is not wholly due to earth tapping. Let us see if calculation bears this out.

Without presuming to quote exact details of an installation on which I am not authorised to report, I state only the facts obvious to inspection of the stations by boat. The distance between the earth-plates, or length of the base line, I take to be: At Lavernock, 1 mile; at Flat Holm, ⅓ mile. The average elevation of the line wire I take as 120ft. above the sea in each case; the elevated lengths as 1,200 and 460 yards respectively; and the distance between the stations as 3½ miles.

It may be noticed that in any case, even in this case where the line is straight, the bulk of the impedance is of the "reactance" kind, when a thick wire and high frequency are employed.* For, whereas the resistance might be something between 1 and 2 ohms, the value of pL is something more like 10 ohms if a note of 400 per second is employed; and in such a case the induced current is almost independent of the frequency, because $\frac{pMC}{pL}$ = constant as regards frequency. Hence, with a stronger primary current and lower frequency—say, 20 amperes alternating 20 times a second—the effect received would be decidedly stronger; whereas, if *resistance* had been the dominant feature, the effect of the stronger slower current would have been just the same as that of the smaller quicker one. It is chiefly for response at low frequency, I take it, that such thick copper wires have had to be employed; for, at low frequency, resistance does become the dominant feature.

Now, treating the sea first as if it were a superficial return circuit, or, rather, treating the case of a return wire along the beach, vertically below the line wire, the mutual induction co-efficient between two facing circuits of areas 40 × 1,200 square yards and 40 × 460 square yards respectively, at a distance of 3½ miles, is

$$M=\frac{2\times 4,800\times 18,400}{(6,160)^3}\text{yards},$$

or, say, 0 008 yard, or 0 73cm.

Accordingly, when a current of frequency 400 and 1 ampere mean strength is sent round either circuit, an E.M.F. is induced in the other of average value,

250 M C.G.S., or 1·8 micro-volts.

And I doubt if this could produce any appreciable effect; unless, indeed, the whole of the receiving circuit were attuned and arranged in the way to be presently described.

But a return circuit along the beach is not employed, and would evidently be very ineffective if it were. A return by the sea gives a more open area, and therefore an inductive advantage, in addition to any conductive contribution which it may furnish.

The other extreme case, decidedly more unfair in the opposite direction—so extreme that it is hardly worth consideration except as a warning not to reckon the mutual induction in this way—would be to treat the line wires as if isolated in space—bits of infinite parallel wires—the return current being at infinity. Taking this case for a moment, the mutual induction would be

$$M=\frac{1,200\times 460}{6,120}\text{ yards},$$

or about 80 metres, which must be far beyond the truth.

The actual return circuit depends on the distribution of conductivity in the earth, and is therefore indefinite. The fact that the resistance of the circuit varies with the height of the tide shows that the *sea* conveys most of the current.

Earth Conduction.

Now, calculating what share earth conduction ought to contribute in the matter, we may either treat the shallow sea as a conducting sheet fairly insulated in its bed, or we may postulate equal conductivity through the whole earth; the latter being certainly further from the truth than the former. Considering the electrodes as approximating in area to spheres of radius c, at a distance $2a$ apart, the applied difference of potential between them is

$$V=\frac{Q}{\pi k\delta}\log\frac{2a}{c};*$$

k being the conductivity, and δ the depth of the sea, supposed uniform and small, and Q being the quantity of electricity supplied per second.

The potential at any point distance r from one electrode and r' from the other is

$$U=\frac{Q}{2\pi k\delta}\log\frac{r'}{r};$$

so between two fairly neighbouring points situated symmetrically on either side of a point at a considerable distance r from either electrode,

$$dU=\frac{Q}{\pi k\delta}\cdot\frac{dr}{r}.$$

The distance between these tapping points being $2b$, we have

$$\frac{dr}{b}=\frac{a}{r};$$

therefore, the ratio of the tapped voltage to the total applied voltage is

$$\frac{dU}{V}=\frac{\frac{ab}{r^2}}{\log\frac{2a}{c}}.$$

Now, taking c as a metre, $2a$ as a mile, $2b$ as ¼ mile, and r as 3½ miles, we find that the tapped E.M.F. is a certain fraction of the difference of potential on the primary electrodes; the fraction being,

$$\frac{1}{\frac{3\times(3\frac{1}{2})^2}{\log 1,500}}=\frac{1}{37\times 2\cdot 3\times 3\cdot 18}=\frac{1}{270};$$

which represents a very considerable voltage. But this is the most favourable case, with the current limited to a sheet of sea only a few metres thick. An uncertain amount of current would be certainly lost by real earth conduction, and the other extreme case would be to take the whole earth as of uniform conductivity with sea water. This would give us very much too low a result, as the hypothesis of sea conduction alone has given us one too high. Considering the whole earth as conveying the current, half the tapped E.M.F. is

$$U=A\left(\frac{1}{r}-\frac{1}{r'}\right)=A\frac{dr}{r^2}=A\frac{ab}{r^3},$$

while the applied E.M.F. is

$$V=2A\left(\frac{1}{c}-\frac{1}{2a}\right)=\frac{2A}{c}\text{ approximately};$$

so the fraction $\frac{dU}{V}$ in this case is $\frac{abc}{r^3}$, a fraction so small as to give an imperceptible result.

Part II.—*Preliminary Experiments.*

I will relate briefly a selection from some of the early experiments made on simple wire circuits, at first often without condensers, in order to find what sort of value of mutual induction coefficient (M) was sufficient to give audible signals between a couple of coils of wire lying horizontally in the same plane.

1. Two coils of thin wire, each of 350 turns, and 30cm. (1ft.) diameter, with 5 amperes maintained in one at a frequency of about 100 by an alternating dynamo; a telephone connected to the other coil responded audibly when it was at 6 metres distance. The M in this case is 287 C.G.S., which is large, but no capacity was used to assist.

2. Two coils of No. 15 wire, each of eight turns, on a hoop 92cm. (1 yard) in diameter, and with 11 amperes maintained in one at a frequency of 120 by means of a make-and-break tuning-fork; a telephone in the other responded at 3½ metres. In this case the M=67 C.G.S.

3. A pair of coils in separate buildings 100 metres distant, each with a condenser, the transmitter being 60 turns of No. 18 wire

* I emphasise this because it has been doubted by the Post Office. A method for calculating the self-induction of a straight wire of length l and sectional radius c is given by Lodge and Howard in the *Phil. Mag.*, July, 1889, p. 64, and results in $L=2l\log\left(\frac{4l}{c}-\frac{3}{4}\right)$. Apply this to the Lavernock line wire: say $l=1$ mile, $c=\frac{1}{8}$in., we get L=4 millihenries; so for a note of 400 per second p L=10 ohms; and this is the practical impedance of the straight wire—its resistance being much smaller. It is a great mistake to suppose that in straight wires the self-induction is negligible.

* See, for instance, Foster and Lodge, *Phil. Mag.*, June, 1875, p. 453.

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round a small room nearly four metres square, the receiver being one of the above hoops a yard across wound with eight turns of wire; the hum could be just heard. The M in this case is only 0·6 C.G.S., which is good.

4. The next experiment is worth quoting in fuller detail. It was made in 1897, a month or so later than the above called (1), when things had improved. Fig. 1 is a diagram of the connection at the sending end; the dynamo being replaced by a tuning-fork intermitter (all kinds of intermitters have been used in different experiments).

F is the Koenig fork on its massive stand, vibrating 111 complete swings a second.
b is a single storage cell, and M is the magnet and vibrating solid contact to maintain the fork's motion.
H is the mercury cup contact for the main current.
B is a battery of 16 storage cells.
S is a condenser of variable capacity, and C the coil of 60 turns approximately 4 metres square.
V is a voltmeter to indicate the potential difference at the terminals of the condenser.

The self-induction of the coil being calculated roughly as 0·06 henry, the appropriate capacity for tuning, to the fundamental and the different harmonies, would be :—

For the note 111 per second, S should be about 3·5 microfarads.
" " 222 " " " 8·6 "
" " 444 " " " 2·2 "

Practically it was found that 2·0 microfarads gave excellent tuning, sending up the voltmeter to 98 volts, though the applied E.M.F. was only 32 volts. And under these conditions the note of 440 could be distinctly heard in the small coil in the distant tower; and by introducing a key into the sending circuit, without interfering with the continual vibration of the fork, messages could be sent and read with ease. The receiving circuit was about 100 metres

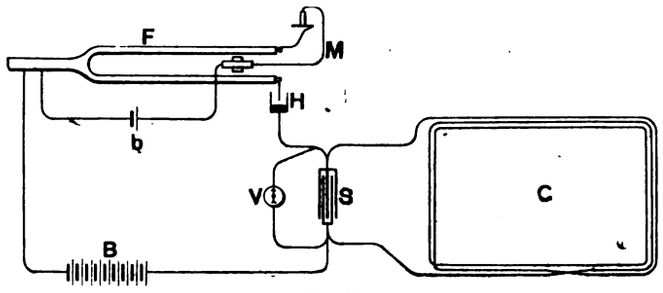

FIG. 1.

distant, high up in the College clock tower across the quadrangle, as in the last experiment; but the small hoop coil was replaced by a square coil of 22 turns of No. 18 wire about 3·8 metres square, whose L was, therefore, 0·008 secohm. A capacity of 16 microfarads was needed to attune the circuit to the note listened for.

5. Instead of any maintained alternator or intermitter of any kind, the make and break, or the reversals, of a signalling key were sometimes used alone to do the whole thing; and when a battery, such as 144 very small Planté cells, was employed, the induction ticks heard in the secondary at each charge and discharge of the primary condenser sufficed to give clear signals at a moderate distance, on the "sounder" plan, the beginning and end of each long and short signal being marked.

6. Another method is to have a much better insulated wire for the primary coil, and to discharge round it a Leyden jar with a short spark gap, excited by a Ruhamkorff coil; the spark being made whistling by a moderate glass-plate condenser (*see* "Modern Views of Electricity," Lecture III., p. 435, second edition), the shrill momentary sounds can be heard in a suitable distant telephone and coil.

7. A pair of coils nearly two miles distant were now arranged, the transmitter being a rough square 100 yards across with five turns of four No. 16 wires in parallel, and the receiver being a long rectangle of the same periphery, about 30 yards wide, consisting of 19 turns of No. 18 wire. A dynamo with a multiple armature was employed, which was coupled up so as to give a nominal voltage of 175 volts (240 as measured). Nothing could be heard at the distant station without condensers, although the M = 100 C.G.S. This was expected, because of the high impedance and resistance. But when condensers were added at both ends and adjusted for resonance to the first harmonic—about 200 per second—the tone became faintly audible. The transmitting condenser was 10 microfarads, viz., four 5-microfarad condensers, two in parallel and two in series, which, by resonance, ran the effective voltage up to 1,100 volts; and the receiving condenser was 2 microfarads, shunted by an ordinary 70-ohm Bell telephone.

The self-induction of the sending cable was in this case 0·02 secohm, to which has to be added 0·04 secohm for the dynamo; while the resistances were 4 ohms for cable and 1 ohm for dynamo. So the reactance part of the impedance for the octave frequency was nearly 80 ohms, and the current therefore only about 3 amperes without sending condenser. A condenser magnified it four or five fold. The sending condenser can always be replaced by a dynamo of higher voltage; but, on the other hand, given any dynamo, a sending condenser will increase its power, except on circuits whose resistance, and therefore damping, is excessive.

The self-induction of the receiving cable, as connected, was $\frac{1}{3}$ secohm approximately, and its resistance was 133 ohms. Even here, therefore, the impedance was more due to self-induction than to resistance, the value of pL being 410 ohms, and so the condenser was a great advantage. In fact, without it nothing could be heard, with the given amount of power expended.

It may be serviceable here to show how quickly to calculate the frequency for any given self-induction and capacity.

Let L be expressed in secohms or henries; let S be expressed in microfarads; then the resonance frequency of the circuit is

$$\frac{160}{\sqrt{(LS)}}.$$

So in the above case the syntonised sending frequency comes out,

$$\frac{160}{\sqrt{(0{\cdot}06\times 10)}}=208 \text{ per second};$$

the syntonised receiving frequency.

$$\frac{160}{\sqrt{(0{\cdot}32\times 2)}}=200;$$

and the fundamental note of the dynamo oscillated about 100.

The damping term of these particular cables, viz., $\frac{R}{L}$, is, however, certainly too high, and the wire used for such large circuits ought certainly to be thicker than No. 18 or 16. Coupling up the strands of wire in a telephone cable in different ways does not affect the damping constant, for the R and the L vary similarly; but the power of coupling them up differently is often convenient in enabling tuning to be got with a moderate condenser capacity, and, in general, in giving an adjustment for different notes. Otherwise, greater number of turns has just the same effect as thicker wire; it is simply *mass of copper* which is required to increase the power of a circuit to send or receive over big distances, and telegraphy over any distance by this method becomes, therefore, chiefly a matter of cost.

It may be well here to give the elementary theory of induction between a pair of circuits, each with condensers, especially for the case where the circuits are syntonised to the applied frequency. Consider a circuit with self-induction and resistance and capacity, driven by an alternator of E.M.F. $=E\cos pt$: the primary current in it is

$$C=\frac{E\cos(pt-a)}{\sqrt{\left\{R^2+p^2\left(L-\frac{1}{p^2S}\right)\right\}}},$$

where the lag a is given by

$$R\tan a=p\left(L-\frac{1}{p^2S}\right).$$

If there is exact tuning ($p^2SL=1$) the lag vanishes, and the current becomes

$$C=\frac{E\cos pt}{R},$$

its maximum value.

On a distant circuit with mutual coefficient M the induced E.M.F. is $\dot{MC}$, or, in the above case,

$$Mp\frac{E}{R}\sin pt;$$

so the induced current there is

$$x=\frac{Mp\frac{E}{R}\sin(pt-\epsilon)}{\sqrt{\left\{R'^2+p^2\left(L'-\frac{1}{p^2S'}\right)\right\}}};$$

which, if again there be tuning ($p^2S'L'=1$), becomes

$$x=\frac{MpE\sin pt}{RR'}. \quad \ldots\ldots\ldots \quad (3)$$

Let a cable contain $N=nm$ turns of wire, of resistance ρ_1 per unit length, coupled n in series and m in parallel, and be laid round a circuit of radius a: then

$$x=\frac{nn'\pi^2\frac{a^2b^2}{r^3}}{\frac{nn'}{mm'}2\pi a2\pi b\rho_1\rho_1'}pE\sin pt$$

$$=\frac{mm'}{4}\cdot\frac{p}{\rho_1'}\cdot\frac{ab}{r^2}\cdot\frac{E}{\rho_1 r}\sin pt$$

$$=\frac{ab}{4r^2}\cdot\frac{p}{R_1'}\cdot\frac{E\sin pt}{rR_1}, \quad \ldots\ldots\ldots \quad (4)$$

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where R_1 is the resistance of unit length of the cable itself as connected.

Here the last factor in (4) is the maximum strength of current which the dynamo could send direct to the distant station if its cable were long enough to reach all the way, and if it were opened out as connected and laid straight, all the parallel turns parallel and all the series turns end to end; and with all the remaining self-induction impedance abolished by a suitable very large condenser.

The actual current received inductively is, therefore, a definite fraction of this direct line current: the fraction depending on the linear dimensions of each circuit compared with the distance, and on the frequency and on the effective thickness of the receiving cable.

Suppose we tried to signal a distance of 12,000 kilometres (across the earth) with a pair of No. 0 equal cables, each once round an area comparable to England, say a circle 200 kilometres in diameter, using a frequency of 1,000 and an applied voltage of 200; ignoring all hysteresis and other losses (which in condensers are often important), and ignoring also the conductivity of the earth, which may be very troublesome:

$$\frac{E}{R_1 r} = \frac{200}{0{\cdot}322 \times 12{,}000} = \frac{1}{20} \text{ ampere};$$

$$\frac{p}{R_1} = \frac{1{,}000 \times 2\pi}{3{,}220} = \frac{2\pi}{3};$$

$$\frac{ab}{4r^3} = \frac{100 \times 100}{4 \times (12{,}000)^2}$$

These are the three factors; so the induced telephone current is about 2 microamperes. which is within the limit of audition. The self-induction of such a cable would be between 2 and 3 secohms, its resistance about 200 ohms, and the capacity needed only about $\frac{1}{100}$ microfarad. This arithmetic is a mere illustration of what would happen if everything were favourable.

Consider further the arrangement of coils adapted to really distant syntonic magnetic space telegraphy with very precise tuning. The mutual induction coefficient depends upon $mm'a^2b^2/r^3$; or for imilar equal coils, each of periphery l and n turns,

$$Mr^3 = \text{the effect of the coil at a given distance} = n^2l^4.$$

The amplitude of disturbance maintained by an alternator of frequency p and voltage E_0, in a circuit whose natural frequency $p_0 = \frac{1}{\sqrt{(SL)}}$, may be written,

$$\frac{E_0/R}{\sqrt{\left\{1 + \frac{L}{SR^2}\left(\frac{p}{p_0} - \frac{p_0}{p}\right)^2\right\}}},$$

which in case of exact resonance becomes E_0/R. Hence, to make resonance *sharp*, the coefficient $\frac{L}{SR^2}$ must be great. If this condition is not satisfied there will be a considerable range of resonance within which some exaltation of voltage is felt, but no decided peak; whereas, if L/SR^2 is great compared with the period of one oscillation, then, except at a particular frequency, the circuit is nearly inactive, but as the correct frequency is approached the activity of the circuit suddenly runs up to a high steep maximum, and condensers are liable to be burst by the immense and rapid magnification of voltage.

Take the case of approximate resonance, so that $p^2SL = 1$ nearly, and introduced this value of S: then the coefficient which has to be big is $\frac{p^2L^2}{R^2}$; *i.e.*, for a given frequency simply the damping constant or logarithmic decrement, R/L, must be small, or the current-decay time constant, L/R, big, compared with the frequency time constant. Now

$$\frac{L}{R} = \frac{n^2l\left(\log\frac{3l}{c} - 2\right)}{\frac{nl}{c^2}} = nc^2 \text{ approximately}$$

where c is the thickness of the wire, which does not enter much into the numerator.

So the two things which we want big are n^2l^4 and nc^2; wherefore, in case of magnification of circuit for bigger distances, the thickness of the wire should be magnified as well as its length. Of course, for really high frequencies it is no use having a thick wire *solid*. It must either be ribbon-shaped, or be stranded, with the strands roughly insulated even if they are not going to be used otherwise than in parallel.

Magnification Ratio.

The amount of magnification of voltage caused by resonance is to be calculated thus:—The impressed E.M.F., or the E.M.F. of the sending dynamo, being E_0, the effective potential difference between the condenser terminals is such that, when there is syntony and when the damping is small,

$$\frac{V}{pL} = \frac{E_0}{R};$$

in other words, the magnification ratio is

$$\frac{V}{E_0} = \frac{pL}{R} = \tan a,$$

and approaches infinity as the lag of current behind E M F. approaches $\frac{1}{2}\pi$.

The primary current without a condenser would be $\frac{E_0}{\sqrt{(R^2+p^2L^2)}}$, but with the syntonising condenser it is $\frac{E_0 \tan a}{\sqrt{(R^2+p^2L^2)}}$, or, approximately, $\frac{E_0}{R}$.

But it is to be remembered that all hysteresis losses—whether they be due to an iron core in the coil, however subdivided, or by reason of a stratified or other imperfect dielectric in the condenser—and also all eddy-current losses by reason of induction in neighbouring conductors, whether insufficiently subdivided iron or earth or sea, all go to increase resistance—*i.e.*, to increase damping—and thereby to diminish the magnification ratio. If the R be measured in the usual way, by steady currents, it is liable to be supposed much smaller than it really is—*i.e.*, smaller than the really effective R for alternating currents—especially for high frequency. Part of the art of magnetic space telegraphy will consist in avoiding or minimising these various sources of loss, all of which show themselves as an increased resistance.

Perhaps the neatest way of proving that the magnification ratio equals pL/R is as follows:—Since in free oscillations $\frac{1}{2}SV^2 = \frac{1}{2}LC^2$, where V and C are the potential and current amplitudes respectively, and where $p^2LS = 1$, we get

$$C = V\sqrt{\frac{S}{L}} = \frac{V}{pL} = \frac{E_0}{\sqrt{(R^2+p^2L^2)}};$$

so the magnified or syntonic voltage, when the damping is small, is

$$V = \frac{pL}{R}E_0$$

To maintain these oscillations is the function of the dynamo, and for this purpose it has only to supply the waste power, viz.,

$$\tfrac{1}{2}RC^2.$$

Hence, in cases where R is large from any cause, considerable power is necessary; but where the R is small, including all the spurious losses which go to make up the effective R or dissipation constant, then violent oscillations can be maintained in a circuit with very little outside power.

The whole matter is analagous to the swinging of a heavy pendulum or bell whose motion is excited and maintained with little energy if the impulses are properly timed, but which requires more energy when swung in a viscous fluid. The time of applied impulses should be the same as if it were free, although the actual time of free swing is a little lengthened by the friction. For circuits oscillating with extreme rapidity one of the principal sources of spurious resistance, and therefore of damping, is radiation of waves, but with these leisurely circuits there is no radiation that need be taken into account in estimating the waste of power. A church bell stiffly hung would become but little easier to swing if its clapper were removed and its wave-emitting property destroyed.

Best Condition for Distant Sending.

Having realised that any distance can be reached if enough copper and enough power are employed, it remains to reckon what is the best way of arranging the copper, and how little will serve to enable a given power to signal a given distance. When nothing else has to be considered, the condition to be satisfied for signalling to a great distance is to make the magnetic moment of either coil as great as possible; its value is $n\pi a^2\mu C = \frac{\mu\kappa WE}{4\pi n}$ when syntonised; so all the copper available, W, should be disposed in one large single circuit at each station.

Possibility of Using Iron.

If iron is used as the core of a sending coil, it should be minutely subdivided, and should, if possible, be hot—as near its critical point as practicable—because then both hysteresis and eddy losses are at their minimum: see a most interesting communication on the behaviour of iron at different temperatures by Mr. D. K. Morris in *Proc. Phys. Soc.* for 1896-97.* A transmitter, shaped like a chimney or a lighthouse, with a long vertical thin iron strip core surrounded by many turns of wire, would be most efficient if only the damping losses could be got rid of. For the function of the sender is to produce the strongest possible alternating magnetic field at a distance, and this depends simply on magnetic moment, being $\frac{m}{r^3}$ at any distance r in an equatorial plane; and this field, though excessively and imperceptibly weak at any point, is then to be detected by the integrating power of the receiving coil over

* Abstract in *The Electrician*, Vol. XXXIX, p. 143.—[Ed. *E.*]

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a large area. So, in general, if a magnet of moment m oscillates $2\pi p$ times a second, and the receiving circuit is of area A, the number of lines passing through that circuit is Am/r^3, and p times this is the maximum induced E.M.F. which a telephone or other instrument in the receiving circuit has to detect if it can.

Best Size and Shape of Coil for Violent Resonance.

It is of interest to find the shape of coil adapted to reduce damping due to ordinary resistance to a minimum. Let the coil be of mean radius a, of sectional radius c, and consist of n turns: then the volume of copper in it, ignoring insulation, is

$$W=\frac{\pi^2 c^2}{4n}\times 2\pi na=\tfrac{1}{2}\pi^3 ac^2;$$

$$L=4\pi n^2 a\left(\log\frac{8a}{c}-1{\cdot}75\right);$$

$$R=\frac{2\pi na}{\pi^2c^2}=\frac{8n^2a}{\pi c^2\kappa}=\frac{(2\pi na)^2}{\kappa W}.$$

The damping time-constant, or reciprocal of the logarithmic decrement, is

$$T=\frac{L}{R}=\tfrac{1}{2}\pi^2\kappa c^2\left(\log\frac{16W}{\pi^3c^3}-1{\cdot}75\right)=\frac{\kappa W}{\pi a}\left(\log\frac{8a}{c}-1{\cdot}75\right).$$

So T will be a maximum, and the damping a minimum for

$$\frac{dT}{dc}=2c\left(\log\frac{16W}{\pi^3c^3}-1{\cdot}75\right)-3c=0;$$

or $$\log\frac{8a}{c}=1{\cdot}75+1{\cdot}5=3{\cdot}25;$$

or $$\frac{a}{c}=3{\cdot}22;$$

which is, therefore, the condition for maximum T with a given W—*i.e.*, the condition for least damping, with a given bulk of copper.

This maximum $T=T_m=\frac{3}{4}\pi^2\kappa c^2=\frac{3\kappa W}{2\pi a}=\frac{3\kappa}{5{\cdot}5}W^{\frac{1}{3}}$

(=3·4 seconds for a ton of copper).

The E.M.F. which the condenser will have to stand is pTE_0.

The L appropriate to T_m is

$$L_m=6\pi n^2 a=16{\cdot}5n^2W^{\frac{1}{3}}$$

(=1,650n^2 for a ton of copper).

The mean periphery of the coil is $5{\cdot}5W^{\frac{1}{3}}$

(or 5½ metres for a ton of copper).

The thickness of the coil, $2c=\frac{4W^{\frac{1}{3}}}{2{\cdot}345\pi}$

(=53 centimetres for a ton).

Such a thickness of coil may seem preposterous, but in certain confined spaces (*e.g.*, a lighthouse) it is advantageous so to be able to dispose the circuit, and the coil may consist of any amount of turns without detriment. What has to be scrupulously avoided in the neighbourhood of any coil is conducting material; but the reaction effect of such material falls off rapidly with distance—as the inverse 6th power (*see* Lodge, *Phil. Mag.*, Feb., 1880, p. 142)—and accordingly it is to be hoped that the general conductivity of the earth will not exert a very deleterious effect. Its effect will certainly be in the direction of increasing the resistance, and therefore the damping, of either coil; but, beside this reaction effect, a true partial screening of one coil from the other is to be found.

The thickness of wire is

$$c\sqrt{\frac{\pi}{n}}=\frac{W^{\frac{1}{3}}}{2{\cdot}07\sqrt{n}}\left(=\frac{50}{\sqrt{n}}\text{ for a ton of copper}\right).$$

Thus, for instance, the coil might have 10,000 turns of wire half a centimetre thick (No. 5½); the outside diameter of the coil would be 2½ metres, and the inside diameter 1¼ metres. Such a coil would weigh a ton, and its resistance would be

$$R=\frac{48{,}000\,n^2}{W^{\frac{1}{3}}}=480n^2\text{ C.G.S.}=48\text{ ohms}$$

Its self-induction would be 165 henries; its time of falling to $\frac{1}{e}$ the current, 3·4 seconds; and its magnification ratio, with a note of 400 per second, would be 8,500. The condenser to be used with it for this note would be about $\frac{1}{10{,}000}$ microfarad, or 9 metres electrostatic capacity. It might have an air or fluid dielectric to lessen hysteresis, and must be able to stand a very high potential—for instance, nearly a million volts if the applied dynamo E.M.F. is 100 volts. The current in the wire would be only 2 amperes, and the energy expended therefore insignificant, viz., about 200 watts. In such a case the signalling would be done by the agency of the mass of copper rather than by mechanical power, and the tuning would be excessively sharp. There may be a few places where it is desirable to economise power to this extent, as, for instance, when the dynamo has to be driven by hand, or where space is very cramped, as in a lighthouse; but in most cases it would be far better to expend more power and open out the coil into a circuit enclosing a large area. This could nearly always be done at *one* of the stations.

A compact coil like this is not a powerful sender or receiver, in spite of its high magnification ratio. For instance, using a pair of such coils, one as sender and one as receiver,

$$Mr^3=(\pi na^2)^2=\tfrac{1}{4}\kappa RWa^2=\frac{10^{18}}{18}\text{C.G.S.}$$

So the induced current, when properly attuned, is

$$\frac{pEM}{R^3}=2{,}500\cdot\frac{100}{48}\cdot\frac{10^{18}}{18r^3\times48\times10^9}=\frac{6{\cdot}4\times10^9}{r^8}\text{C.G.S.}$$

So the distance at which this current would be a microampere (10^{-7} C.G.S.), or something quite audible, would be

$$r=\sqrt[8]{64\times10^{16}}=4\text{ kilometres only.}$$

Throttling.

The thickness of wire permissible without insulated subdivision into strands is regulated by the frequency. Taking Lord Rayleigh's value of the initial throttling, $p^2L^2\mu^2/12R^2$, it comes out $1{\cdot}2n^2a^4\times10^{-5}$ C.G.S. for copper; so, if the throttling is not to result in a greater increase of resistance than 1 per cent., a thickness of wire 1·08cm., or No. 5/0, may be used for a frequency of 100 per second.

For 500 per second nothing thicker than 0·48cm., or No. 6, should be used without subdivision.

For 1,000 per second No. 10, or 0·34cm. thickness, is permissible.

For 1,600, No. 12; and for 2,500 per second the appropriate thickness is 0·216cm., or No. 14 S.W.G.

If No. 2 wire, or 19/16, is used for 500 per second frequency, the loss due to throttling is 5 per cent.

If No. 0, or 19/12, is used, the loss is 9 per cent.

But if the strands are each cotton-covered before stranding, then there is practically no loss.

(To be concluded.)

LUMINOUS SIGNAL TELEPHONE SWITCHBOARDS.*

BY KEMPSTER B. MILLER.

The advantages of incandescent lamps over the electro-mechanical signal are many, and among them may be mentioned the following: First, they are capable of attracting the attention of an operator with much more certainty than the ordinary mechanical shutter; second, they are entirely free from mechanical complication, and, therefore, unlikely to get out of order or to fail in action, unless entirely destroyed; third, they are much more compact than even the simplest electro-mechanical signals; fourth, they are entirely automatic in their operation, being always restored to their normal condition by a cessation of the current through them; fifth, by the use of various coloured glass in front of them they may be used in the same board as indicating separate kinds of information; sixth, they are easily replaced when destroyed; and, seventh, they are as cheap, if not cheaper, than the high-grade tubular drops now in such common use.

Obviously there are two different methods of associating incandescent lamps with the circuits of the subscribers' lines. The first of these, and without mature consideration the most desirable, is to place the lamp directly in the circuit of the subscriber's line, and operate it automatically by a change in resistance in the line, brought about by the removal of the subscriber's receiver from the hook. The second is to have the lamp in a local circuit controlled by a relay directly in the line circuit, which relay may be operated by an ordinary subscriber's magneto-generator or by a source of current at the central office thrown into action by a change of resistance at the subscriber's station.

In the former method we find ourselves confronted with several rather serious objections; in the first place, the resistances of no two subscribers' circuits are the same, owing to the differences in the lengths of these circuits and other causes, and, therefore, either the inductive resistances at the exchange end of the circuit or the resistance of the subscribers' bell magnets will have to be varied in each case in order to ensure the proper amount of current passing through the lamp. This is a feature easy to overcome, and a much more serious one is that arising from crosses between two line wires from any source whatever, such a cross, of course, always subjecting the lamp to an undue amount of current, and, therefore, burning it out. This latter objection has proved so serious as to cause the abandonment of the plan of including the lamp directly in the line circuit in nearly every case where it has been tried. Of course, for underground systems this objection is not such a serious one.

Passing now to the second method of associating the lamp signal with the line circuit, reference will be made to Fig. 1. This shows the circuits of three subscribers' stations, S, S^1 and S^2, these

* Abstract from the *American Electrician*.

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circuits being connected with the central office by the metallic circuits 1, 2. The line wire 1 in each case passes to the sleeve spring d^2 of the spring-jack J, and thence through the relay contacts c^1 to the ground. The line wire 2 passes in a similar manner to the tip spring d, thence through the relay contacts c^2, the winding of the relay b, and the battery a to the ground. The signal lamp e is in each case included in a local circuit, containing a battery f, common to all lamps, and the contact 4 of the relay b belonging to its line. The relay c of each line, which controls the contacts c^1 and c^2 is known as the cut-off relay, and is included in a local circuit through the jack thimble d^1, and the plug contact m, with the battery n, whenever a plug l is inserted into a jack for making connection with the line. The two sides of the line at the subscriber's station are permanently closed through a high-resistance bell B and a condenser C, the latter being of considerable capacity, so as to allow the alternating currents from the calling generator at the central office to pass through it and operate the call-bell in the usual manner. The high impedance of the call-bell magnets, however, prevents the short-circuiting of the voice currents when the receiver is removed from its hook. The call-bell circuit, therefore, presents an open circuit to the direct current from the battery a, thus normally insuring a condition of no current upon the line wire. When, however, the receiver at the subscriber's station is removed from its hook, a path of comparatively low resistance is formed

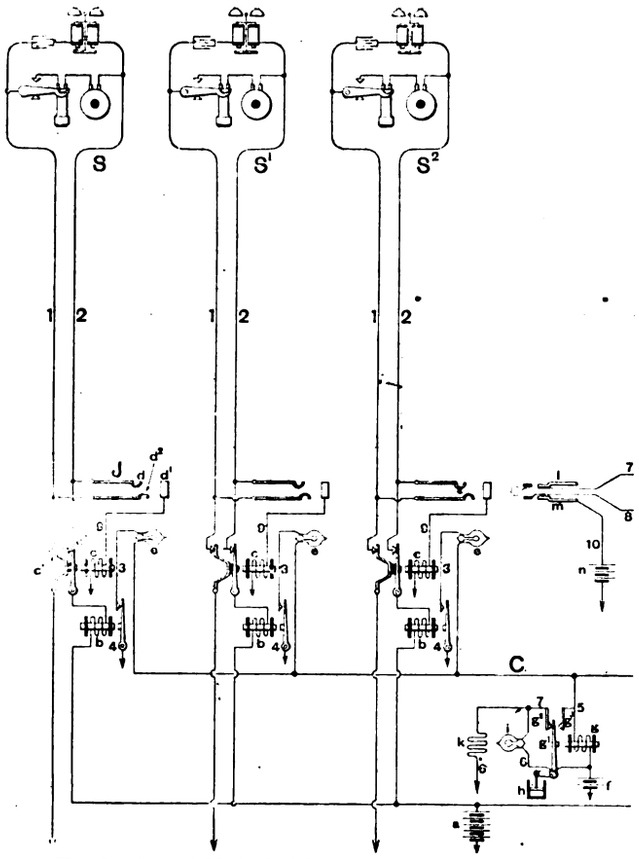

FIG. 1.—Second Method of Luminous Signal Connections.

between the two low line wires, and a current proceeds from the battery a, through the relay b, contact c^2, line wire 2, to the subscriber's station, back by line wire 1, through relay contact c^1, and by ground to the opposite terminal of the battery a. This current is sufficient to operate the relay b, and unlike the case where the lamp was used directly in the line wire, a considerable variation in the amount of this current is allowable. The operation of the relay b closes the circuit of the lamp e through the following path :—From the battery f, through the relay g, wire 5, common wire C, lamp c, wire 3, relay armature 4, and back by ground to the opposite pole of battery f. For the purpose of clearness, the relay g need not be considered at all at present, as it has nothing to do with the operation of the lamp e, and we may, therefore, consider one pole of the battery f to be connected directly to the common wire C. The closure of this circuit illuminates the lamp e. The next step in the operation of the system is the insertion of the plug l into the jack of the line on which the signal is displayed. The insertion of this plug closes the circuit through the relay c over the following path :—From the battery n, wire 10, plug sleeve m, thimble d^1, wire 9, relay coil c, to ground and back to the opposite pole of the battery n. This causes the relay to attract its armature and break both of the contacts c^1 and c^2, thus accomplishing a double purpose, the first of which is to break the circuit through the relay b, and thus cause it to release its armature 4, breaking the circuit through the lamp e ; and the second of which is to cut off both sides of the line circuit 1, 2, beyond the spring-jack J. This latter feature is a very important one, since it removes all difficulty from cross talk and other troubles in the auxiliary circuits of the central office.

The circuits illustrated in Fig. 1 are substantially those in common use by the Bell Company in their lamp signal exchanges, so far as the circuits of the relays and lamps are concerned. Several different modifications of the circuits at the subscribers' stations have, however, been used. The subscribers' stations may or may not include local batteries, and the tendency of practice is now to do away with these entirely and to supply current from central office for the operation of the transmitters as well as for all signalling purposes.

The relay g and its associated apparatuses form a very interesting addition to the system as outlined. It is found desirable to use what are termed pilot lamps for certain groups of line lamps, for the purpose of attracting the operator's attention more surely to a signal on her board. If two or more signals are displayed at once but one of them may attract the attention of the operator, who might, therefore, neglect the other. Pilot lamps are used in such connection that they remain lighted as long as any one of the line lamps in their group are lighted, and as they occupy a very conspicuous position and are as a rule brighter than the others, they cannot escape the operator's attention. Obviously it would be a serious objection to put a relay for operating such a pilot lamp in the common wire C of the local circuits of the lamps e, for the reason that the fall of potential or drop through such a relay would vary, according to the amount of current passing through it, and if several of the lamps e were operating at the same time they would probably not, therefore, receive enough current to properly illuminate them. The relay g is, therefore, included in circuit with battery f, and means are provided whereby its resistance will be short-circuited the instant it is operated. To accomplish this, the armature g^1 makes contact with the point g^3, as soon as it is attracted, thus short-circuiting the resistance of the coil g. At the same time it breaks contact with the point g^2, and

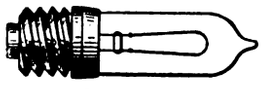

FIG. 2.—Signal Lamp.

thus allows the current to flow from the battery f, through the lamp i and resistance k, thus illuminating the lamp. In order that the armature g may not fall back against the contact point g^2, as soon as the coil d is de-energised by being short circuited, a small dash pot h is provided in connection with the armature to render its movements sluggish. Thus before the armature g^1 has time to move very far away from the point g^3, owing to its sluggish action, it will be at once attracted again, and the interval during which the resistance coil g is in circuit with the common wire C and the lamps e is so small that it does not have time to affect these lamps. This system is due to Mr. C. E. Scribner.

The incandescent lamps commonly used for signalling purposes and telephone work are of the type shown in Fig. 2 ; the lamp is about $\frac{3}{8}$in. in diameter, and $1\frac{1}{4}$in. long over all. They are commonly built for 10 or 20 volts pressure, the tendency being rather to increase the voltage than to decrease it. At first lamps of two and four volts were used, but for various reasons, not the least among which was the trouble of securing proper contacts at the relay and switch points for such low voltages, the voltage was gradually increased to the above-mentioned figures. Mr. A. H. Abbot, of Chicago, has recently given some interesting figures concerning the life of incandescent lamps in switchboard work, and mentions one case where a lamp was flashed over a million times without showing serious signs of deterioration. His tests seem to indicate that for general service in switchboard work the average lamp will live for a period of about 1,200 hours, although in laboratory tests a much longer life has proved possible. He points out, as a result of his observations, that, according to theory, the lamps used in subscribers' line circuits should last about 25 years, and those in the cord circuits used as "supervisory" and clearing-out lamps, for from one to two years. He also says that such a life has already been obtained in the cord circuit lamps, but that it is doubtful if the theoretical limit for the line lamps will ever be closely approximated.

BOOKS RECEIVED.

"The Official Gazette of the United States Patent Office." No. 10. Vol. LXXXV. Published by Authority of Congress. (Washington : Government Printing Office.)

"Annuaire de L'Observatoire Municipal de Paris" for 1899. (Paris : Gauthier-Villars). Price 2fr.

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LEGAL INTELLIGENCE.

Employers' Liability.

In the City of London Court, on Monday, Mr. G. Pitt-Lewis, Q.C., heard an action brought under the Employers' Liability Act by Charles H. Wild, 16, Seckford-street, Clerkenwell, London, to recover £50 damages for personal injuries sustained while in the service of the defendants, the County of London and Brush Provincial Electric Lighting Co. (Limited).

In opening the case, Mr. THOMPSON, for plaintiff, said that the claim arose from a set of circumstances quite out of the common. Plaintiff was in the employ of defendants, and on July 22 last, after having been working at the mains in various capacities for three or four years, he was ordered by defendants' foreman, Strahan, to go into a transformer box in St. John-street-road, Clerkenwell, and there to put a new fuse into a high-tension switch. While engaged at this work an explosion suddenly occurred. Plaintiff was very severely injured on the left arm and hand, and was unable to follow his occupation for some time. The transformer box was about 9ft. deep and 7ft. 6in. square. Plaintiff was a labouring man, and no doubt ought not to have been put to do the work at which he was engaged when the accident happened.

Defendants asserted that plaintiff was an inspector, and not a labourer.

The DEPUTY-JUDGE suggested that he would probably be called a ganger."

Mr. THOMPSON said his client was not a skilled electrician, and the work was dangerous. The defendant company drew up a series of rules, the first of which required the plaintiff to wear rubber gloves (which they had provided), when he was engaged near the high-tension mains, because of the danger. The work in question was the first the defendants had ordered the plaintiff to do of so dangerous a nature. It was really fitter's work, and should not have been entrusted to him. The fact was, the high tension mains should have been disconnected at the head offices, or head-quarters, before plaintiff did the particular work which brought about the accident. He thought the high tension mains were disconnected, instead of which they were not. The accident was brought about by an explosion, not a shock. The explosion was heard 40 or 50 yards off, and had nothing to do with the wearing of the gloves as had been suggested.

Mr. BELL (for defendants) said he would show that the whole accident had been caused through the plaintiff not wearing the rubber gloves. He had broken the rule requiring him to wear them, and he must put up with the consequences. It was idle to suggest that electricity could cause an explosion.

The DEPUTY-JUDGE: It was a sort of young thunderstorm?

Mr. THOMPSON agreed. If the electricity had been switched off, there would have been no explosion.

The PLAINTIFF said he ought not to have been put to supply a new fuse pot. The weather was very hot at the time, and his hand was very hot indeed. To enable him to do his work better, he took one of his rubber gloves off. The explosion was a terrible one. "The room filled with electricity, and at first he thought the place was blown away." He reported himself to the office, but the superintendent told him his injuries were nothing, and for the day he was to keep on at work. For ten weeks he was unable to follow his occupation. His hand was in dreadful agony at the time, and he went to St. Bartholomew's Hospital, where he was treated. He denied that he used a screw-driver improperly, and formed an arc which brought about the explosion. If he did form an arc, he certainly did not know it. He had had no experience with electricity. It was true he had been with the defendants for some years, but he had never had any technical instruction.

JAMES WILD, who had had, he said, long experience in electrical matters, gave it as his opinion that the plaintiff ought not to have been put to do the work allotted to him. Just as the plaintiff would not be allowed to go into a generating station, so no one but a fitter should have done the plaintiff's task.

The DEPUTY JUDGE supposed the plaintiff was being promoted, and was generally bettering himself.

Mr. BELL said no responsibility could attach to the defendants for the accident which had happened. They provided the plaintiff with a pair of rubber gloves, which would have completely insulated him from any danger, but he left them off. He must have formed an arc with the screw-driver or the explosion could not have occurred.

Mr. CHILD, assistant engineer to the defendant company, said it was the plaintiff's duty to do any small things, such as the job at which he was engaged when the accident happened. The plaintiff was altering one of the "sneezers," and it was not customary then to turn off the current. It could be done, but it was not the practice. The electricity did not go through the sneezer in any way. If a man was ordinarily careful and wore his gloves there was no danger about the work. The gloves were a perfect protection. The terminal was about 1½in. from the sneezer. The plaintiff's first duty was to go into the boxes and see that all the fittings were in order and that no fuses had gone. If any had gone his duty was to replace them. He could not class plaintiff as a labourer, although he only received 29s. 6d. per week.

STRAHAN, defendants' foreman, said that if the plaintiff had 2,000 volts to contend with, and he was wearing his gloves, no acccident would have befallen him, even if flame came out.

The DEPUTY-JUDGE, in giving judgment, said no doubt the plaintiff did not know much about electricity, but everybody must have a beginning, and no doubt he was an improver. There were certain risks which had to be borne by everyone. He did not think the plaintiff was sufficiently cautioned about the dangers which were around him. No doubt very proper instructions were given him, but only in a general way. The plaintiff might think himself very lucky that worse injuries did not befall him, for it had been shown in the evidence that if he had been a little taller he would in all probability have been killed. The injuries were serious, and, at the same time, he would like to say that he did not think the defendants' men were to blame. Nevertheless he must hold that it was one of those accidental circumstances which would happen, and that as the plaintiff was not sufficiently cautioned, there must be judgment in his favour for £15. He wished to add that the accident was one which no one could be expected to have foreseen as it occurred through a combination of circumstances.

Illegality of Picketing.

At the end of November last an action was tried in the Court of Appeal before the Master of the Rolls and Lords Justices Chitty and Vaughan Williams, viz., "Lyons and Sons *v.* Wilkins and Others," and was an appeal of the defendants from an order made by Mr. Justice Byrne in February last, restraining defendants by perpetual injunction from watching or besetting plaintiff's premises with the object of preventing persons from working for the plaintiffs or for any other purpose than that of obtaining or communicating information. The plaintiffs are the owners of a large manufacturing business in London in the leather trade, and the defendants are the secretary, chairman, and trustees of the Amalgamated Trade Society of Fancy Leather Workers. The proceedings arose out of a strike of plaintiffs' workpeople in January, 1896. It was admitted in the action that there had been picketing and peaceful persuasion by defendants. The original action was brought under Sec. 7 of the Conspiracy and Protection of Property Act of 1875. This section reads:—

"Every person who, with a view to compel any other person to abstain from doing or to do any act which such other person has a legal right to do or abstain from doing, wrongfully and without legal authority" (*inter alia*). "(4.) watches or besets the house or other place where such other person resides, or works, or carries on business, or happens to be, or the approach to such house or place, shall, on conviction thereof by a court of summary jurisdiction, or on indictment as hereinafter mentioned, be liable either to pay a penalty not exceeding twenty pounds, or to be imprisoned for a term not exceeding three months, with or without hard labour. Attending at or near the house or place where a person resides, or works, or carries on business, or happens to be, or the approach to such house or place, in order merely to obtain or communicate information, shall not be deemed a watching or besetting within the meaning of this section."

After hearing evidence, judgment was deferred and was given on Monday.

The MASTER OF THE ROLLS said: The construction put by this Court on the act of 1875 when the case was heard in March, 1896, is adverse to the present appellants, and was, in my judgment, correct. Upon the present appeal, however, one or two important questions were raised which do not appear to have been considered on the former occasion, and to them I now confine myself. The great point made by the appellants' counsel turned on the word "wrongfully" in sec. 7. He contended that to "watch and beset" another person's house was only illegal if done—(*a*) with a view to compel him to abstain from doing or to do some act which he has a right to do or not to do; (*b*) wrongfully and without legal authority. He further contended that nothing could be said to be wrongful which did not violate some right of complainant, and that there was nothing wrongful in watching or besetting a house simply in order peacefully to persuade others to conduct themselves in some particular way which was not unlawful for them to follow. This argument is, in my opinion, based on a misconstruction of the section, which is a penal section, as is shown by the sub-heads 1, 2, 3 and 5 of the section to which those words are as applicable as they are to sub-head 4. If the overt acts mentioned in sub-head 1, for example, in using violence or intimidation are proved, and it is proved that they were done with a view to compel, &c., and there is no reasonable ground for justifying them, it is unnecessary to give further evidence to prove that they were committed "wrongfully and without legal authority." The truth is that to watch or beset a man's house with a view to compel him to do or not to do what it is lawful for him not to do or to do is wrongful and without lawful authority unless some reasonable justification for it is consistent with the evidence. Such conduct seriously interferes with the ordinary comfort of human existence and ordinary enjoyment of the house beset, and such conduct would support an action on the case for a nuisance at common law. Proof that the nuisance was "peaceably to persuade other people" would afford no defence to such an action, Persons may be peaceably persuaded provided the method employed to persuade is not a nuisance to other people. Another point made by appellants' counsel was that what was done in this case gave the plaintiffs no cause of action. It is said that to beset one person's house with a view to compel some one else is not within the section. Such a construction would render the Act nugatory in a great number of cases clearly within the mischief intended to be remedied. In the present matter, the whole object of what was done was to compel the plaintiffs to comply with Mr. Wilkins's (the secretary) terms, and although there was no violence or overt threat of violence, it is quite plain that the relays of men set to watch and beset the plaintiffs' house (and the house of a man named Schönthal, who worked for him) were sent to do, and that they did, a great deal more than "attend" where they were "in order merely to obtain or communicate information." It is all very well to talk about peaceable persuasion and to draw fine lines between persuading and giving information. In this case there is no difficulty whatever in coming to the conclusion that what was done was watching and besetting as distinguished from attending "in order merely to obtain or communicate information." That the provisions of the Act were infringed appears to me to be plain and beyond all reasonable doubt. This appeal must therefore be dismissed, with costs.

Lord Justice CHITTY said: Mr. Justice Byrne, when trying the action, found that it was clearly proved that the appellants watched and beset the plaintiff's works or place of business and the approaches thereto for the purpose of persuading or otherwise preventing persons from working for the plaintiffs, and for purposes other than that of merely obtaining or communicating information. This finding of facts is accepted by

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counsel on both sides. It was admitted by plaintiffs' counsel that the pickets (as they are called) used no violence or intimidation or threats. The picketing extended over some months, covered all the working hours of the day, and was conducted by relays of men in succession. The object in view was clearly shown by the white cards distributed by the pickets and the other documents referred to. The picketing and the acts done by the pickets were done with a view to compel the plaintiffs to abstain from doing or to do acts which the plaintiffs had a legal right to do or abstain from doing, viz., to compel them to change the mode of conducting their own business. To avoid any possible misapprehension, I state that the strike itself was lawful. The question on the appeal, in my opinion, turns on the 7th section of the act of 1875, and the construction and effect of that section were dealt with by this Court on the motion, and the decision then arrived at is binding upon us, subject, of course, to the point whether it can be shown to be erroneous as being in conflict with previous rulings, and I cannot find that it is. The acts of watching and besetting proved in the present matter were acts in themselves unlawful at common law and are not made lawful by the Legislature. In my opinion they constitute a nuisance at common law. It is true that every annoyance is not a nuisance; the annoyance must be of a serious character and of such a degree as to interfere with the ordinary comforts of life. To watch or beset a man's house for the length of time and in the manner and with the view proved would undoubtedly constitute a nuisance of an aggravated character. It must be borne in mind that the 7th section referred to, although it probably arose out of trade disputes, is not confined to trade disputes or to disputes between masters and men. It applies equally to all Her Majesty's subjects of every class. It would embrace the case of besetting a man's house with a view to compel him not to receive guests or visitors. Lord Herschell, in a House of Lords appeal "Allen v. Flood," said: It must now be considered clear law that a person who "wrongfully and maliciously or, which is the same thing, with notice, interrupts the relation subsisting between master and servant commits a wrongful act." It had been urged, in regard to the picketing of the workman Schöntal's residence, that besetting the house of one person with a view to compel another is not within the section. I think it is. Besetting a workman to compel a master and besetting a master to compel a workman are both plaints within the mischief aimed at. Schöntal was an outworker for the plaintiffs. The result is that the appellants have failed.

Lord Justice VAUGHAN WILLIAMS concurred.

The appeal was dismissed with costs.

Mr. Sam Woods, M.P., secretary to the Parliamentary Committee of the Trades' Union Congress, has issued a manifesto to the officers and members of trade unions on the subject of picketing. With the object of securing a decision in the courts more favourable to trade unionists on the question of picketing an appeal for funds is made. It is said to be the intention of the trade unionists to take the appeal "Lyons and Sons *v.* Wilkins and Others" to the House of Lords.

Gold v. Winter.

At Westminster (London) C.C. last week an action "Gold v. Winter" was heard.

Mr. C. P. ROSE-INNES, counsel for plaintiff, said the claim was for £75, the balance of £100 commission due to the plaintiff. In 1891 the Chiswick local authorities obtained a provisional order and Messrs. Bourne and Grant had obtained an option under that order. Nothing much had been done, and the Chiswick Council was afraid they would lose the order. His client came upon the scene, and defendant arranged to pay him a salary and £100 as commission upon each provisional order he was instrumental in introducing to him and which he obtained the option of. He went to many places and among them Chiswick. He there saw Mr. Trentham. By the introduction thus brought about, the provisional order was obtained by defendant from Bourne and Grant. All his client had received was £25.

Mr. H. S. GOLD said the interview took place at defendant's office in Norfolk-street, Strand, in the presence of Mr Presland. In consequence of the arrangement referred to he went to Chiswick to see Mr. Trentham, and afterwards placed Mr. Trentham in communication with defendant, and told defendant that, through Mr. Trentham, he would be able to get this business. Defendant subsequently got the option of the order and sold it to Mr. Brooke-Hitching, and for that defendant got £1,000 in cash, and if a company was formed within six months he would get a further £1,000 in shares; if not, he would have the cash. He believed defendant had had the whole £2,000. Defendant discharged him after paying him £25 because he had stood up for Mr. Trentham, who had only come into the business on condition that he was to be the consulting engineer in the matter.

Judge LUMLEY SMITH: Has Chiswick got the electric light yet?

Mr. ROSE-INNES: They are playing with the option. It has been resold for £5,000.

WITNESS: Mr. Presland was an engineer, and was present at the conversation when the arrangement was made at the defendant's office. Defendant promised him a salary of £3 a week and all disbursements, and £100. He entered into an engagement with Messrs. Sax and Co., and there was an action, which was settled. He had been secretary of the Lambeth Ratepayers' Association for three years, which body was opposed to a monopoly, and wanted the parish to have the control of the lighting itself. It was absolutely untrue that he used his position as secretary of the Lambeth Association to further the interests of Messrs. Sax and Co. Mr. Winter was connected with Lambeth. He introduced Mr. Trentham to Mr. Winter, and Mr. Trentham brought the matter through by introducing Mr. Winter to Bourne and Grant. Defendant paid him his salary all through.

Mr. W. H. TRENTHAM said plaintiff called upon him, and eventually he was introduced to defendant., and he introduced defendant to Mr. Marks, of Bourne and Grant's, and he was to be appointed consulting engineer to the new company. He was not, so he brought an action against defendant and Mr. Brooke-Hitching, which was settled without going into Court. He knew the engineer at Bourne and Grant's, and he introduced defendant to Mr. Marks in December last or January of this year. He knew those gentlemen were not acquainted with one another. He had previously made Mr. Marks' acquaintance. He introduced the business through Mr. Gold. He had never paid Gold anything on account of Chiswick. Plaintiff was in his employ in July at a salary.

Mr. ROSE-INNES called Mr. Brooke-Hitching, who did not appear, and a solicitor on his behalf said there was no need, as he produced the agreement. Mr. Brooke-Hitching did not know so much about it as he (the speaker) and it was only done with another object, viz., to bring pressure to settle the action. He produced the agreement.

Mr. G. CROYDON MARKS said in 1896 he was acting for Mr. Bourne, who was the largest shareholder in Bourne and Grant (Limited), and he had instructions to sell the option owing to the death of Mr. Grant. This was advertised, and he received several replies, but the purchase was not carried out until 1897. He first saw defendant in December 1897, and at that time he had not seen Mr. Trentham or heard of him. Defendant came alone to see him, and he said, in answer to witness's questions, that the matter had been brought under his notice. This was not a sale of the option, but of the shares of Mr. Bourne in the company. A few days after he called again with Mr. Trentham. The sale took place to Mr. Winter. Those who bought the shares really bought the option. The option would have expired in two months from the date of the sale. His company got the option in 1893. Winter sold it to Mr. Brooke-Hitching. The Bourne and Grant Company had provisional orders at Aberystwith and Chiswick. Instead of Mr. Trentham bringing Winter, it was the other way about.

The further hearing was adjourned for the attendance of witnesses.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

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"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free; abroad, 6s. 6d. Digest post free.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By R. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free; abroad 13s. 6d. Prospectus post free.

IN THE PRESS.

"THE ELECTRIC ARC."—By Mrs. Ayrton.

"THE MANUFACTURE OF CARBONS FOR ALL ELECTRICAL PURPOSES."—By Francis Jehl.

"ELECTROMAGNETIC THEORY." By Oliver Heaviside. Vol. II.

"SECONDARY BATTERIES, THEIR DESIGN AND MANUFACTURE."—By E. J. Wade.

"PRIMARY BATTERIES: THEIR CONSTRUCTION AND USE."—By W. R Cooper.

"PRACTICAL TELEPHONY."—By Dane Sinclair and F. C. Raphael.

"'THE ELECTRICIAN' WIREMAN'S POCKET-BOOK."

"The Electrician" Electrical Trades' Directory and Handbook.—An important announcement in connection with the 1899 issue of the "Big Blue Book" will be found in an advertisement on another page of the present issue, to which our readers will please refer.

TENDERS INVITED.

The *Leeds* City Council require tenders for the supply of underground conductors, switchboards, &c., in connection with the extension of their electric tramways. Additional particulars are given in an advertisement elsewhere. Plans and specifications may be obtained from the city engineer, Municipal Buildings, Leeds, or from Messrs. Hopkinson and Talbot, 26, Victoria-street, Westminster, S.W. Tenders, addressed to the town clerk, must be in by 10 a.m. of the 29th inst.

The Committee of Visitors of the *Cumberland* and *Westmoreland* Asylum invite tenders for the supply and erection of an electric tell-tale clock, with 30 stations. Further particulars can be had from the Medical Superintendent and tenders must be sent in to the Committee, Garlands Asylum, Carlisle, not later than 2nd Jan. next. Some further particulars are given in an advertisement.

The *Glasgow* Corporation invite tenders for providing and erecting generating plant at one or other of their new electricity works, including two 200 I.H.P., two 400 I.H.P., three 1,100 I.H.P. and two 2,200 I.H.P. engines, with dynamos and condensing plant. Copies of specification, &c., may be obtained from the city electrical engineer (Mr. W. A. Chamen), 75, Waterloo-street, and tenders must be lodged with the town clerk (Sir J. D. Marwick), City Chambers, Glasgow, by *Saturday, Jan. 21.* Some additional particulars are given in an advertisement.

The Corporation of *Sunderland* require tenders for the supply of three 125 kilowatt, direct current, high speed, steam dynamos. Tenders to the office of the town clerk (Mr. Fras. M. Bowey), by noon, 30th inst.

The Corporation of *Dublin* invites tenders for the supply of a high-tension single pole switchboard. Tenders to Mr. Henry Campbell, City Hall, Dublin, by 10 a.m. of 28th inst.

The Corporation of *Burnley* invite tenders for the supply and delivery of underground cables. Tenders to Town Hall, Burnley, by Jan. 10.

The *Edinburgh* City Council require tenders for the supply of switchboards and boosters for their Macdonald-road electricity station. Tenders to Mr. Thomas Hunter, W.S., City Chambers, Edinburgh, by *Monday, Jan. 9, and not Jan. 2* as previously advertised. See advertisement.

The *Londonderry* Corporation require tenders for arc lamp globes and carbons for the year ending Dec. 31, 1899. Tenders to Sir R. N. Chambers, Kt., Guildhall, Londonderry, by 30th inst.

The Commissioners of the Burgh of *Stirling* invite tenders for the following:—(1) Lancashire boilers, with mechanical stokers; (2) engines, dynamos, pumps, steam pipes, &c., Green's economiser and tools; (3) storage batteries; (4) switchboard and boosters; and (5) arc lamps. Tenders to Mr. Thomas L. Galbraith by Jan. 2.

Hull Corporation require tenders for pipes and fittings for power station and condensing main from dock; builder's works for two car sheds, &c.; steel roof trusses, columns, &c., for sheds. Tenders to chairman Works committee by 30th inst. for the pipes and fittings, and by Jan. 13 for the remainder.

The *Islington* Vestry invite tenders for certain building work in connection with the extension of their electricity station at Edengrove. Tenders to the Vestry clerk, Upper-street, N., by 28th inst.

The Cleveland and South Durham Assets Co. require tenders for the erection of an electricity generating station at *Saltburn-by-the-Sea.* Tenders to the architect, 59, High-street, Stockton-on-Tees, by 27th inst.

The *Tunbridge Wells* Town Council require tenders for the erection of telephone fire alarms within the borough. Tenders to Town Clerk by Dec. 11.

Tenders are required for wiring the new buildings and other parts of the Castle, *Winchester.* Tenders to clerk to County Council, at the Castle, by the 27th inst.

Tenders are invited for wiring shop premises in Silver-street, *Halifax,* for the Cash Supply Stores (Limited).

The *Shanghai* Council invite tenders for a concession, for a period of thirty years, for the exclusive right of establishing and working a telephone system in Shanghai. Particulars of Messrs. J. Pook and Co., 8, Jeffrey's-square, London, E.C. Tenders to Mr. J. O. P. Bland, Shanghai, by noon of March 31.

The *Shanghai* Council also invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system. Particulars from Messrs. John Pook and Co., 8, Jeffrey's-square, London, E.C. Tenders to Mr. J. O. P. Bland by noon of March 15, 1899.

Tenders are being invited until Jan. 4th by the *Norwegian State* Railway authorities for the supply of 3,500 porcelain insulators, 1,000 zinc cylinders and 10,000 zinc rods for primary batteries, four kilometres of insulated copper wire, and 14 tons of telegraph wire. Tenders to the Expeditions Bureau der Verwaltung der Staats-Balnen, Jerntanetorvet, 8-9 Christiania.

TENDERS RECEIVED AND ACCEPTED.

The *Coventry* Electric Light Committee have accepted the tender of Mr. C. H. Barber for erecting five transformer sub-stations at £818.

The Watch and Lighting committee of the *Aberdeen* Corporation have accepted the tender of Messrs. Shirras, Laing and Co. for the electric lighting of the new fire engine station.

The *Douglas* (Isle of Man) Town Council have accepted the tender of Messrs. Veritys (Limited) for wiring the municipal buildings and public library at £312.

The *Bristol* Docks committee have accepted the tender of Messrs. Willway and Sons for the wiring of their engineer's offices.

The Lighting committee of the Barnsley Town Council recommends the following tenders for the supply of electric lighting plant for acceptance:—

(1) Lancashire boilers and Green's economiser, and setting of same, W. Arnold and Co., £3,280; (2) Engines, dynamos, switchboard, condensers, feed-water pumps, balancing transformers, boosters, piping, tanks, crane, wiring of electricity supply works, and engine, &c, foundations, Johnson and Philips, £8,030; (3) Secondary batteries and accessories, Pritchetts and Gold, £1,319; (4) Feeder and distributing mains (solid system), and (5) Potential leads, network and service boxes, and service connections, British Insulated Wire Co., £6,322 4s, 2d., and £110 for maintenance.

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The *Morecambe* District Council have accepted the tenders of Thomas Parker (Limited) at £1,955 and Messrs. C. A. Parsons and Co. at £2,525 for the supply of additional plant at the electricity works. The Callender Co. have obtained the contract for low-tension cables.

The *Llanrwst Electricity Supply Co.* have accepted the tender of Messrs. Calvert and Co., of Manchester, for the electric lighting of Llanrwst.

The *Shoreditch* Vestry have accepted the tender of the British Insulated Wire Co., for supplying, drawing in and jointing the cable required for the Haggerston extension, at the following rates:—1°/ conductor at 11s. 6d. per yard, ·75°/ at 9s. 4d., ·5°/ at 6s. 5d., and ·25°/ at 3s. 8d.

APPOINTMENTS VACANT AND FILLED.

The Carlisle Corporation require an assistant engineer for their electricity department. Salary £130 per annum. Also a switchboard attendant and two engine drivers (accustomed to Willans' engines). Further particulars in advertisements elsewhere. Applications to the city electrical engineer (Mr. C. D. Burnett), James-street, Carlisle, by 31st inst.

Applications are invited for the post of evening instructor in electric wiring at the Northampton Institute, Clerkenwell, E.C. Applications by Jan. 3. Further particulars from the principal, Dr. R. Mullineux Walmsley. See also advertisement.

The Tramways committee of the Manchester Corporation require a competent engineer to assist in carrying out engineering work in connection with the permanent way. Salary £200 per annum. The committee also require a temporary engineering assistant. Wages 50s. per week. Applications to the Chairman of the committee, Town Hall, Manchester, in each case, by Saturday, 31st inst. See advertisement.

The London County Asylum, Bexley (Kent), require a working foreman engineer to take charge, under the asylum's engineer, of the engineering appliances, including heating, electric light, laundry and cooking. Salary £12. 10s. per month, and quarters. Forms of application can be obtained from Mr. R. W. Partridge, clerk to the Asylums Committee, 21, Whitehall Place, London, S.W., and applications have to be sent in by 9 a.m. on Wednesday, Jan. 11. Some further particulars are given in an advertisement on another page.

The Urban District Council of St. Anne's-on-the-Sea, Lancs., invite applications for the appointment of electrical engineer to design and superintend the erection of an electricity supply station and the laying of mains, and to afterwards take charge. Commencing salary £170 a year, advancing to £200 and beyond, proportionally to the success of the undertaking. Applications to Mr. Thomas Bradley, clerk to the Council, by 5 p.m. of Jan. 2nd. See also an advertisement elsewhere.

The Blackheath and Greenwich Electric Light Co. require a secretary. Applications to the Company, 11, Charing Cross-road, London, W.C., by Dec. 30.

BUSINESS NOTICES.

Messrs. Warren and Hammond, electrical and mechanical engineers, of Bridge-crescent, Sunderland, have dissolved partnership. The business will be carried on by Mr. W. E. Hammond in his own name.

BANKRUPTCIES, LIQUIDATIONS, &c.

At the London Bankruptcy Court on Monday, before Mr. Registrar Hope, Robert Martin Houldsworth, 7, Fenchurch-avenue, E.C., was examined. Gross liabilities £19,435, unsecured £19,189, and assets £3,909. Failure attributed to loss in connection with the promotion of the British Steam Generator and Refuse Utilisation Co. (Limited) formed to work Levett's patent for producing electric current from town refuse.

Under the failure of Edward Baldwin Pym, electrical engineer, late of Bar-chambers, Scarborough, the first meeting of creditors was held on Monday, at the London Bankruptcy Court. Debtor has not surrendered under the proceedings, and the meeting was adjourned for three weeks. Debtor is said to be at Monte Carlo.

A receiving order has been made against John Evelyn Liardet, engineer, 16, Hyde Park-gate, Kensington-road, London.

The creditors of the London Provincial Electrical Co. (Limited) (in liquidation) are:—

J. Crawford	£3,965	S. J. Dixon and Co.	£20
E. McLaughlin	175	Birmingham Accessories Co.	19
L. G. Russell	175	Binney and Son	18
H. S. Blaydes	173	Braulik and Co.	17
Birmingham Brass Foundry.	146	Rhodes and Co.	14
Ellis and Ward	58	J. Sykes	14
Paddison, Son and Co.	57	Beanland and Perkin	13
W. T. Glover and Co.	57	Bayliss and Co.	13
— Spooner	26	A. R. Dean (Limited)	12
Crompton and Co.	23	British Insulated Wire Co	10
Gilman and Son	21		

Lionel Riley, trading at 10, Throgmorton-avenue, E.C., and 168, Upper-street, Islington, N., London, as L. V. Riley and Co., engineers and electricians, and at 2, Holloway-road, N., as the Highbury Art Metal Co., has "found it necessary to place his financial matters in his solicitor's hands." A meeting of creditors is to be held at the Guildhall Tavern, London, E.C., on Wednesday, 28th inst., at three o'clock. Messrs. Harries, Wilkinson, and Raikes, 38, Nicholas-lane, E.C., act in the matter.

At a meeting of Pearson's Automatic Fire Indicator Co. (Limited), on Nov. 24, it was resolved to wind up the company voluntarily, Mr. K. L. Skinner is liquidator.

Patent Amendments.—Notice is given in advertisements elsewhere that Mr. F. G. W. J. Adams has applied for leave to amend specification of Letters Patent (No. 19,431 of 1897) for "improvements in or relating to electric lamps," and also specification of Letters Patent (No. 11,526 of 1891) for "improvements in and connected with portable electric lamps and primary batteries, and lenses for deflecting light to be used therewith." Mr. A. R. Adams proposes to amend specification of Letters Patent (No. 3,831 of 1897) for "improvements in or relating to electric batteries." Mr. G. W. H. Adams proposes to amend specification of Letters Patent (No. 7,696 of 1888) granted to Theophilus Coad for an "improved portable incandescent electric safety lamp." Notices of objection must be lodged in each case by Jan 14 next.

Plant for Sale.—As elsewhere announced, the plant, machinery and stock of electro-plating and electric lighting works, in Blackburn, are for sale.

Award.—A bronze medal has been awarded to the Stewart enclosed arc lamp at the Turin Exhibition, 1898. This was, we are informed, the only medal awarded to enclosed arc lamps at the exhibition.

Refuse Destructors and Forced Draft Boiler Furnaces.—The Horsfall Furnace Syndicate (Limited) has established a London office at 36, Great George-street, Westminster. The firm have at the present time in hand a number of important contracts for the supply and erection of refuse destructors for the Corporations of Ashton-under-Lyne, Huddersfield, Ramsgate, West Hartlepool and St. Heliers, Jersey; the County Councils of Lanarkshire and Cheshire, the Vestries of St. Luke's and Fulham (London), Strand Board of Works, the Pembroke Commissioners (Dublin), the Metropolitan Asylums Board, H.M. Government, and the Irish Board of Works. Most of these contracts include complete steam-raising plant for use in connection with public electric light and power stations.

Calendars.—The Indo-European Telegraph Co. send a handy hanging sheet calendar with tear off pad for 1899, which gives the tariffs for messages over the company's system.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Dec. 14 to Dec. 20, with the ports of destination:—

Australasia—Adelaide, £33; Auckland, £223; Brisbane, £129; Hobart, £103; Launceston, £60; Melbourne, £360 (telegraph wire); Perth, £49; Sydney, £1,665; Wellington, £628 (including £579 telegraph material). *Belgium*—Antwerp, £65; Ghent, £195; Ostend, £36. *British Guiana*—Demerara, £10. *Burma*—Rangoon, £92. *Canada*—Halifax, £27. *Ceylon*—Colombo, £79. *China*—Shanghai, £177 (including £147 telegraph material). *Denmark*—Copenhagen, £23. *Egypt*—Suez, £516 (telegraph apparatus). *France*—Boulogne, £60. *Germany*—Hamburg, £120. *Gibraltar*, £82. *Holland*—Amsterdam, £55. *India*—Bombay, £240; Calcutta, £845. *Malta*—£223. *Norway*—Christiania, £45. *South Africa*—Cape Town, £144; Chinde, £16; Durban, £29; East London, £361; Port Elizabeth, £95. *Spain*—Vigo, £45 (telegraph apparatus). *Straits Settlements*—Singapore, £117 (telegraph material). *United States*—New York, £36. Total, £6,983, against £21,433 in the corresponding week last year (Dec. 15 to Dec. 21).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Accrington.—The General Purposes committee having approved the electric lighting and refuse destructor scheme, the Town Council will at its next meeting be asked to proceed with the scheme at once.

Asylum Lighting.—The Natal Government Asylum has been provided with an electric lighting installation. The capacity of the plant is about 300 16-c.p. incandescents. The work was executed under the supervision of Mr. Oswald Swete.

Barnsley.—The Town Council on Tuesday accepted tenders for the supply of electric lighting plant and for the erection of electricity supply buildings.

Bangkok.—The Union Elektricitäts Gesellschaft, of Berlin, has acquired the works and undertaking of the Bangkok Electric Light Co., and the concession has been prolonged for 40 years.

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Belfast.—At present there is an equivalent of 35,004 8-c.p. lamps connected to the electric light mains, and applications are in hand for 5,649 additional lamps.

Bermondsey (London).—The Vestry will oppose the application of the County of London Company to Parliament for power to lay trunk mains through Bermondsey. The districts affected by the Company's proposal are Bermondsey, Deptford, Lambeth and Lewisham.

Blackburn.—The Corporation have agreed to join with the Darwen Corporation in purchasing the steam tramways connecting the two towns. The purchase price is £48,500. The line will be equipped for electric working.

Blackpool.—Various extensions of the tramway system are to be carried out at an estimated expenditure of £70,000. The scheme, which affects all the principal thoroughfares in the town, was sanctioned at a special meeting of the Town Council on Monday, when it was decided to obtain a Provisional Order for carrying out the work.

Bolton.—The Lighting superintendent has been instructed to prepare a comparative statement of the cost of lighting the streets by arc lamps and by gas. This is the outcome of a proposal of the Electricity committee to adopt arc lighting in the principal streets of the borough.

Brentford.—The Middlesex County Council are taking steps to obtain clauses excluding Brentford and Kew county bridges from the operation of the proposed Brentford electric lighting scheme, or they threaten opposition to the application for a provisional order.

Brighton.—The Town Council have increased the salary of the mains superintendent (Mr. Fowler) from £3. 10s. per week to £225 per annum, rising to £250 at the end of 12 months. The salary of Mr. Tapper, inspector of house fittings, has been increased from 55s. per week to £175 per annum, rising to a maximum of £250 per annum. The salary of the chief clerk (Mr. Joyce) has been increased from £2. 10s. per week to £150 per annum. The question of the appointment of a deputy-manager to take charge of the undertaking in Mr. Wright's absence or illness has been postponed.

Bury St. Edmunds.—The Lighting committee have formulated a modified electricity scheme, and the Local Government Board are to be asked to sanction a loan of £14,000 for establishing works for supply of current in the compulsory area.

Camborne.—The Town Council have assented to the application of the Camborne Electricity Supply Co. for a provisional order, reserving the usual purchase rights.

Carlisle.—The Carlisle Corporation have offered to supply Messrs. Cowans, Sheldon and Co. with electric current for power purposes at 2d. per unit for the first 100,000 units per annum, and a sub-committee has been appointed to fix the price in the event of more than 100,000 units per annum being required.

Chatham.—Mr. John Hewett (of Harrap, Hewett and Duffield), consulting engineers, has been appointed consulting engineer for the electric lighting of the new town hall and municipal buildings.

Chester.—A Local Government Board enquiry was held here on Friday into the application of the Corporation to borrow £20,000 for electric lighting extensions. The Town Clerk stated that the electric lighting undertaking had been remarkably successful, in fact he asserted that this undertaking was the most successful in the county. There were numerous applicants for current and the city electrical engineer (Mr. F. Thursfield) had been instructed to report upon the estimated cost of the extension of the cables into various districts in the city. It was therefore absolutely necessary that the money asked for should be obtained to enable the work to be proceeded with.

Cork.—There seems to be a friendly rivalry between the various religious denominations as to the introduction of the electric light into their respective places of worship, several of which are already wired.

Devonport.—A special meeting of the Council is to be held to consider a proposal to purchase the undertaking of the local tramways company.

Dublin.—In deference to the wishes of the Corporation the Dublin United Tramways Co. have discontinued the use of trailer cars within the city.

Ealing.—The District Council have instructed their electrical engineer to prepare specifications for two additional 500 H.P. steam alternators and other extensions of the electricity works. The estimated cost of the extensions is £14,700.

Edinburgh.—The Simplex Electric Conduit Syndicate have submitted a proposal to the Town Council for introducing their system of electric traction on the Edinburgh-Portobello tramways.

Electric Traction in Italy.—The Italian Ministry for Public Works recently decided to construct a number of secondary railway lines, of a total length of over 370 miles, amongst which is an electric line from Milan to Lecco. The concession for constructing this line has been granted to the Electrical Trust, which is backed by Messrs. Ganz and Co., the Hungarian Credit Bank, the Berlin Union Elektricitäts Gesellschaft, and the Banca Commerciale of Milan.

Epsom.—A special meeting of the Town Council will shortly consider a recommendation that Mr. W. C. C. Hawtayne be appointed to prepare plans and estimates of an electric lighting scheme for the district.

Glasgow.—An agreement has been entered into by the Glasgow Corporation with the Partick authorities for a transfer of the Partick provisional order (1893) and a sub-committee has been appointed to arrange, if possible, terms for the purchase of the undertaking of the Kelvinside Electricity Co.

The Tramways sub-committee recommend that, owing to the difficulties presented locally to the adoption of the conduit system, especially in consequence of the nearness of the roof of the Central Railway tunnel to the street level, it is inadvisable to experiment with the conduit system in Glasgow. It is recommended that the conversion of the whole of the lines from horse traction to the trolley system be proceeded with as soon as possible.

Gloucester.—A Local Government Board inquiry was held on Wednesday into the application of the Town Council to borrow £50,000 for electric lighting purposes. The consulting engineer (Mr. Robert Hammond) submitted details of the scheme, to which there was no opposition. The works are to be erected on the Bearland estate. It is intended to erect 36 arc and 286 double 16-c-p. incandescents for public lighting, besides supplying current for private lighting. The total public lighting estimated for is 158,950 units, and for private lighting 187,500 units, or a total of 346,000 units per annum. The estimated revenue is—for private lighting, £3,906; public lighting, £1,987; meter rentals, £150. The total working cost is estimated at 1·85d. per unit, £2,670, or a gross profit of £3,375, which, after deducting charges on loan and sinking fund (£2,426. 5s.), leaves a margin of £946. 15s.

Grays (Essex).—In a preliminary report by the Council's electrical engineer (Mr. A. H. Preece) it is stated that there would be no difficulty in competing with gas at 4s. 4d. per 1,000ft., even with a charge of 7d. per unit for electric current. The cost of an electric lighting scheme would be over £10,000. It is proposed to erect 188 public incandescent lamps. The output of the proposed works for the first year is estimated at 48,000 units for street lighting and 32,000 for private lighting, and the upkeep expenses are put at £950.

Greenock.—The Police Board have adopted Mr. S. E. Fedden's electric lighting scheme, some particulars of which were given in our last issue.

Hampstead (London).—The Vestry have authorised the Lighting committee to prepare plans for the extension of the electricity work, with a view to the provision of additional plant equal to 4,000 H.P. The net profits of the undertaking are to be set aside to form a reserve fund until this reaches 10 per cent. on the capital outlay.

Inquest.—The Southampton Borough Coroner (Mr. Wm. Coxwell) resumed the inquest on Tuesday into the death of Walter Day, an electrical jointer in the employment of Messrs. W. T. Glover and Co., who was killed on the 12th inst., while engaged in jointing a cable. Deceased was about 30 years of age, and was working at Southampton on behalf of his company. He was called on to repair a joint in a live high tension cable. He had no gloves, and accidentally touching the exposed part of the main, he died almost instantaneously from the shock. The jury returned a verdict of "accidental death," recommending that gloves should always be used.

Light Railways.—Sir Courtenay Boyle, K.C.B., on Monday heard the objections to the confirmation of the order of the Light Railway Commissioners to construct a light (electric) railway from the Portsmouth tramway terminus to Cosham, Horndean and Portsdown Hill. Mr. Balfour-Browne, Q.C., appeared for the objectors (the London and South-Western Railway Co.), and suggested that the promoters should be compelled to construct a bridge over the South-Western line at a cost of between £3,000 and £4,000. Judgment reserved.

Application is to be made by the Reigate Corporation for the construction of a light (electric) railway between Reigate and Redhill.

Limehouse (London).—The question of applying for a provisional order had been under consideration of the District Council, but the matter has been further adjourned.

Lincoln.—A sub-committee has been appointed to confer with the Tramway Company on the purchase of the tram lines, and also as to the desirability of adopting electric traction.

London City Lighting Contracts.—Mr. Alpheus Cleophas Morton, common councillor of the City of London, notwithstand-

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ing that he has had time to seriously consider his statement before the Streets committee that the contracts for the lighting of the City of London are "null and void," as late as Tuesday last repeats his opinion in a letter addressed to the daily press on the subject of a reported conference between the City authorities and the City of London Electric Lighting Co.

London County Council.—At Tuesday's meeting it was announced that the Treasury had sanctioned loans of £11,020 and £10,000 to the Vestries of Hammersmith and Newington respectively.

The Establishment committee of the Council has been authorised to expend £450 in the erection of an electric lift. It was announced that the cost of electric power would be considerably less than that of hydraulic power for working the lift.

The Fire Brigade committee reported that in February last the Council accepted the offer of the Post Office to provide portable telephones on fire alarm posts, to enable firemen to use the apparatus for the transmission of telephonic messages, and that their chief officer (Commander Wells) had since obtained provisional protection for an improved appliance to effect this object. The trials made of the apparatus had been very satisfactory. The chief officer has suggested that extended trials shall be made, and the Post Office have notified their willingness to fit fire alarm posts with microphones and plug holes for telephones and to provide plug holes in the corresponding indicators in the fire stations for an annual rental of £31. 15s. per 50 posts. The comm ttee were authorised to enter into an arrangement with the Post Office to this effect.

Mr. Benn, Chairman of the Highways committee, stated that the Nottingham Corporation had refused to release Mr. Alfred Baker from his engagement for six months. Meantime, a sub-committee of five members of the Highways committee has been appointed to carry on the business, the sub-committee consisting of Sir John Hutton, Ald. Hubbard and Messrs. Westacott, Parker and Benn.

Messrs. Benn, Parker, Beachcroft, Dickinson, Johnson and Thornton were appointed to represent the Council at the telephone conference at the Guildhall, London, convened by the City Corporation.

The Parliamentary committee recommended "that the Parliamentary committee be authorised to seek powers in the next session of Parliament, either by a separate bill or by the insertion of provisions in the General Powers bill, to enable the Council to use electrical traction on all or any of its tramways, and for that purpose to reconstruct the tram lines, and erect and place in, under, or over the roads such apparatus as may be necessary." The recommendation was approved.

Lowestoft.—Mr. W. C. C. Hawtayne has been instructed to prepare a report for the Town Council on the question of the supply of current to the Light Railway Company.

Llandudno.—The Great Orme Tramway Syndicate have decided to accept the offer of a London syndicate to purchase their undertaking and to introduce electric traction.

Llanrwst.—The work in connection with the electric lighting scheme for this town is to be proceeded with immediately.

Marylebone (London).—The Guardians have accepted the recommendation of the Workhouse committee to advertise for tenders for the electric lighting of the front blocks of the workhouse. The estimated cost is £1,200.

Moss Side.—The District Council have been informed by the Manchester Corporation that a supply of electric current for the Moss Side district will shortly be available.

Morecambe.—At the last meeting of the District Council tenders were accepted for the supply of an additional plant for the electricity works. The draft agreement with Messrs. Stoddart and Co. for wiring the premises on the "easy" system was considered, but was sent back for amendment.

Newton Abbott.—The Urban Electricity Supply Company, which is applying for a provisional order for this town, has succeeded in arranging terms with the District Council, and formal consent to the application of the company has been given. Mr. Handcock, of Messrs. Handcock and Dykes, acted as consulting engineer to the Council.

Paddington (London).—At Tuesday's meeting of the Vestry, the Electric Light committee reported that after considering their correspondence with the Metropolitan Electric Supply Co., unless the Vestry were prepared to purchase the undertaking of the company, no advantage would be derived from further correspondence on the subject. Col. Barchard, Chairman of the committee, said that while they had been empowered to correspond with the company they had been given no powers to negociate for the purchase, nor had any terms been mentioned upon which the Vestry were prepared to take over the Paddington section of the company's enterprise. He thought it would now be best that the whole subject should be postponed until September next, as the Vestry could not apply for a provisional order till then, when their position might be much stronger. The neighbouring parish of Marylebone was striving to obtain the passing of a bill next session to enable them to purchase the Metropolitan Company's undertaking in their district, and they should wait to see how Marylebone fared. Sir T. G. Fardell, M.P., said he thought it would be best for the Vestry to take decided action rather than wait months before doing anything. He complained that the Metropolitan Company had failed to carry out their undertaking under the provisional order as they had not erected testing stations in accordance with their promises. When a fire took place some time ago at the company's Manchester-square station his lights went out, and he was informed by the company that he was supplied from Manchester-square, and not from Amberley-road. Also the company had failed to supply any public testing station in the parish. It was further promised that mains should be put down throughout the parish, and this had not been done. It was time that the Vestry took the matter in hand and insisted that the company fulfil its obligations. The company's £10 shares now stood at £16, and if it was known that the Vestry were desirous or likely to purchase the undertaking the shares would go up in price. It was time they seriously considered their position in this matter, and he moved that the vestry should write to the Metropolitan Co. asking whether the obligations imposed by the provisional order of 1890 were to be carried out and that the attention of the London County Council should be called to the fact that no public testing station had been provided by the company. Col. Blair pointed out that by treating the company hitherto in a civil manner the Vestry had obtained many concessions, the price for current being as low as that charged by any company in the metropolis. The company had spent something like £200,000 in the parish, therefore, if they intended to buy the Company out and secure the electric lighting in their own hands, they must be prepared to spend at least a quarter of a million of money. Sir George Harris said that, with regard to the testing station, they did not want an arrangement, such as was in existence with regard to the testing of gas, as 24 hours' notice had to be given to the gas company of the intention to test, enabling the company to put on an especially good light so that testing was useless. Mr. Smith suggested that the committee should be empowered to ascertain from an expert valuer the value of the company's plant, &c. Mr. Hunter considered the company should name the price at which they were prepared to sell, and then the Vestry could say whether it was prepared to entertain the offer or not. Finally it was decided that the Vestry were not prepared to give the committee any further instructions, the committee being left to act as they consider best. It was decided to give the Vestry's support to the proposal of the Hammersmith Vestry to oppose legislation on the lines of the report of the Joint Committee on Electrical Energy (Generating Stations and Supply).

Penny Postage.—A list is published of the British colonies and dependencies, between whom and the mother country penny postage is established on and after Christmas Day. The list includes:—

Aden.	Falkland Islands.	Niger Coast Protectorate.
Ascension.	Fiji Islands.	Niger Territory.
Bahamas.	Gambia.	St. Helena.
Barbados.	Gibraltar.	Sarawak.
Bermuda.	Gold Coast Colony.	Seychelles.
British Central Africa.	Hong Kong.	Sierra Leone.
British East Africa.	India.	Straits Settlements.
British Guiana.	Jahore.	Tobago.
British Honduras.	Lagos.	Trinidad.
Canada.	Leeward Islands.	Turks Islands.
Ceylon.	Malay States.	Uganda.
Cyprus.	Natal.	Windward Islands.
	Newfoundland.	

The Cape is, we learn, likely to be added to the list by the beginning of the new year.

Poplar (London).—The electric lighting scheme prepared by Mr. A. Blackman is to be discussed at the next meeting of the District Board of Works. The low tension continuous current three-wire system of distribution is recommended, and 54 10-ampere and 71 7½-ampere arcs are to be erected for street lighting. The charge for current for private lighting will be 5d. per unit for the first hour of maximum demand, 4d. for second hour, and 3d. for all further consumption for lighting, and 3d. for the first hour of maximum, and 1½d. for all subsequent consumption for power. The estimated cost of the scheme is £79,000, and application is to be made to the London County Council to loan this sum.

Portsmouth.—Application is to be made to the Local Government Board for sanction to borrow a further £18,000 for electric light extension purposes.

St. Luke (London).—The Vestry have decided not to oppose the application of the Smithfield Markets Electric Supply Co., for a provisional order, but the Vestry retain the right to lay their own

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mains if they decide to establish electricity supply works. The Metropolitan Electric Supply Co. have decided not to proceed with their application for this district.

St. Pancras (London).—The Vestry will apply to the London County Council for a loan of £30,000 for certain extensions at the Regent's Park electricity station. The committee have been in communication with the Board of Trade respecting the supply of current to premises on the border line of the parishes of St. Pancras and Islington, and the Board intimate that they do not appear to have power to authorise the erection of overhead wires for this particular purpose. The matter, it is suggested, is one for arrangement. The Vestry will support the Hammersmith Vestry in its opposition to the powers suggested by the Parliamentary joint committee on the supply of electric energy.

Shoreditch (London).—This Vestry will also support the Hammersmith Vestry in opposing the proposal of the joint Parliamentary Committee on the supply of electrical energy depriving local authorities of their present powers over provisional orders in their districts. The Lighting committee have received an application for the supply of current to the extensive factories of Messrs. Waterlow and Sons, printers. It is estimated that 100,000 units per annum will be taken, and it is not certain that the capacity of the present plant is sufficient to meet this order. The Lighting committee recommend that Messrs. Kincaid, Waller and Manville be instructed to prepare a specification, in conjunction with the chief electrical engineer, with a view to tenders being obtained for the supply of two 750 kilowatt sets of engines and dynamos, boilers and switch gear in connection with the proposed new generating station. This recommendation was, however, discussed in private, and we are unable to report the Vestry's decision.

Southtown (Great Yarmouth).—Messrs. Jewson and Sons, timber importers, have recently put down plant for the electric lighting of their establishment. The installation comprises 7 arcs and about 70 16 c.p. incandescents. The installation has been provided by Messrs. Whitmore and Binyon.

Surbiton.—The Board of Trade have deferred the question of the revocation of the District Council's provisional order for 12 months.

Telegraphs in the Soudan.—It is stated that after Lord Kitchener's arrival at Omdurman, the construction of overhead telegraph lines will be begun to Fashoda and the Sobat river, also between Kassala, Gedaref and Sennar.

Sunderland.—Mr. John F. C. Snell, A.M.I.C., M.I.Mech.E., M.I.E.E., has been appointed by the unanimous vote of the Corporation to be engineer for the construction and subsequent running of the Corporation tramways, a bill for which is now before Parliament. Mr. Snell has to be responsible for the carrying out of the whole of this contract, including the permanent way and car sheds, as well as the purely electrical overhead and other equipment. Mr. Snell also has in hand large extensions to the present lighting station, both for lighting and traction purposes, and is changing the existing system over to 440 volts. The Council have agreed to pay Mr. Snell 100 guineas for his tramways report, and his present engagement is to be terminated, and a further five years' agreement entered into, on the following rates of salary:—First year, £600; second year, £700; third year, £750; and fourth and fifth years, £800.

Tasmanian Customs Duties.—By the recent re-arrangement of the Customs' tariff of Tasmania the following duties are now levied on machinery, apparatus, &c., imported into the colony in connection with electric light work:—An *ad valorem* duty of 10 per cent. on cables and mains, transformers, insulators, dynamos, motors, engines, engine fittings, boilers, engine packing, boiler composition and railway and tramway plant and material.

Towyn and Aberdovey.—Col. Ruck has submitted particulars of a scheme for the electric lighting of these districts. The total expenditure entailed would be about £16,000. The scheme has been referred to the Towyn and Aberdovey committees for consideration and report.

Whitechapel (London).—The District Board of Works have appointed Mr. Arthur Wright their engineer for 5 years at a salary of £600 per annum, to carry out their electric lighting scheme.

Wigan.—The Electric Lighting committee have decided to appoint an electrical engineer to carry out the proposed electricity lighting supply scheme.

Wolverhampton.—A town's meeting, held on the 19th inst., unanimously approved the bill which is being promoted by the Corporation. Powers are being sought for the construction of additional and the electrical equipment of the whole of the tramways, and also for power to wire houses and let electric light fittings, &c., on hire.

Wrexham.—By a majority of two the Town Council have decided to oppose the scheme for the construction of electric tramways in this district.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom all information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

November 22, 1898.

24,593. O. Y. RHODES and THE MINERS' LAMP ELECTRIC LIGHTING CO. (LIMITED). Halifax. Improvements connected with the lighting of miners' and other lamps by means of an electric current.
24,605. W. H. HANSON. London. Improvements in secondary battery plates, grids and the like.
24,641. N. H. EDGERTON and A. H. MASTERS. London. Improvements in secondary batteries.*
24,655. E. T. GREENFIELD. London. Improvements in electric cables.*

November 23, 1898.

24,708. D. S. BURNS. Glasgow. A new or improved instrument for interlocking railway point and signal levers with electric block or train signalling switch on double lines of railways.*
24,714. R. HILL. Newcastle-on-Tyne. Improvements in or connected with trolleys for the overhead system of electric traction.
24,727. W. A. PRICE. London. Improvements in apparatus for measuring a supply of electricity.
24,734. P. PINCKNEY. Portsmouth. Improvements in electric traction.
24,747. E. HOUPIED and C. V. GIRARD. Liverpool. Improvements in or connected with electric sparking devices, more particularly for igniting devices of motors operated by explosive mixtures. (Date applied for under Patents, &c., Act, 1883, Sec. 103, June 13, 1898, being date of application in France.)*
24,757. M. WUILLOT. London. Improved manufacture of lead plates for secondary batteries.

November 24, 1898.

24,795. C. BOLLÉ. Manchester. Improved method of making insulating conduit tubes. (G. Brandt. Germany.)*
24,812. R. E. B. CROMPTON. London. Improvements in electrical meters.
24,833. S. H. SHORT. London. Improvements in means for suspending electric motors on electrically-propelled vehicles.*
24,843. W. C. P. TAPPER. London. A new or improved method of connecting shunt dynamos to the switchboards of electric generating stations.
24,855. A. U. ALCOCK. London. Method of and apparatus for electrically transmitting orders or signals suitable for use as a ship's telegraph and the like.
24,859. F. R. SIMMS. London. Improvements in electic sparking plugs for explosion engines or motors.

November 25, 1898.

24,872. J. ATKINSON. Cheshire. Improvements in electric dynamos and motors.
24,887. T. MILLAR. Glasgow. An electric alarm clock specially applicable for use in public works and other institutions.
24,905. R. BAYER. London. Preparation of hydrocyanic acid and other cyanogen compounds from rhodanic acid and its salts by means of electrolysis.
24,912. C. S. BRADFORD. Kingston-on-Thames. Improvements in and pertaining to lamps, gas and electric fittings, and the like.
24,914. F. E. CHANDLER. Kingston-on-Thames. Improvements in electric current conducting hinges.
24,949. SIEMENS BROS. and Co. (LIMITED). London. A regulating transformer for rotary phase current or polyphase current installations. (Siemens and Halske, Aktiengesellschaft, Germany.)*

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1897.

27,509. MÖHRLE. Meter for electric current.
27,683. LANE. Electrical storage batteries.
28,726. BOOTH. Lamp and shade holders for incandescent electric lamps.
28,727. BOOTH. Insulating blocks connected with holders for incandescent electric lamps.
28,728. BOOTH. Holders for incandescent electric lamps.
30,848. TIMMIS. Operating railway points by electro motors.

1898.

11,518. MEYER. Electrical lighting devices for kerosene and other burners.
12,322. EDWARDS. (Emanuel.) Electric batteries.
12,893. STEELE. Safety devices for electrical circuits.
16,877. BYNG and BELL. Desk telephones.
17,622. ALLISON (Lister and Chamberlain). Method of manufacturing incandescent electric lamps.
17,984. WARWICK. Electric railways and tramways.
19,951. SEILER. Electrical gas-lighters.
20,418. SHORT. Motors for electric railways.
20,894. THE BRITISH THOMSON-HOUSTON CO. (LIMITED) (Geisenhoener). Trolley cars for electric railways.
20,895. THE BRITISH THOMSON-HOUSTON CO. (LIMITED) (Potter). Electric surface contact railway systems.

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COMPANIES' MEETINGS AND REPORTS.

Aron Electricity Meter (Limited).

The statutory meeting of this Company was held on Tuesday, at Winchester House. Sir JAMES PENDER, Bart., M.P., presided.

The Secretary, Mr. W. CHAPLIN, read the notice.

The CHAIRMAN, in the course of his remarks, said: As only some nine weeks have elapsed since the Company was brought under the notice of the public, we are not yet in a position to report anything definite as to the results obtained by the transfer of Dr. Aron's business into our hands. Satisfactory arrangements have been arrived at for the gradual taking over of the business from Dr. Aron, as the purchase-money could only be paid as the calls on the shares fell due; but this is a mere matter of detail, and is being satisfactorily carried out. Upon the Directors taking over the business they instructed Messrs. Price, Waterhouse and Co. to send one of their representatives to Berlin for the purpose of reorganising the books, so as to comply with the practice usual with English companies, for, although the present system was suitable for a private business, it would not have enabled the Company to watch in London, week by week, the progress of a business the bulk of which is done in Berlin and Vienna, and would not have enabled the Directors to place before the shareholders a yearly balance sheet within a reasonable time after the close of the financial year. This representative has now returned to London, having completed his object. We are making arrangements with the various branch managers in London, Vienna and Paris, for the purpose of securing the continuance of their services, and, in order to settle the respective responsibilities and to carry out the necessary improvements and increase at the factories, some of your Directors will proceed to Berlin early after Christmas. The Company have secured the lease of No. 46, Upper Thames-street, which they consider the most suitable place for their testing station and stores in London, and, owing to its convenient situation, the Directors have decided to move their offices there, which means a saving to the Company of several hundred pounds a year. I have great pleasure in informing the shareholders that the business which has been done during the last 11 months has exceeded our expectations; for instance, we are informed by Dr. Aron and Dr. Juttke, our Managing Directors, that the business on the Continent has kept up its normal steady increase, about 14,000 meters having been ordered during the last 11 months in comparison with about 11,000 during the preceding year, and the sales in England have risen from about 400 in 1897 to over 1,800 for the first 11 months of this year. The most gratifying feature of this increase does not lie in the number of meters sold, but in the fact that they have been placed with about 40 different central stations and other users, all of whom are beginning to give us repeat orders which lead us to believe that a rapid development of the business and much larger sales may be looked for during the next year. The remarkable progress of the business in England will no doubt lead very shortly to a considerable number of inquiries and orders from the Colonies, which will then become an additional source of income. You are aware that the profits derived from the business from Jan. 1 this year belong to this Company, but, as the Company only work the business on their own account from Oct. 1 last, the profits resulting from the working from Jan. 1 to Sept. 30 will go towards and considerably increase the working capital of £45,000 set aside for this purpose, as mentioned in the prospectus. The profits made from Oct. 1 will go towards future dividends, and, without taking into account the economies which we propose to introduce, and assuming only that the business maintains its present level and without allowing for any increase, there will be sufficient to pay at least a dividend of 6 per cent. on the Preference shares and 10 per cent. on the Ordinary shares.

In reply to a Shareholder, the CHAIRMAN said that the whole of the capital of the Company was underwritten, and about 30 per cent. was subscribed for by the public.

On the motion of Mr. MYERS, seconded by Mr. BEACHCROFT, a vote of thanks to the Chairman closed the meeting.

Smithfield Markets Electric Supply Co. (Limited).

The report of the Directors for the first year's working, ended Sept. 30, states that the trading account shows a profit of £759. The Directors found it necessary at the outset to discontinue the method of charging by "lump sum" contracts which had previously been in force (and which had led in many cases to extravagant use of the current), and to adopt the customary fixed rate per unit, based on the actual meter consumption. The effect of this necessary change was a loss on trading for several months. The Directors, are, however, satisfied that their policy was correct and necessary in order to establish the company's business upon a sound basis. A substantial increase in the price obtained per unit has been effected, and the total number of customers now connected shows a net gain upon the number connected at the commencement of the company's operations. The price charged per unit is still below that of any other London supply company. The working of the station and the conduct of the company's business has been carried on in a satisfactory manner. The cost of production has been substantially reduced, and when the installation of the large storage battery (with a capacity of 2,000 ampere-hours), now on order, has been completed, the cost per unit will be still further reduced. As the tendency is in the direction of increased demand, and as there is a very large scope for increase of business in the Corporation markets alone, the Directors are confident that the company will be upon a dividend-earning basis in the second year of its operations. Applications have been made to the Board of Trade for provisional orders for the adjoining areas of the City of London, the parish of St. Luke and the Holborn district. The Chairman (Mr. G. H. Brougham Glasier) has been regretfully obliged to resign his seat on the Board, owing to the fact that the Charing Cross and Strand Electricity Supply Co., of which he is also the chairman, has made an application (in competition with this company) for a provisional order for the City of London.

NEW COMPANIES, STATUTORY RETURNS, &c.

CHAMBERLAIN AND HOOKHAM (LIMITED).—This company was registered on Dec. 15, with a capital of £100,000, in £5 shares, to acquire the business now carried on by Chamberlain and Hookham (Limited), at 4, New Bartholomew-street, Birmingham, and elsewhere, to enter into an agreement with the said company and Joshua Brown (its liquidator), and to carry on the business of manufacturers of and dealers in electricity meters, electrical plant, machinery and apparatus, electrical engineers, suppliers of electricity, iron, steel and brass founders and metal workers, &c. The first subscribers (each with one share) are:—Arthur Chamberlain, J.P., John S. Nettlefold, J.P., Miss Helen Chamberlain, Philip Hookham, Frederick Hookham, Richard P. Hookham and Mrs. Margaret Nettlefold. The first Directors are Arthur Chamberlain and George Hookham.

E. J. CLARK (LIMITED).—This company was registered on Dec. 17, with a capital of £2,000, in £1 shares, to acquire the business carried on under the style or firm of Tizzard and Co., to enter into an agreement with Mr. D. R. Butters, and to carry on the business of electricians, electrical and general engineers, &c.

CLAYTON ENGINEERING AND ELECTRICAL CONSTRUCTION CO. (LIMITED).—This company was registered on Dec. 14, with a capital of £40,000, in £1 shares (20,000 Six per Cent. Cumulative Preference), to acquire the business of the Clayton Foundry Co. (Limited), and to carry on the business of mechanical engineers, millwrights, engine, dynamo and motor builders, electrical engineers, rubber and cotton machinery manufacturers, &c. The first subscribers (each with one share) are: J. P. Bedson, engineer; Tom Westgarth, engineer; R. Le Neve Foster; G. Garner, engineer; J. H. Nuttall, engineer; J. R. Garner, electrical engineer; and C. J. E. Hall. The first directors are: E. J. Byrne, R. Le Neve Foster, J. P. Bedson and G. Garner.

ENGINEERING UNDERTAKINGS (LIMITED).—This company was registered on Dec. 13, with a capital of £5,000, in £1 shares (4,500 Five per Cent. Cumulative Preference), to carry on the business of mechanical and general engineers, machinists, electricians and suppliers of electricity.

LAND AND WATER ELECTRIC POWER SYNDICATE (LIMITED).—This company was registered on Dec. 6, with a nominal capital of £10,000, in £1 shares, to acquire the business now carried on under the style of Kerbey Bowen, and to carry on the business of ship, yacht, launch and boat builders and repairers, electricians, electrical and mechanical engineers, suppliers of electricity, and manufacturers of electrical apparatus. The first subscribers, with one share each, are:—A. A. Cooper, E. R. Baines, I. H. Campion, F. B. Conyard, S. B. Saunders, T. H. Greenwood, and K. Bowen (engineer).

NILE SYNDICATE (LIMITED).—This company has been registered with a capital of £50,000 in £1 shares, to acquire and develop certain concessions, grants, &c., in Egypt; to adopt an agreement made between J. H. Bailey (as trustee for this company) and J. E. Liardet and F. H. Medhurst; and to carry on the business of a mining, smelting and metallurgical company, to construct and maintain rail and tram roads, gas and electric works, &c.

HARRY W. COX (LIMITED).—The statutory return to Oct. 17 gives the nominal capital as £2,000, in £1 shares, of which 1,505 have been taken up. Three shares have been issued, with 2s. 6d. per share paid; the full amount has been called on the others.

ELECTRICAL DEVELOPMENT AND FINANCE CORPORATION (LIMITED).—The annual return to Sept. 1, gives the capital as £500,000 in £1 shares (of which 10,000 are Deferred); 10,477 Ordinary and all the Deferred have been taken up, and the latter have been issued as fully paid; 15s. per share has been called on the 10,477 Ordinary.

MATHER AND PLATT (LIMITED).—The annual return to Nov. 15 has been filed. The capital is £200,000, in £10 shares, of which 15,000 have been taken up. Calls amounting to £9 per share have been made.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Oct. 13, 1898). Price of silver 27⅞d. per oz. (Dec. 22). Consols (2¾ per cent.) 110⅛—110¼ for money, 110 5/16—110 7/16 for account; 2½ per cent. 104—104¼ (Dec. 22). Stock Exchange Settling Days: Stocks and Shares Continuation Days, Dec. 28 and Jan. 11; Ticket Days, Dec. 29 and Jan. 12; Pay Days, Dec. 30 and Jan. 13; Mining Share Carry-over Days, Dec. 27 and Jan. 10.

AFRICAN DIRECT TELEGRAPH CO. (LIMITED).—Coupons in this company's Four per Cent. Mortgage Debentures, due Jan. 1, will be paid at Parr's Bank, Bartholomew-lane, London, E.C., and the debenture register will be closed from 26th to 31st inst. inclusive.

BRAZILIAN SUBMARINE TELEGRAPH CO. (LIMITED).—The coupons of this company's second issue of Five per Cent. Debentures, due 31st inst., will be paid at Parr's Bank, Bartholomew-lane, London, E.C.

CANADIAN, BRITISH COLUMBIAN AND DAWSON CITY TELEGRAPH CO. (LIMITED).—Letters of allotment in the £225,000 Five per Cent. First Mortgage Debenture stock of this company have been posted.

CLAYTON ENGINEERING AND ELECTRICAL CO. (LIMITED).—During the week this company invited subscriptions for 15,000 Ordinary and 15,000

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Six per Cent. Preference shares of £1 each, and debentures to the amount of £15,000.

PACIFIC AND EUROPEAN TELEGRAPH CO. (LIMITED).—The coupons of this company's Four per Cent. Guaranteed Debentures, due 31st inst., will be paid at Parr's Bank, Bartholomew-lane, London, E.C.

PERTH AND DISTRICT TRAMWAYS CO. (LIMITED).—The Directors announce in their annual report that they have taken preliminary steps to enable them to adopt any system of electric traction.

PAISLEY TRAMWAYS CO. (LIMITED).—It has been decided to extend until June 22 the time for confirmation of the agreement with the British Electric Traction Co., whereby the latter could exercise their right of purchase.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT CO. (LIMITED).—The transfer registers of the Four per cent. Debenture stock of this company are closed.

SHEFFIELD ELECTRIC LIGHT AND POWER CO. (LIMITED).—A meeting of the shareholders of this company was held on Tuesday to declare a dividend for the past year, and to authorise the voluntary liquidation of the company. Ald. Franklin presided, and said the Act of Parliament obtained by the corporation for confirming the agreement for purchase received the Royal assent on the 12th Aug., and they expected the purchase would be completed by the 31st inst. The company was, under the agreement, entitled to retain a sum of £10,267. 16s. 8d. towards the dividend for 1897. Of this sum there was a balance of £803. 5s., which was undistributed in 1897. The Company was also entitled to distribute to the shareholders a dividend of 10 per cent. for the year ending 31st inst. Thus the 10 per cent. for 1898, added to the undistributed balance from 1897, gave them 14s. 11d. per share upon 4,000 shares, and 14s. 9d. per share upon the remaining 10,000 shares. It was obviously impossible to arrive definitely at a precise figure as to the purchase money, because it involved investigations into transactions which were going on more or less from day to day, but probably the shareholders would feel somewhat comforted if he told them at once what would be the result of the division of the purchase money among them. Shareholders would remember that they had the option in the agreement of taking £220 of 2½ per cent. stock, or an alternative of £213. 8s. in cash for each £100 spent. It was a fortunate thing for the company that they took this precaution, becauee from one cause or another, ever since the agreement was negotiated, municipal securities had been depreciated in the market. The result was that £220 of 2½ per cent. stock was not to-day worth £213 8s. in cash. Seeing that they had the alternative of taking either stock or cash, the Directors had determined to ask the corporation to pay the £213. 8s. in cash, instead of £220 in stock. If any shareholder felt dissatisfied with that arrangement, and would take his £213. 8s. to any sharebroker for investment, he would get considerably more than £220 per cent. in stock. On Jan. 4 liquidators would be appointed, who the following day would make their first distribution amongst the shareholders. The final distribution would work out that the value of each share, after paying the dividends declared at that meeting, would be between £17. 10s. and £18, and probably considerably nearer £18 than £17. 10s. Therefore, the shareholders would see that they would be getting, in addition to their dividend, about £17. 10s., or from that to £18 per share for each £7 of original capital. In 1893 and 1894 they had no dividend, in 1895 5 per cent., in 1896 7½ per cent., in 1897 12½ per cent., and in 1898 he supposed it would be about 10½ per cent. In 1894, when 6,000 shares were offered to the public at par, only some 4,620 were subscribed of that issue. That showed, first, that it was an uphill struggle to fight the battle of the company in its infancy; secondly, that they had overcome that struggle, and that the result of the Company's labours had been such as to supply the Sheffield public with electric current at, he believed, a price lower than that in any other city or town in the kingdom; and that they had also been able to divide a dividend among the shareholders larger than that paid by any other electric light company in the kingdom. He ventured to say that the shareholders of the company would never have any occasion in looking back upon its history to regret anything that had happened in connection with it. The resolutions were then passed.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee has appointed Thursday, 29th inst., as a special settling day in 7,440 Five per cent. £5 (£3 paid) Cumulative Preference shares (Nos. within 1 to 20,000) and 12,560 Five per cent. £5 (fully paid) Cumulative Preference shares (Nos. within 1 to 20,000) of the *Callender's Cable and Construction Co. (Limited)*, 78,000 Four per cent. £10 (£2 paid) Preferred Ordinary A shares, (Nos. 1 to 78,000) of the *Great Northern and City Railway Co. (Limited)*, and the further issue of 22,500 £10 (£4 paid) Ordinary shares, (Nos. 62,501 to 85,000) of the *Metropolitan Electric Supply Co. (Limited)*. The Committee has ordered 78,000 Four per cent. £10 (£2 paid) Preferred Ordinary A shares of the *Great Northern and City Railway Co. (Limited)*, £100,000 Four per cent. First Mortgage Debenture stock of the *London Electric Supply Corporation (Limited)*, and the further issue of 22,500 £10 (£4 paid) Ordinary shares (Nos. 62,501 to £85,000), and the further issue of 100 £10 (fully paid) Ordinary shares (Nos. 1 to 100) of the *Metropolitan Electric Supply Co. (Limited)*, to be quoted in the Official List. Application has been made to the Committee to appoint a special settling day in and to grant a quotation to £130,000 Five per cent. Debentures of the *Costa Rica Electric Light and Traction Co. (Limited)*, and to allow the further issue of 5,403 £5 (fully paid) Ordinary shares (Nos. 484,598 to 490,000) of the *National Telephone Co. (Limited)* to be quoted in the Official List.

WESTERN AND BRAZILIAN TELEGRAPH CO. (LIMITED).—This company's traffic receipts for the week ended Dec. 16 (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Co., Limited) were £2,932.

WEST INDIA AND PANAMA TELEGRAPH CO. (LIMITED).—The estimated amount of the traffic receipts of this company for the half-month ended Dec. 15 is £2,379, against £2,240 in the corresponding period of 1897.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
*Birmingham Tramways.	Dec. 17	3,847	+ 270	...	...	...
Blackpool Corporation...	„ 15	119	+ 25	37	16,062	+ 2,370
Blackpool and Fleetwood Co.	„ 17	139	...	23	14,126	...
*Bristol Trams & Carriage	„ 16	2,550	+ 187	24	71,758	+ 8,400
City & South London Ry.	„ 18	1,080	...	25	24,834	+ 772
Dover Corporation	„ 17	139	+ 30	37	6,858	...
Dublin United (Southern)	...	...	...	...	...	...
Liverpool Overhead Rly.	„ 18	1,324	+ 18	25	38,379	+ 3,159
*Sheffield Tramways.....	„ 18	1,255	+ 261	50	51,412	+ 2,511
*South Staffs. Trams.....	„ 16	603	+ 38	50	31,553	+ 12

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Dec. 14.	Price Wednesday, Dec. 21.	Rate per Cent. Yielded.	Dividends Due.	Business Done During Week Ending Dec. 21. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.			£ s. d.			
6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	11 11½	11 11½	—	—	—	—
6,000	10	6/3.5	Do. 4½ per Cent. Cumulative Pref.	10⅞ 11¼	10⅞ 11¼	4 4 0	—	..	—
30,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	11¼ 12⅝	11½ 12⅝	2 16 0	February & August	..	..
20,000	5	2/3	Do. 4½ per Cent. Preference	6 6¾	6 6¾	3 9 3	„ „	..	..
£34,000	5	2/6	Chelsea Electricity Supply Ordinary	8½ 9½	9 10	3 0 0	March	9 1/16	9½
£ 0,000	*Stock	4½%	* Do. 4½% Debenture Stock (red.) ..... xd	115 117	118 115	3 18 3	June and December	—	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red)	103 105	103 105	4 15 3	..	..	..
60,000	10	5/0	City of London Elec. Lighting Ord. 40,001 to 90,000	24 25	23 24	5 4 2	February & August	2 ⅛	21
10,000	10	1/9	Do. Ordinary 90,001 to 100,000	23½ 21½	21 23	..	..	22	21½
40,000	10	6%	Do. 6% Cumulative Pref.	15½ 16½	15½ 16½	3 13 9	January and July ..	15½	—
£4 0,000	Stock	5%	* Do. 5% Debenture Stock (red.)	127 128	127 128	3 16 1	June and December	128	127½
20, 00	10	—	County of London & Brush Prov. Ord. (fully paid	12½ 13⅝	13½ 13⅝	—	—	..	—
10,000	10	..	Do. (£8 paid)	10 11	10 11	..	—	—	—
2 ,000	10	6/0	Do. 6% Cumulative Preference	14½ 15½	14½ 15½	4 0 0	March & September	—	—
15,660	5	2/6	House-to-House Electric Lighting Supply Ord.	9 10	9 10	2 0 0	..	..	—
17,000	5	3/6	Do. 7 per Cent. Preference	9½ 10½	9½ 10½	3 6 8	March & September	9⅛	—
15,000	5	10%	Kensington and Knightsbridge Ord.	13 14	13 14	3 18 7	..	..	—
10 000	5	6%	Do. 6% 1st Pref.	7⅞ 8¼	7⅞ 8¼	3 13 9	January and July ..	..	—
110,000	3	—	London Electric Supply Ordinary	2⅝ 2⅞	3 3⅛	—	—	3⅛	—
48 (0	5	—	Do. Preference	6 6¾	6 6¾	—	—	—	—
64,40	10	5/0	Metropolitan Electric Supply Ordinary	17½ 18½	17½ 18½	3 4 10	April and October ..	19 1/16	17⅞
£12 (0	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117 121	117 121	3 14 9	June and December	118½	—
6,4 2	10	6/0	Notting Hill Electric Ordinary	16½ 17½	17 18	3 6 8	March	17⅛	17½
975,0 0	1	—	Rand Electric	⅜ 1½	⅜ 1½	—	—	—	..
£ 25,000	Stock	5%	River Plate Elec. Lt. & Tr'c't'n, Ltd., 5% 1st Mor. Deb	83 93	88 93	5 8 1	—	—	—
150,000	$100	$3	Royal Electric Company of Montreal Shares .. xd	155 160	150 155	5 5 3	—	—	—
1 0,900	100	4½%	* Do. 4½% 1st Mort. Debs.	104 106	104 106	4 5 0	April and October ..	—	..
51,980	5	5/0	St. James and Pall Mall Electric Ordinary	16 17	16 17	4 14 2	February & August	—	..
11,000	5	2/6	Do. 7 per Cent. Preference	9 10	9 10	3 10 0	„ „	—	..
£ 0,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.)	105 108	105 108	3 15 6	June and December	..	—
65,000	5	..	South London Electric Supply Ordinary (£3 paid)	2⅝ 3⅛	2⅝ 3	..	..	2 1/16	2⅛
79,900	5	5/0	Westminster Electric Supply Ordinary	16 17	15½ 16½	3 18 9	March & September	16 1/16	16
18,848	5	5%	Yorkshire House-to-House	7⅜ 8	7⅜ 8	3 2 6	February and July ..	—	—
18,626	5	5%	Do. (£4 paid)	5⅜ 6⅛	5⅜ 6⅛	3 18 5	February and July ..	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Dec. 14.		Price Wednesday, Dec. 21.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 21.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS								
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	101	105	101	105	3 17 0	January and July	..	..
25,000	10	..	Amazon Telegraph	3	4	3	4	—	—	—	—
£125,000	100	5%	Do. 5 per Cent. Debentures	92	95	92	96	5 5 3	—	—	—
£905,560	Stock	15/0	Anglo-American	64	67	64	67	4 10 5	Feb., May, Aug., Nov.	66	64½
£3,047,220	Stock	30/0	Do. Preferred	115	116	115	116	5 4 4	" "	116½	115⅝
£3,047,220	Stock	5/0	Do. Deferred	16½	17	16	16½	—	—	17	16½
130,000	10	5/0	Brazilian Submarine	15½	15¾	15½	15⅝	4 15 3	Mar., June, Oct., Dec.	15⅝	15 5/16
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	111	115	111	115	4 8 0	June and December	..	..
10,000,000	$100	$1½	Commercial Cable Capital Stock	180	190	180	190	4 4 3	Jan., Apr., July, Oct.	..	..
£1,232,523	Stock	4%	* Do. 4 per Cent. Debenture Stock	104	106	104	106	3 15 6	" "	105½	105½
16,000	10	8/0	Cuba Submarine Ordinary (Deferred)	10	11	10	11	6 7 3	February and August	10½	10½
6,000	10	10/0	Do. Preference 10 per Cent.	16½	17½	16½	17½	5 14 3	" "	—	..
12,931	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October	..	—
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	..	—
£80,000	50	4½%	Do. 4½ per Cent. Debentures	105⅞	108⅞	105⅞	108⅞	4 5 0	January and July	—	—
60,710	20	3/0	Direct United States Cable	11½	12	11½	12	5 8 4	Jan., Apr., July, Oct	11⅞	11 11/16
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	103	106	103	106	4 6 8	..	..	..
£4,000,000	Stock	..	Eastern Ordinary	172	177	173	178	3 19 0	Jan., Apr., July, Oct.	176	173¼
£1,295,000	Stock	17/6	Do. 3½ per Cent. Pref. Stock	104	107	104	107	3 5 5	" "	105⅞	104½
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	124	128	124	123	3 2 6	May and November	124	..
£89,900	100	5%	* Do. 5 per Cent. Debentures, 1899	101	104	101	104	4 17 0	February & August	..	..
£500,000	Stock	8/9	Do. Provisional Certificates 50% paid	54	57	54	57	..	..	..	..
250,000	10	2/6	Eastern Extension	17½	17¾	17½	18	3 17 9	Jan., Apr., July, Oct.	17½	17⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	129	125	129	3 2 4	February & August	125⅛	..
£16,200	100	5%	* Do. 5 p. c. (Austin.Gov.Sub.) Debs.1900 (reg.)	101	105	101	105	4 17 1	January and July	..	..
£64,400	100	5%	Do. (Bearer)	103	105	102	105	4 17 1	" "	..	..
£35,100	100	5%	*Eastern and S. African 5 p. c. Mor. Deb.,1900 (reg.)	101	105	101	105	4 17 1	" "	—	—
£46,500	100	5%	Do. (Bearer)	102	105	102	105	4 17 1	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures,1909	103	106	104	107	3 15 8	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	103⅞	103⅞	104⅞	107⅞	3 15 2	May and Novembsr	104	—
180,227	10	1/9	Globe Telegraph and Trust	12½	12¾	12½	12¾	4 0 9	Jan., Apr., July, Oct	12⅝	12⅝
180,042	10	6%	Do. 6 per Cent. Preference	16¾	17⅛	16⅞	17⅛	3 9 7	" "	17 5/16	16⅞
150,000	10	5/0	Great Northern of Copenhagen	28½	29½	28½	29½	3 7 10	January, April, July	..	—
£150,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B"	100	103	100	103	4 17 10	March & September	—	—
£97,800	100	4½%	Halifax and Bermuda Cable 4½% 1st Mort. Deb.(red)	101	104	101	104	4 7 0	June and December	101	—
17,000	25	12/6	Indo-European	54	57	55	58	4 6 2	May and November	57	56¾
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	109	112	109	112	5 7 7	March & September	..	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs.(red)	105	108	105	108	3 14 3	June and December	—	—
11,889	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October	7	—
3,331	£100 Cert.	6%	Submarine Cables Trust	134	139	134	139	4 6 9	" "	140	..
15,609	10	..	West African Telegraph	..	..	..	..	..	—	—	—
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	100	103	4 18 6	March & September	..	—
80,008	2½	—	West Coast of America	¼	¾	¼	¾	..	—	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	103	106	103	106	3 16 6	June and December	..	—
88,321	10	1/6	West India and Panama xd	1½	1½	1⅜	1⅝	—	May and November	1 11/16	1 5/16
34,568	10	6/0	Do. 6 per Cent. 1st Preference xd	9⅝	10½	10	10⅝	5 14 3	" "	10⅞	9½
4,669	10	6/0	Do. 6 per Cent. 2nd Preference xd	7	9	8½	9½	6 6 4	" "	8⅜	—
£80,000	100	5%	* Do. 5 per Cent. Debentures	106	109	106	109	4 12 10	January and July	..	—
64,269	15	5/0	Western and Brazilian Ordinary	12½	12¾	12½	12¾	4 13 2	May and November	..	—
88,129	7½	3/9	Do. 5 per Cent. Preferred Ordinary	8	8½	8	8½	4 8 2	" "	..	—
88,129	7½	1/3	Do. Deferred Ordinary	4	4½	4	4½	—	" "	..	—
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	107	110	107	110	3 13 1	June and December	—	—
1,168,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	—	..	..	..	6 7 10	Feb., May, Aug., Nov.	—	—
£158,100	100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	98	103	98	103	5 16 6	March & September	—	—
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	2⅜	3½	2⅜	3½	6 8 1	August	—	—
224,850	10/0	1½d.	Consolidated Telephone Const. & Manufacturing	1/16	3/16	1/16	3/16	6 7 0	July	—	—
28,000	5	4/0	Monte Video Telephone 6 per Cent. Preference	—	..	..	..	7 5 6	October	—	—
484,597	5	3/0	National	5½	5¾	5½	5¾	5 4 4	February & August	5¾	5⅝
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	12	14	12	14	4 5 9	" "	—	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	12	14	12	14	4 5 9	" "	..	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	5½	5¾	5½	5¾	4 10 11	" "	5¾	..
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	100	103	100	103	3 6 8	June and December	103½	..
171,504	1	0/4	Oriental	⅜	½	⅜	½	6 13 4	April and October	—	—
58,000	5	6/0	United River Plate	4½	4¾	4½	4¾	6 6 5	July	..	..
£151,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	104	107	104	107	4 15 5	June and December	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	2	1/2½	Brush Electrical Engineering	1⅝	2	1⅝	1⅞	3 4 0	—	—	—
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	—	2 5/16	—
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	111	115	111	115	3 19 0	February & August	—	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	103	105	102	105	4 7 0	June and December	..	..
£20,000	5	5/0	Callender's Cable Construction	9½	10½	9½	10½	6 8 7	" "	—	—
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	111	114	112	115	3 19 10	November and May	..	—
300,000	1	9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	—	..	..
50,000	1	..	Chadburn's Ship Telegraph Ordinary	1⅛	1⅜	1⅛	1⅜	—	—	1 5/16	..
50,000	1	7½	Do. 6 per Cent. Cumulative Pref.	1	1¼	1	1¼	4 16 0	—	..	..
32,038	3	..	Crompton and Co. (Nos. 1 to 32,038)	1⅞	2¼	1⅞	2¼	..	..	—	—
£82,850	100	5%	* Do. 5% First Mort. Deb. (red.)	91	96	92	96	5 5 10	January and July	—	—
99,261	5	2/1½	Edison and Swan United ("A" Shares) (£3 paid)	2	2½	2⅛	2⅜	6 11 9	February & August	—	—
17,139	5	3/1½	Do. (£5 paid)	4	5	4	5	6 0 0	" "	—	—
£194,023	Stock	4%	Do. 4% Mortgage Debenture Stock (red.) xd	99	101	97	99	4 0 10	June and December	..	—
17,400	5	5%	Edmundson's Electric Corporation Ord (fully paid)	5	5½	5	5⅛	4 10 11	Half-yearly	5⅛	..
110,000	2	1/2½	Electric Construction Co. (Limited)	2⅛	2⅜	2⅛	2⅜	4 12 0	February & August	—	..
25,000	2	2/9½	Do. 7 per Cent. Cumulative Pref.	2⅝	3⅛	2⅝	3⅛	4 6 2	August	..	—
£111,100	Stock	4%	Do. 4% First Mortgage Deb. (red.)	105	107	105	107	3 16 2	..	..	—
91,196	1	—	Elmore's Patent Copper Depositing	⅛	⅜	⅛	⅜	..	—	—	—
12,500	10	8/0	Henley's Telegraph Works Ordinary	20½	21½	21½	22½	5 15 7	February & August	22½	21⅝
18,000	10	7/0	Do. 7 per Cent. Preference	18	19	18	19	3 13 8	" "	..	—
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 3	" "	113	—
40,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	4 8 11	" "	22½	22
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	102	106	102	106	3 15 6	March & September	—	—
37,850	12	12/0	Telegraph Construction and Maintenance	37	41	37	41	4 6 2	March and July	—	—
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	104	107	104	107	4 14 9	January and July	—	—
£50,000	5	4/0	Willans and Robinson Ordinary	7⅜	8½	7⅜	8½	4 17 0	April and October	—	—
£30,000	5	3/0	Do. 6% Cumulative Preference	6⅞	7½	6⅞	7½	4 2 9	" "	—	—
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	106	108	105	108	3 18 8	May and November	106	—
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	..	Blackpool and Fleetwood Tramways	19	20	19	20	..	—	20	19½
25,000	10	6%	Bristol Tramways and Carriage	21½	22	21½	22	2 14 7	—	—	—
25,000	10	6%	Do. (£7. 10s. paid)	18⅜	18⅞	14⅜	18⅞	1 14 1	—	—	—
£90,410	Stock	4%	Do. 4% Debenture	121	123	121	121	3 5 1	—	—	—
80,000	10	..	British Electric Traction Ordinary	16	17	15½	16½	..	—	16½	15⅞
10,000	10	2/4 7/16	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm.pd.)	13	13½	13	13½	4 8 11	—	13½	1 5/16
£35,250	10	5/0	Central London Ordinary	9½	10½	9½	10½	2 18 6	June and December	10¼	10
178,303	10	1/9⅜	Do. (£6 paid)	5⅞	6½	5⅞	6½	3 16 6	" "	5⅞	..
£350,000	Stock	2½%	City and South London Railway Con. Ordy.	65	68	65	68	2 19 4	January and July	—	—
22,500	10	..	Do. Ordinary (£4 paid)	3½	4	3½	4	..	..	..	—
9,251	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	3 4 6	January and July	—	—
£137,701	Stock	4%	Do. 4% Perpetual Debenture	134	133	134	136	2 18 10	May and November	..	—
20,000	10	6%	Imperial Tramways Ordinary (old £6 shares)	16½	17	17	17½	3 8 7	March & September	17½	16⅞
10,000	10	6%	Do. 6% Preference	15⅜	15⅝	15½	15¾	3 17 5	" "	15⅝	15½
£70,000	Stock	4½%	Do. 4½% Debenture	116	118	117	118	3 16 3	..	118½	117
37,840	10	3%	Liverpool Overhead Railway Ordinary	10 1/16	10 3/16	10 1/16	10 3/16	3 3 9	February & August	—	—
10,000	10	5%	Do. 5% Preference	14½	15½	14½	15½	3 5 7	" "	—	—
125 000	Stock	4%	Do 4% Debenture	108	110	108	110	3 13 1	January and July	—	—
20,000	5	3,3⅛	New General Traction 6% Cumulative Pref	4⅜	5½	4⅜	5½	—	—	—	—
£540,000	Stock	3%	Waterloo and City Ordinary	112	115	111	114	2 13 4	June and December	..	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

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CONTENTS OF THE CURRENT NUMBER.

NOTES	321	Tramway Construction over Chilkoot Pass. By W. A. Burkholder	333
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe. Illustrated	324	Electricity Works Accounts	334
Electrical Stage Appliances at Drury Lane Theatre. Illus.	325	ELECTRICITY IN STAGE-LAND	336
Electrical Installation at the Kennington Theatre	327	Reviews	337
The Commercial and Business Aspects of Municipal Electrical Supply. By A. H. Gibbings, M.I.E.E. Concluded	327	Portable Electric Propeller for Boats. Illustrated	340
The Effect of Commutation on the Field of Dynamos and Motors. By W. H. Everett, B.A., B.E., and A. H. Peake. Illustrated	328	The "Ballott" Shaft Coupling and Propeller. Illustrated	340
Telegraphy by Magnetic Induction. By S. Evershed. Illus.	330	Correspondence	340
		American Notes	341
		The Use of Electricity in the Spanish-American War. By Thos. G. Grier. Illustrated	341
		Trade Notes and Notices	343
		Companies' Meetings & Reports	348
		City Notes	349
		Companies' Share List	350

NOTES.

THE conflict between local authorities and companies, which has been so marked a feature of electric supply affairs during the closing year, threatens shortly to break out again with intensified vigour. A premonitory symptom is a species of newspaper skirmish which is now being conducted in the interests of the local authorities, who are fond of posing as a very much aggrieved party in the strife. We have on a former occasion remarked the curiously opposite interpretations which these authorities give to the word "monopoly" according to its association with themselves or with company undertakings.

WHILE not hesitating to open up rate-aided competition with company undertakings, local authorities are raising a foolish and illogical protest against the various schemes that are being projected for the distribution of electric power over very large areas, each area embodying the spheres of influence of several petty authorities. There can be no doubt that this method of distributing power is far cheaper than by the erection of a number of small isolated networks, each with its separate generating station. Equally certain is it that such a concern will be better managed by a company than by a caucus formed out of a number of petty local authorities.

THE fixed rental system of charging for electric light has, after a lengthy trial, ceased to find favour with the Directors of the Smithfield Markets Electric Supply Co. (Ltd.). At the first ordinary general meeting, held on Friday last, it was announced that the plain and simple method of charging by meter would henceforth be used. On a blackboard, or on paper, and among symbols for constant capital and variable costs and revenue, &c., an equation showing the superiority of the rental system may appear convincing; but when the indeterminate coefficients of human wastefulness, indifference and "sheer cussedness" are put into the calculation, it is generally found best to make the consumer pay according to what he actually consumes.

WE do not intend to convey by the foregoing remarks that the tariff should be always a fixed rate of so much per unit, whatever the consumption. The Wright "maximum demand" system is, in many localities, a far better method of improving the magnitude and fruitfulness of the revenue; but then, Mr. WRIGHT'S system is merely a device for ingeniously turning to the account of the electric supply business those indeterminate coefficients of human nature which the theoretical mind is apt to ignore.

IN the concluding portion of Mr. GIBBINGS' series of articles on "The Commercial and Business Aspects of Municipal Electric Supply," published in this issue, the subject treated is not an engineering one, and consequently is often overlooked by those managing electricity supply undertakings. It is, of course, not the duty of the supply authority to sell fittings or apparatus for consuming the electrical energy furnished, although in some cases it may hire out these; but on the other hand more influence is required than that exerted by wiring contractors to secure new consumers and to introduce various applications of electricity which are profitable, especially to the central station. For such purposes the efforts of the canvasser may well be supplemented by a show-room which can, as Mr. GIBBINGS suggests, most suitably be combined with an inquiry office, and his views as to its equipment and management may be read with advantage.

WHENEVER a new application of science is brought to the notice of the public, it is followed by a number of crude suggestions as to its further possibilities, put forward with no regard to detail and oblivious of any constructive or commercial difficulties which may stand in the way of their adoption. These are for the most part put forward either by the non-technical press or by those cranks and amateurs whose futile

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desire it is to act as lay-helpers to the engineering and scientific professions. Occasionally, however, a scientist or engineer of repute will be carried away by his enthusiasm over a new invention, or by his desire to have his name associated with it, and will publish schemes for the future benefit or destruction of mankind, whose fulfilment, if not utterly impracticable, must at all events be several years distant. As such we may characterise Mr. TESLA'S recent proposal to transmit energy usefully at high pressures through the upper strata of the atmosphere, and his system of automatically manipulating torpedo boats with the assistance of Hertzian waves. The unfortunate part of these fantastic proposals is that they encourage other people to rush into print, in the desire to "go one better." Thus in a recent issue of the *Electrical Engineer* of New York, Mr. FRANK J. SPRAGUE describes—*apropos* of Mr. Tesla's torpedo boat idea, although the connection is hard to find—a suggestion for the utilisation of atmospheric electricity, which he made 17 years ago when a midshipman on board the training ship "Minnesota." FRANKLIN'S kite is replaced by a balloon, fitted with collecting points, and the cable which keeps the balloon captive is connected to the primary of a transformer whose other terminal is earthed. The secondary of the transformer is connected to a "regulator" and to "translating devices," which are apparently expected to furnish a utilisable form of electrical energy. The nature of these very necessary devices is not explained.

Cable Interruptions.—	Date of Interruption.
Para—Maranham	Nov. 15. 1898

Opening of Lincoln Municipal Electric Supply Works.—The new electric supply station of the Lincoln Corporation was formally inaugurated last Friday.

The Recent Gale and the Telephone Wires.—We are glad to record that Tuesday's serious gale caused practically no disturbance to the lines of the National Telephone Co., there being only one or two instances of standards being damaged.

Errata.—In Mr. Jehl's article in our last issue, the 18th and 19th lines from the bottom of the left-hand column of p. 803 should be transposed.——In the abstract of Dr. Kallmann's Paper in the pages immediately following, the letter e has been printed throughout in the letter-press, in place of ρ.

Fire Alarm Telephone Service in New York.—We hear that arrangements have been completed for a fire alarm telephone service in New York City. Telephones will be attached to every lamp-post on which a fire alarm box already exists, thus enabling conversation to be carried on with head-quarters. Broadway will be the first street to be equipped in this manner.

Use of the Telegraph in the German Army.—The new German Army Bill proposes to make considerable improvements in the telegraph service of the German army. Three battalion staffs for the telegraph service troops will be instituted, seven companies and two-thirds in Prussia, one company in Saxony, one in Bavaria, and one-third of a company in Wurtemberg.

Train Lighting on the Midland Railway.—We hear that some coaches on the Midland Railway have been fitted experimentally with Stone's system of lighting. These are chiefly on the 5:40 express from St. Pancras and the first-class dining car on the 6:45 train. In addition to the above, a third-class dining carriage and two composite bogie carriages are being fitted with the electric light at the carriage works, a novelty in these being that the passengers will in some cases be afforded the means of turning the light in or out.

Accident on the Halifax Tramway.—An unfortunate accident occurred on the electric tramway at Halifax, on Thursday last week. It appears that the rope connected to the trolley on one car became entangled with a passenger seated on the roof of a car on the parallel track. When one of the cars moved, the unfortunate man was dragged from his seat, and fell into the road, fracturing both his arms and sustaining other injuries.

A Memorial to Lucien Gaulard.—Subscriptions are being solicited for the purpose of finding a suitable burial place for, and erecting a monument to, Lucien Gaulard, one of the pioneers of the alternating-current transformer system of electrical power distribution. Those who wish to contribute are requested to communicate with M. E. Sartiaux, President of the Syndicat Professionel des Industries Electriques, 48, Rue de Dunkerque, Paris.

220-Volt Enclosed Arc Lamp.—The General Electric Co., of America, has put on the market an enclosed arc lamp for use on 220-volt circuits. It operates with 120 volts at the arc, and takes a normal current of 2·5 amperes, and one pair of carbons are said to last from 130 to 150 hours. Owing, no doubt, to the increased length of the arc, the light is of less volume and more violet in colour than in arc lamps for circuits of lower voltage. There is a variable resistance placed at the top of the mechanism, which permits the lamp to be adjusted for use on circuits of from 210 to 250 volts.

The American Institute of Electrical Engineers and Research Work.—A committee, appointed by the American Institute of Electrical Engineers to suggest problems for research on the part of scientific schools, and to co-ordinate the results obtained, has just issued a list of 27 suitable subjects. This list suggests many useful problems worthy of investigation. But in this country Professors have little trouble in finding out sufficient objects for their students' research work; to find the requisite number of capable students and the apparatus necessary for the experiments is often not such an easy matter.

Duty on Electrical Energy in Copenhagen.—The current supplied for the electric lighting of the Osterbro railway station in Copenhagen is derived from a generating station within the free port of Copenhagen. Practically every import into Denmark has to pay duty, and electric energy is not excepted, for in this case a duty of 10 per cent. has to be paid. From the point of view of equity, however, this is quite justifiable, as the coal used at the generating station would have to pay duty in any part of Denmark except within the free port, so that the current is generated cheaper than it would be elsewhere. What makes the fact more amusing is that the Danish railways are the property of the State, so that the duty is merely paid from one State department to another.

The Automobile Club.—The Automobile Club of Great Britain and Ireland, with which is incorporated the Self-propelled Traffic Association, have arranged for an international show to be held at Richmond, Surrey, on Saturday, June 24, 1899, and continuing till the following Saturday, July 1. The show will include an exhibition of motor vehicles and accessories, time tests of motor vehicles on the track (three laps to the mile), motor cycle races, hill-climbing tests in the neighbourhood of Richmond, awards for the best design and general appearance of motor carriages, competition for commercial motor vans, omnibuses, &c., and an exhibition of conveyance of public in motor vehicles on the track. It is proposed to invite the recognised automobile clubs of the world to a congress during the show.

Motor-Car Race in France.—A short-distance hill-climbing race for motor-cars was recently organised by the paper *La France Automobile*. It was won by the heaviest among the 47 competitors, an electric carriage constructed by the Compagnie Générale des Transports Automobile. This carriage, which weighed 28 cwt., accomplished the distance of 2,000 yards in 8min. 52sec., the average gradient being 5·3 per cent. *L'Industrie Electrique* estimates that the output of the accumulators in the car must have been 15 kilowatts on an average during the 4min., which is about four times the normal listed discharge rate for a five hours' discharge. As

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the maximum gradient was 10·6 per cent., our contemporary surmises that five or six times the five-hour discharge rate must have been attained on parts of the course. The battery consisted of 76 cells of the Fulmen B_{17} type.

Parsons Steam Turbines. — According to the *Pittsburg* (U.S.A.) *Times*, a large order has been received by the Westinghouse Company of America, who own the patents for these machines in the United States. The United Electric Light and Power Co. of New York, in which undertaking the Westinghouse Company is said to be largely interested, is to put down a 2,500 H.P. Parson's engine, to be followed by four other engines of similar size. The Westinghouse Air-Brake Co. are also said to be displacing the ordinary steam engines for the Parson's type, the order in this case being for three 500 H.P. machines, to drive generators and Tesla motors at the Brake Company's works at Wilmerding. When the order for the United Electric Light and Power Co.'s five machines is completed the company's 28th-street Station in New York will have a capacity of 20,000 H.P., and the smaller space occupied by the Parsons engines will, it is said, enable the company to abandon their 29th-street station.

Experiments with Electric Traction on the Paris, Lyons and Mediterranean Railway.—Experiments with an electric locomotive have recently been made under the direction of M. Baudry, the mechanical engineer of the Paris, Lyons and Mediterranean Railway Co. The locomotive had been made in the Company's workshops from the designs of M. Duvert. It is a two-axle truck, on each axle of which is mounted a 600 H.P. motor designed for a maximum current of 700 amperes at a speed up to 500 revolutions per minute. Behind the locomotive proper is a tender containing 192 accumulator cells, which are connected by conductors to the motors. In the front part of the locomotive are 18 cells, intended to drive the locomotive by itself when it is not drawing a train or its tender. The engine is intended to do half the work of an engine used for a fast train. It weighs 44½ tons, and has drawn, according to the *Electricien*, 147 tons at 28 miles an hour and 100 tons at 62 miles an hour. By the addition of a second motor on each axle, it is stated that it can draw 125 tons at 62 miles an hour. Tests on it have been continued for more than a year, and a most successful trial between Paris and Melun was made a few weeks ago, in the presence of several prominent French railway men.

Electrical Equipment at McGill University, Montreal.—The *Western Electrician* states that Prof. R. B. Owens is engaged in extending the course and adding to the equipment of the electrical department of McGill University. In the laboratory all the machines, instead of being permanently fixed, will now be mounted on testing blocks, so that it will be possible to move them about from place to place, and a special crane for this purpose has been supplied. There are also being constructed a number of testing tables permanently wired up to facilitate experimental work. The number of accumulators has been increased, and a number of high-potential transformers has been added. The wiring for the laboratories will be under the floors and testing blocks, and distributing boards will be used, so that it will be possible to throw any individual laboratory on to any circuit. There has also been provided a number of specially designed electrical speed indicators for extremely accurate measurements of speed. These instruments have been worked out by Prof. Owens himself, and have been constructed to give an instantaneous reading accurate to one-fifth per cent. Alternating-current machines giving one, two and three-phase currents at frequencies varying from a few periods per second to 150 periods per second, a number of two and three-phase induction motors, and a number of transformers for changing two-phase currents into three-phase, have also been installed. It has been decided to establish a standardising laboratory, thoroughly equipped with all necessary primary and secondary standards for electrical and magnetic measurements. A separate laboratory will be equipped for tests and investigation work, and, if possible, arrangements will be effected with manufacturing companies whereby the University will have the use of new types of machines

The Locomotives Act, 1898.—The Locomotives Act, 1898, comes into operation on January 1st next. It applies to the whole of England, and will effect some radical changes in the law relating to the licensing and use of traction engines, steam road rollers, and other locomotives in the public streets. In anticipation of the Act coming into force, says the *Engineer*, suggestions have been submitted to the Local Government Board by the officials of the several County Councils of districts adjoining London with reference to the new bye-laws which will have to be made, and the forms of licences and other forms which will have to be used in consequence of the passing of the Act, and it is anticipated that model bye-laws and forms will be issued by the Local Government Board on the subject. The Act provides that the existing bye-laws shall remain in operation until August 2, 1899, unless previously repealed or suspended by bye-laws made under the new Act. In this connection it may be mentioned that the London County Council is empowered under Section 1 to grant permission for vehicles drawn or propelled by a locomotive on a highway to carry weights in excess of those stated in Section 4 of the Locomotives Act, 1861; and under Section 8 the County Council is authorised to give consent to more than the three vehicles allowed by the new Act being drawn by a locomotive. It is thought probable that applications under those sections may have to be dealt with in London immediately the Act comes into force, and under Section 14 the County Council can act through its surveyor or other authorised officer. As a result of this the London County Council has just decided to permit the Highways Committee to act on its behalf in relation to all matters under the new Act pending the issue of a further order on the subject, and has also authorised Sir Alexander Binnie, the chief engineer, to deal with all applications made to the Council under Sections 1 and 8, already referred to.

Train Lighting by Electricity.—A recent number of the *Electrical World* of New York contains some interesting notes on the subject of the electric lighting of railway trains. After a reference to the system of axle-driven generators and storage batteries, in which automatic means are provided for cutting out the dynamo when it is running below its normal voltage, and for preventing the voltage from assuming too high a value—the latter being frequently done by a slipping belt, as on Stone's system—our contemporary suggests the following as the only known method of obtaining practically constant voltage with high variable speed, and without troublesome devices:—"The use of a dynamo with a flat-topped characteristic with shunt exciting coils of magnetomotive force sufficient at the storage battery voltage to carry the magnetisation well above the bend of the curve, and with field coils in series with the armature tending—when the machine generates current—to oppose the shunt excitation. With such an arrangement small outputs through the series coils would not materially lower the voltage, but in case the speed rises, tending to increase the output, and the excitation falls below the bend of the magnetisation curve, any further increase of the load would materially diminish the field density and, consequently, the voltage. With proper design such a machine could be made to run over a wide range of speed with a small change of output at constant pressure if delivering to a storage battery. The latter would, of course, maintain the stability of voltage otherwise unattainable with shunt machines or under-saturated fields, and would absorb the variations in load necessary to the differential compounding. The series coil, instead of reducing the equilibrium of voltage between the machine and battery, as with ordinary compound generators, would tend, with this reverse action, to increase it. With any system of field density inversely proportional to the speed, the armature reaction with constant load becomes a troublesome factor at the high speeds and consequent weak fields, but there are several well-known methods of obtaining a proper commutation with variable field strength, so that this difficulty is probably not a serious one." *Apropos* of train lighting, we may mention that a number of new carriages, lit on Stone's system, have recently been started on the Metropolitan Railway.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Conservation of Matter.—The ultimate test for the existence of matter is its inertia, but all quantitative estimations are practically based upon its weight. Hence, if we wish to test the fundamental law of chemistry, that of the conservation of matter, we investigate whether a substance changes in weight when subjected to a variety of chemical actions. It is *à priori* quite conceivable that it should. Gravitational attraction might be a property primarily attached to the molecule, and not to the atom. A pound of matter might, under special circumstances, lose its gravitation, just as a bar of iron loses its magnetisation at the critical temperature. In 1894, Landolt described an apparent loss of weight occurring in silver when reduced from its salts to the metallic state. A similar apparent loss was reported in the reduction of iodine from iodic acid and hydriodic acid. After repeating the silver experiment without a decisive result, F. Sanford and L. E. Ray also examined the iodine reaction between potassium iodide and ferric chloride, obtaining about 80 grammes of iodine. The results showed not a loss, but a gain of about 0·02mg., that being the four-millionth part of the total weight. That amount is very near the limit of experimental error, and is slightly less than Landolt's loss. If gravitation were a molecular and not an atomic property, a much greater change would have to be expected.

[Sanford and Ray, *Phys. Review*, Nov., 1898.]

Calcium Carbide.—The carbides of potassium and lithium, C_2K_2 and C_2Li_2, may be obtained in transparent and colourless crystalline plates. The aluminium carbide, C_6Al_4, sometimes crystallises in transparent yellow plates. But when Henri Moissan first prepared the carbides of calcium, strontium, and barium he described them as opaque, except in very thin sheets. He now finds that calcium carbide is only made opaque by impurities, chiefly of iron. When it contains no trace of iron, it is as transparent as the lithium carbide or sodium chloride. This may be proved by heating to a dull red a mixture of metallic calcium and pure amorphous carbon derived from the rapid combustion of acetylene. This gives a white carbide decomposed by water with formation of calcium hydrate and acetylene. Under the microscope, the white carbide appears as a mass of transparent crystals. It is a noteworthy fact that the heat of combination of the carbon and the calcium suffices to fuse the carbide, whereas that has never yet been accomplished in the electric furnace. On heating the white carbide with a minute quantity of iron oxide, the reddish-brown appearance of the commercial article is obtained.

[Moissan, *Comptes Rendus*, Dec. 5, 1898.]

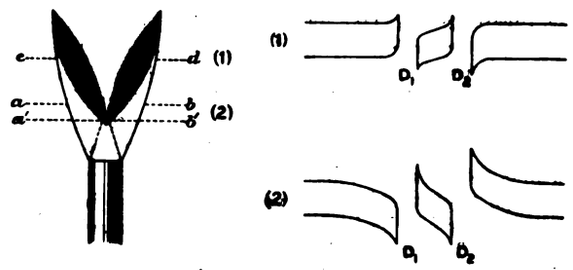
Properties of Aluminium.—Aluminium has long been regarded as a metal capable of resisting most chemical agencies. But A. Ditte has pointed out that if aluminium does not appear to be attacked by air or water, nor by dilute sulphuric or nitric acids, although its heat of combustion of 131 calories places it near calcium, that is solely due to the fact that it immediately covers itself with a layer of hydrogen, nitric oxide, or alumina, which is continuous, impermeable, and very adhesive, and effectually prevents any contact between the metal and the liquid in which it is immersed. When by any chance the protecting layer is removed, chemical action at once sets in, and goes on until the aluminium is completely dissolved. The layer is not proof against the action of acid salts, or common salt in presence of an acid, such as vinegar. Since aluminium compounds have no poisonous effects upon the system no complications as regards health need be feared where aluminium cooking utensils are used, but their rapid wear would render them unfit for military purposes. A 1 per cent. solution of washing soda, so often used for cleaning, attacks aluminium even in the cold.

[Ditte, *Comptes Rendus*, Dec. 5, 1898.]

Absorption in a Magnetic Field.—A. Cotton describes a simplified form of Righi's absorption experiment which places it within the reach of moderate experimental resources. A beam of white light, preferably from an arc lamp, traverses a Nicol with its principal section at 45deg. to the horizon, a strong electromagnet with its lines of force horizontal and at right angles to the beam, and a second Nicol crossed with the first. On introducing into the magnetic field a sodium burner and making the current, the extinction is annulled, and the arc is clearly visible and of a yellow colour. If the first Nicol is turned through 45deg., thus placing its principal section horizontal or vertical, the phenomenon is no longer observed; the extinction once brought about remains, whatever the strength of the magnetic field. Righi, it will be remembered, operated with a field parallel to the beam, and used a circular polariser and analyser. The effect observed by the author is readily explained by the theory of the Zeeman effect. Similar phenomena may be observed on substituting a small vessel containing nitrogen peroxide for the sodium flame. The arc then appears green, that being the complementary colour of the gas. Experiments with didymium sulphate yielded no result.

[Cotton, *Comptes Rendus*, Dec. 5, 1898.]

Anomalous Dispersion of Vapours.—H. Becquerel has already given an explanation of Macaluso and Corbino's discovery of a very high rotatory power of sodium vapour for the rays immediately adjoining the D lines. His explanation was based upon the assumption of an anomalous dispersion, and this he has now succeeded in placing directly in evidence. He made a kind of gaseous prism by the simple expedient of



placing a platinum gutter across the inner cone of the Bunsen burner. The gutter was a sheet of platinum bent into a right angle, and the sodium salt rested in the angle. The two cylindrical lenses shown in the diagram were thus produced. As *a b* and *a' b'* they acted as a prism with its refracting edge below, at *c d* as two prisms with their refracting edges upwards. The spectra observed in the two cases in the neighbourhood of the D lines are shown as observed by means of an auxiliary prism. They conclusively prove anomalous dispersion by the sodium vapours.

[Becquerel, *Comptes Rendus*, Dec. 5, 1898.]

Conductivity and Luminosity of Flames.—A. Smithells, H. M. Dawson, and H. A. Wilson have endeavoured to ascertain whether the luminosity imparted by vaporised salts to flames is related in a definite manner to the electrical conductivity of the salt vapours. Since, according to the electrolytic dissociation theory of Arrhenius as applied to dilute solutions, the metallic ion in virtue of its electric charge can persist in an oxidising medium, it appeared to the authors that if the same theory were really applicable to salts vaporised in flames, it would afford an explanation both of the liberation of the element, and of its persistence in the midst of an oxidising atmosphere of flame gases. It would naturally be expected that the more readily oxidisable the metal is, the less light would it emit in the oxidising portions of the flame. But the results of the experiments show no definite relation between the chemical nature of the electrical conductivity of the base and its coloration or luminosity. The apparatus consisted of an arrangement whereby the two cones constituting a Bunsen burner could be separated widely and maintained apart for any length of time. An electrode system, consisting of two coaxial cylinders of platinum-iridium alloy, was fixed between them. The authors found that the conductivities of the haloid salts of a metal increase with the atomic weight of the halogen, whereas the conductivities of the oxy-salts are approximately equal. No effect is produced upon the conductivity by decolorising the flame by means of chloroform.

[Smithells, Dawson and Wilson, *Proc. Roy. Soc.* for Nov. 17, 1898.]

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ELECTRICAL STAGE APPLIANCES AT DRURY LANE THEATRE.

Up to the present the application of mechanical power for working the stage of a theatre has been limited to the use of steam or hydraulic pressure. In this country, as a matter of fact, there has as yet been no application of mechanical power whatsoever, with the exception of some small experimental hydraulic jiggers laid down in Edinburgh in the seventies, some lifts in the Lyric Theatre in the eighties, and then about two years back, at the Drury Lane Theatre, a somewhat more elaborate installation was attempted in the form of two hydraulic "bridges." The application of modern mechanism has been practically reserved for the Continent, and even in the United States little has been done. As far as the Continent is concerned, hydraulic power has primarily been in favour as compared with steam, and some of the larger stages of the opera houses in those countries, have been entirely equipped with hydraulic appliances. But both in installation and maintenance, the hydraulic stage has been found to be very expensive, hence it was necessary to apply some other power. Attention was naturally at once directed to electricity, and some slight attempts have already been made in Munich to use electrical power in moving the big "turntable" or the so-called "turntable stage." But it has been fortunately left to this country and to the metropolis to apply electricity for stage purposes on a really large scale, and also in a manner that is novel as compared with continental work. It is at the historic old Drury Lane Theatre that this example has been set, and it is here that on Boxing Night last the floor of the stage was for the first public performance moved with electric motors worked in a very economic manner from the ordinary lighting mains.

The work of remodelling the Drury-lane stage has been entrusted to Mr. Edwin O. Sachs, the architect, who for some considerable time has been zealously advocating the application of electricity to the stage, and whose work, entitled "Stage Construction," was recently referred to in these columns. He had the good fortune of holding the commission from Mr Arthur Collins, a manager who believes in the more modern equipment of the theatre, and he has further had invaluable assistance from the Thames Ironworks and Shipbuilding Co., who, whilst acting as contractors, dealt with this experimental order in a manner that should elicit admiration. The present phase of the work entrusted to Mr. Sachs relates primarily to the movability of the stage floor, and he has divided this floor into six large sections. Of these two are the older hydraulic installation, whilst two others include the electrical installation just completed. The remainder will be taken in hand shortly on similar lines, and the hydraulic plant may also be transformed into an electrical one in the near future.

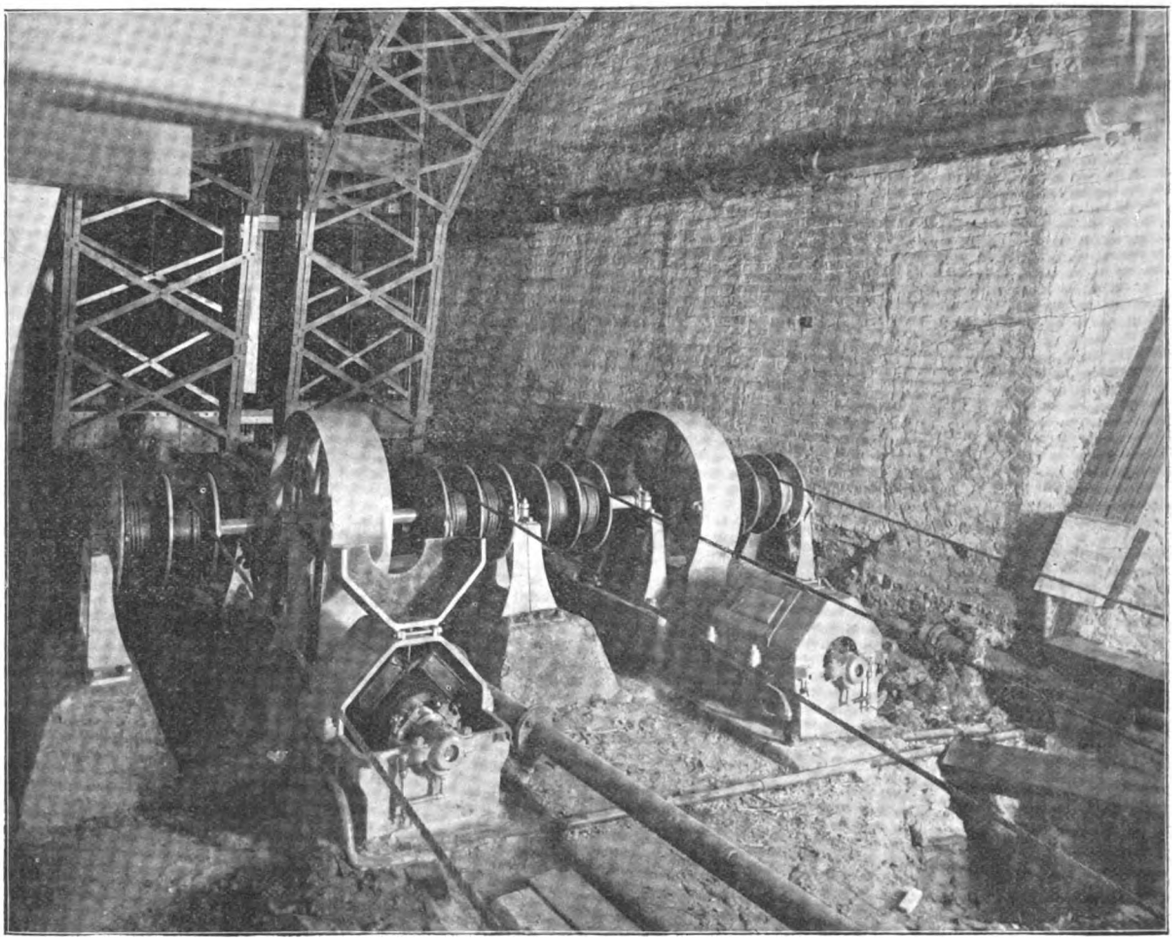

FIG. 2.—Electrically-Operated Hoisting Gear for the Moveable Sections of the Stage at Drury-lane Theatre.

It is not, however, with the stage as a whole, nor even with the stage floor as a whole, that we wish to deal at the moment. The point of interest for us lies in the new electrical plant and its possibilities. This plant, as just completed, practically takes the form of two gigantic lifts (Fig. 1), which rise above the stage or sink below it, and have to be very carefully balanced, so as to travel smoothly, absolutely noiselessly, and with a great factor of safety. The work for which they are principally intended is the rapid change of stage floor level, either with the view of forming terraces, or similar features in the mounting of a play, and, of course, the changes will frequently take place with the curtain up, as for so-called transformation scenes. They are to obviate the former endless building-up, which requires a large staff of men, and is always dangerous and unsatisfactory, and which, further, precludes any such movement as indicated with the curtain up. The load that any one section will probably carry is that of a crowd of 30 or 40 actors, with an ordinary load of scenery; but the contingency of coaches, horses, &c., travelling over

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the lifts had to be considered, for, with the ever-increasing spectacular effects, there seems no limit to the strains which mechanism at Drury Lane would have to meet.

Mr. Sachs' principle for obtaining the desired results might be shortly expressed as that of a railway bridge suspended from cables and travelling in guides, the cables being wound

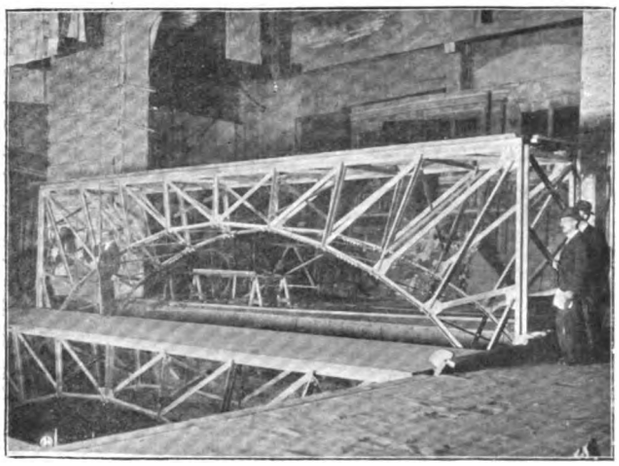

FIG. 1.—Two Electrically-Operated Sections of the Stage Floor at Drury-lane Theatre. One section is shown at the stage level, the other 10ft. higher.

round "drums" and worked by electric motors (Fig. 2). The dead weight of such a bridge has to be partially taken by counterweights, and provision made for working the whole appliance by hand should the current fail. Each section, measuring 40ft. by 8ft., comprises two light steel arched lattice girders of simple but substantial design, 38ft. 10in. in length, spaced 5ft. 6in. apart, and well braced together to form one rigid structure, on the top of which the flooring forming part of the stage is fixed. The steel portion of each lift weighs a little over $4\frac{3}{4}$ tons; the wooden platform which forms part of the stage floor, together with the joists on which it rests, weigh about $1\frac{1}{2}$ tons more, the total weight lying between 6 and $6\frac{1}{2}$ tons. From 4 to $4\frac{1}{2}$ tons of this total weight is counterbalanced. The elevators have been designed to travel from the mezzanine floor, situated 8ft. 6in. below the stage, to a height of 10ft. 6in. above the stage; and to ensure smoothness and silence in working, with freedom from "binding," the ends or legs of the girders have been made of a considerable depth, sliding in angle guides attached to steel stanchions. The mechanism which elevates the lifts is placed entirely below them (Fig. 3), in order to allow a clear, uninterrupted floor when the top of the lifts are "flush" at ordinary stage level. Each lift has a totally independent and complete set of mechanism to work it. Power is supplied from the electric mains to a four-pole enclosed shunt-wound motor, which develops $7\frac{1}{2}$ H P. at 520 revolutions per minute, but is capable of working at higher rates on emergencies. The speed is reduced in the ratio of 104 to 1, through a large worm-gear, the worm-wheel being geared to a shaft which carries two winding drums making five revolutions per minute. Upon these drums are wound steel wire ropes, which pass over guide pulleys and are connected at four places to the legs of the lift—one near each corner. The speed of lifting corresponding to the full speed of the motor is 16ft. per minute, which, however, can be reduced through resistances in circuit with the motor to 6ft. per minute. Compensating arrangements equalise the tension in the ropes, so that the pull is quite steady and uniform. The movement of the lift is controlled by a combined starting and reversing switch, which is operated by a man at a station below the stage level, and so placed that he can see the elevators. The operation of changing from "power" to "hand" working, or *vice versa*, takes but a few seconds. On the end of the worm shaft opposite to the motor is keyed a spur wheel, a similar wheel keyed upon a double hand like an ordinary crab being arranged to slide into or out of gear with it.

These notes will not be complete without duly allotting the credit of certain features in this installation. Mr. Grove, of the Thames Ironworks Co., had charge of everything relating to the electrical part and designed the motors, as well as the minor electrical appliances. The combination of the motor, winding gear and "crab," which is particularly ingenious, particularly well suits its purpose, and there were, of course, numerous difficulties to contend with to obtain what was desired. The execution of the contract generally, and primarily everything relating to the constructional work, was in the hands of Mr. Alexander Stuart, of the same firm.

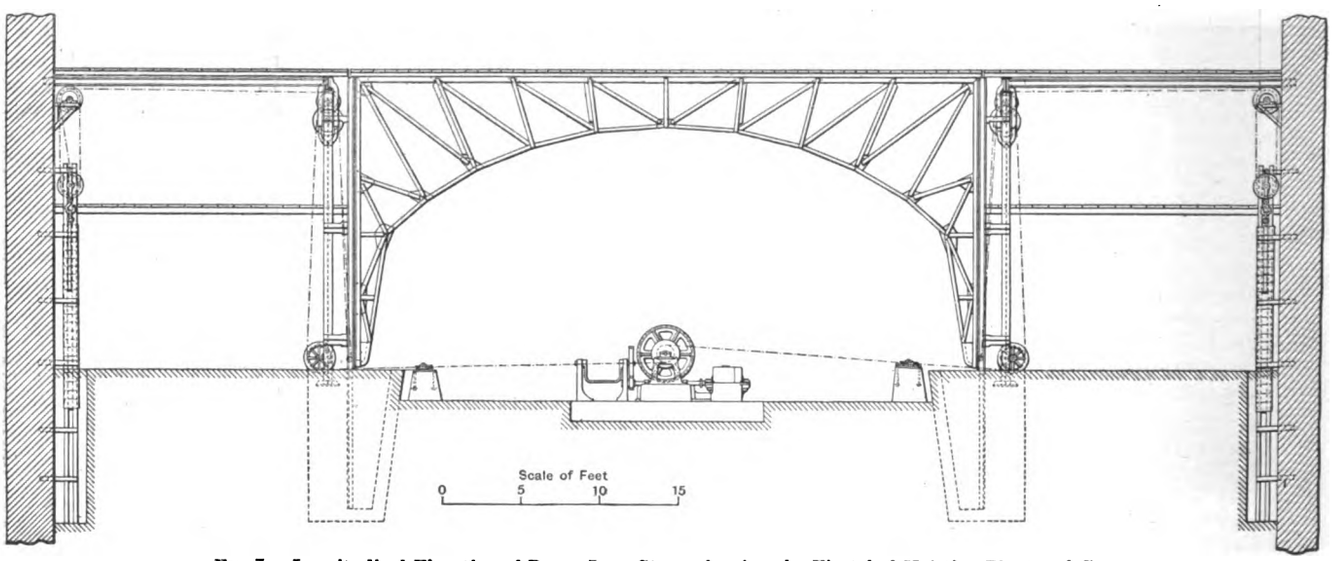

FIG. 3.—Longitudinal Elevation of Drury Lane Stage, showing the Electrical Hoisting Plant and Gear.

India-Rubber Culture.—The *Elektrotechnische Zeitschrift* is informed that an expedition is being equipped which will proceed to the German colonies in West Africa to introduce rational methods of rubber culture. The expedition will first investigate the botanical conditions for a suitable cultivation and utilisation of the plantations, and profit by the experiences of foreign colonies to the advantage of those within the German sphere of influence. It is intended to transplant the wild rubber plants and cultivate them on a large scale in plantations. At the same time investigations will be made as to the relative suitability of the various separation processes to the West African rubbers.

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ELECTRICAL INSTALLATION AT THE KENNINGTON THEATRE.

An interesting electrical installation was put in operation for the first time at the opening of the new Princess of Wales Theatre at Kennington on Boxing Night. This installation has been carried out by Messrs. Owen Lucas and Pyke, to whom we are indebted for the following particulars :—

The steam plant includes a Babcock and Wilcox boiler, which had to be specially designed to fit into the small engine and boiler space at disposal. This boiler is capable of working a 112 H.P. engine; it works at 150lb. pressure, and has a heating surface of 1,010 sq. ft. The water is supplied to the boiler by means of a feed pump, or, as an alternative, an injector, direct from the main, a provisional tank being provided to hold sufficient water for two performances. A feed water heater is provided to raise its temperature to 212°F. Owing to the engine room being below the level of the main drain a special sump tank has been provided to carry all the waste water, &c., it being emptied into a drain trap on a higher level by means of an ejector worked from the boiler. The engine is a compound vertical Willans three-crank engine, with combination bed, coupled direct to a Johnson and Phillips dynamo, compound wound for 75 kilowatts. A battery of E.P.S. accumulators, consisting of 56 115 kilowatt S. type cells, has been erected in a specially-designed battery room, nearly 60ft. long. These cells were delivered and erected by the Company in the exceedingly short space of five days. They have an output of 480 amperes for five hours, and in case of breakdown of the plant are more than capable of supplying light to the theatre for one performance on all ordinary occasions.

The engine-room board has been designed to give great facilities in regulation and equalising of the load. The following circuits are run direct back to this board, and are provided with two-way double-pole switches :—

Auditorium (*b*)	carrying	100	amperes.
Auditorium (*c*)	,,	100	,,
Auditorium (stage)	,,	100	,,
Stage main	,,	750	,,
Dressing room	,,	50	,,
Stage projectors	,,	400	,,
Open main	,,	150	,,
Supplementary service	,,	500	,,
Arc lamps	,,	170	,,

The dynamo and cells are provided with automatic current alarms and indicators, so that immediately the current rises above a certain percentage of the maximum safe load notice is given to the engineer, and he can, by means of these two-way switches, throw off any circuit on to the cells, thus relieving the plant, so that in case of necessity the whole current from the dynamo and the cells can be taken at the same time, giving an available output of over 120 kilowatts. The board is provided with a complete set of indicating and recording instruments. The accumulator charge and discharge switch consists of two sets of contacts mounted horizontally, the connecting arms travelling between them by means of worm gear, the first 10 cells (positive end) being used as regulators. The circuit mains from the board run to the various distribution boards throughout the building in earthenware conduits, provided with brick chambers and draw boxes.

The stage board has been specially designed to give an exceptionally complete control with as few movements as possible. The colour lighting is operated from a board so designed that master switches are rendered unnecessary, the colours being arranged in horizontal lines, two of these switches in each line being linked together in such a way that they can be operated independently or the whole together by the movement of a main lever. The colour plugs on the stage and auditorium lights are controlled by similar means. Special resistance switches have been supplied on a similar principle and have been designed to occupy as little space as possible. Each of these resistance switches can be operated independently or the whole of those belonging to one colour simultaneously by means of a main lever. The resistances consist of platinoid wire coils mounted on slate frames, a special resistance room, with fire-proof lining and ventilating shafts being built to contain them. The pay office and sub-distribution boards are of the porcelain bridge fuse type, each circuit carrying five amperes and being provided with a single pole switch. The stage board, pay office and sub-distribution boards were manufactured by the Edison and Swan Co., and the engine room board by Messrs. Barclay (the main contractors), who have satisfactorily carried out the whole of the wiring.

The wiring system throughout, beyond the main boards, is contained in iron barrel, there being no right angle bends in the building, all tappings and bends being made through the iron draw-boxes. The system is completely watertight, and it is possible by means of these draw boxes to withdraw any length of cable in the building for examination and repairs. Artistic fittings have been supplied by Messrs. Barclay, the Edison and Swan Co. and others. The exits of the theatre are illuminated by eight double-carbon Brockie-Pell arc lamps, worked two in series. There is in addition a powerful search-light mounted on the roof. The total number of lights installed, exclusive of plugs and plug board connections, is over 2,000.

THE COMMERCIAL AND BUSINESS ASPECTS OF MUNICIPAL ELECTRICAL SUPPLY.

BY ALFRED H. GIBBINGS, M.I.E.E.

(*Concluded from page 269.*)

Fitting Up and Managing a Corporation Show room.

A show-room for the purpose primarily of exhibiting and explaining the apparatus and other articles which are supplied to the public will always be found to be an exceedingly useful, if not an absolutely necessary, adjunct to the ordinary works and clerical departments of a municipal electricity undertaking. During the first year of such a business, when the department will probably be fully occupied in connecting to the supply mains a heavy rush of applicants, and in providing a proper complement of machinery, mains and meters, the subsidiary matters already dealt with in these articles may have to be postponed, and no necessity for a show-room would then exist. In the course of the second or third year, however, it will probably be found advisable, because advantageous, to "start" a show-room, the purposes of which will be entirely distinct from those of either the works or clerical departments.

The show-room section should be constituted and arranged to entirely relieve, if possible, the general clerical staff of the casual and extraneous, though no less important work, which would otherwise fall upon it. It should, first of all, perhaps, be an office of general inquiry. By natural sequence it would thus become the medium for imparting information gratuitously to the public on all matters relating to the business of the whole department and the apparatus used. Such a medium may be said to be a recognised necessity. Every municipal electrical engineer knows how many and varied are the inquiries made by consumers and prospective consumers with reference to installation work, fittings and electrical apparatus generally, of which, in the majority of instances, they have no knowledge whatever. It is this want of knowledge which is often taken advantage of by the unscrupulous wiring contractor, and hence in the protection of their own interests, as well as in the interests of the consumer, stringent wiring regulations are, or should be, laid down by the Corporation. Judging superficially, and they can judge in no other way, the public very often consider these regulations unnecessarily severe. There can be no doubt that a little explanation would throw great light on the subject, and the apparent unreasonableness of certain conditions and requirements to be observed in wiring work would soon disappear. The most appropriate means for such a desirable purpose is afforded by instituting a show-room to deal *inter alia* with this matter, and the discharge of this duty should form one of its principal features. It is far, otherwise when such matters are left to take care of themselves, or at best are left entirely to the clerical staff. As the old wise saying has it, "What is everybody's business is nobody's business," and in that case

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inquiries are apt to be treated as no part of the business at all, and answers are given usually in a very perfunctory way. The tendency and temptation to give indifferent and incomplete information is almost sure to exist. At all events the same satisfaction is not likely to be given as if the duty devolved expressly upon one official, specially engaged for the purpose.

The staff of a show-room need not be an expensive item; one man, with the possible addition of an errand boy, will be found amply sufficient in most cases. This very modest equipment has met the requirements of gas companies' show-rooms for the hire of gas stoves, &c., in cases where the customers number many thousands. A great deal depends, however, upon the selection of the man for such a post. Anybody will not do. He should be, of course, specially qualified in a technical sense, and also be of an obliging and courteous disposition. It is advisable that the show-room should be located in a convenient, easily accessible, and, if possible, central position of the town. A shop front, where articles could be exhibited with, say, one or two working models of motors, would possess a double advantage; the premises would be attractive, and their locality would soon become well known. When a portion of the electricity works or the town hall office is set aside for the purpose, much of the usefulness of the show-room will, of course, be lost. The former is usually too far out of the town for many persons to reach, and the latter is not likely to offer the same attractions to the public as a shop.

In addition to the function which it has just been suggested should be the characteristic feature of the show-room, there are other ends it may well subserve. But the further scope will, of course, depend upon local circumstances and the extent to which the electricity committee considers it advisable to enlarge their enterprising borders. Where the Corporation themselves contract for installation work, or a hiring out department exists, much of the clerical work can be allocated to the show-room. The books of these departments, the nature and method of keeping which have been explained under the head of *Equipment and Management* and *Hiring-Out of Motors, Arc Lamps and other Apparatus* should be kept by the show-room staff, which, of course, would have to be augmented for this special and superadded work. In such cases it could be arranged that the payment of small accounts, such as for motor oil, carbon brushes, arc lamp carbons, &c., and the rental for apparatus on hire, should be received at the show-room at the time of making the purchase or applying for goods on hire. This would save considerable time and work by superceding the usual routine of making out formal accounts, which have to be paid at the collector's office at the Town Hall or elsewhere, to say nothing of avoiding bad debts and relieving the consumer from much trouble.

We have thus dealt with the show-room, considered specifically as a general inquiry office. Let us now proceed to look at it in the aspect of a show-room, taking the term in its usual significance. The articles on exhibition should include heating and cooking apparatus, of which the radiator has hitherto been the most popular; electric motors fitted up in sizes varying from ½ H.P. to 10 H.P.; electric fans and forms of ventilating apparatus; samples of material used in wiring work, showing the quality and design required by the Corporation; printed matter relating to every branch of the undertaking; apparatus, if any, used in the method of charging for electricity supplied, such as demand indicators, time switches, &c.; types of arc lamps, such as open, enclosed and double-carbon and incandescent lamps, showing classes of terminals, methods of frosting and efficiencies of different candle-powers for varying situations.

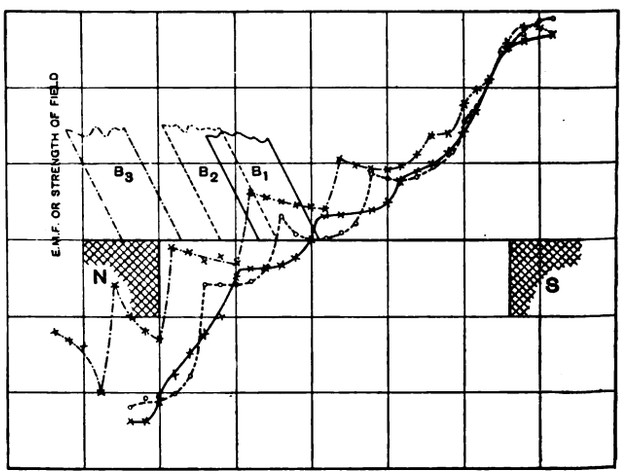
Some municipalities who do not care to undertake the sale of goods enter into an arrangement with different firms to exhibit their goods, referring purchasers to the firms direct, but charging a small commission on transactions. A list is then kept at the show-room, giving prices and approximate current consumption of each article.

It is almost unnecessary to add to what has already been suggested the necessity of having a supply of electricity for show-room requirements. If the system is low tension continuous current with three wires, then the three wires should be brought into the premises. If, however, the system is alternating current, then it will be advisable to keep at hand transformers for varying voltages. Suitable switchboards should be arranged on one or more sides of the room, with cut-outs on both poles, and a series of terminals for branch circuits to be readily connected to any apparatus. Each of these branch circuit terminals should also have double-pole fuses. There should also be ample floor space. Not that a large supply of stock should be stored in these premises. It should not, indeed, be necessary to keep at the show-room more than a sample or two of each kind of apparatus. Space is a desideratum rather because of the necessity which will frequently arise of setting out individual items of stock for inspection and examination. The stock proper should be kept at the works stores, as the storekeeper should be responsible for all goods received into the department, no matter to what particular branch they are ultimately allocated.

THE EFFECT OF COMMUTATION ON THE FIELD OF DYNAMOS AND MOTORS.

BY W. H. EVERETT, B.A., B.E., AND A. H. PEAKE.

In a previous article* we described some experiments on the character of the change of current in an armature coil of a dynamo and motor respectively while that coil is passing under either brush. We now give an account of an investigation as to the effect of this change of current on the field. The experiments were carried out with the two-pole 5 kilowatt Crompton machine previously used. An exploring coil of 10 turns of fine wire was wound on one of the armature coils,



Full line curve, 2·2 amperes. Dotted line curve, 8 amperes. Chain-dotted line curve, 27 amperes.

FIG. 1.—Motor Curves with Thin Brush.

one end being connected to a slip-ring and the other to a revolving adjustable contact-maker. In this way the E.M.F. generated in the coil at any instant could be found by charging a condenser with this E.M.F. and then discharging at will through a ballistic galvanometer. Each armature coil consisted of two layers of three turns each, and the exploring coil was wound between the middle and rear conductors of the upper layer.

In the figures given below, abscissæ show the relative positions of the centre of the armature coil on which the exploring coil was wound, the pole-tips (N, S) and the brush (B), the intercept between successive ordinates representing the width of one coil; and ordinates represent the E.M.F. induced in the exploring coil. A change in the speed of the machine merely produced a proportionate change in the deflections of the galvanometer, so that for the sake of com-

* See *The Electrician* April 22, 1898, p. 861.

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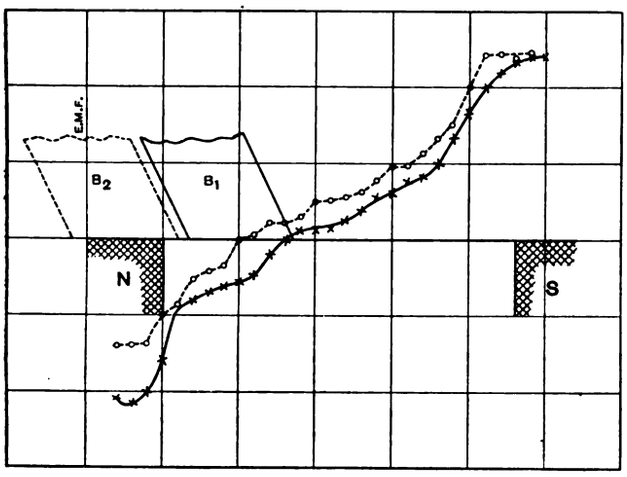
parison the vertical scale is made inversely proportional to the speed in each case.

Three different brushes were successively used. The first was that described in the previous article, being divided into two parts connected by a low resistance, and giving E.M.F. curves under the same conditions as for the current curves previously obtained. The second was an ordinary brush, but of the same thickness only as the first. The third was an ordinary brush of sufficient thickness to cover about one segment and a third.

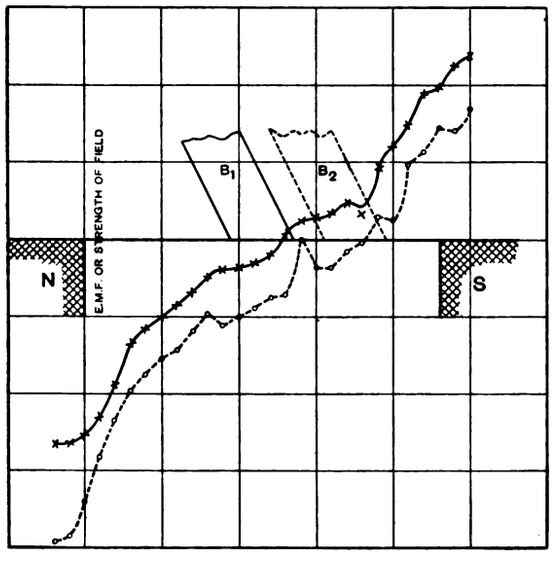
Broadly speaking, the curves show that the E.M.F. decreases from its initial negative value under the trailing horn,



Full line curve, 2·3 amperes. Dotted line curve, 26 amperes.

FIG. 2.—Motor Curves with Ordinary Brush.

rapidly at first, then more gradually, to zero; and then increases, slowly at first, and afterwards more rapidly, to its final value. The general shape of the curve is, of course, due to the distribution of the main field. The relative flux densities under the pole-tips are shown by the heights of the first and last ordinates of the curve, but the examination of the field was not carried beyond these points. The greatest



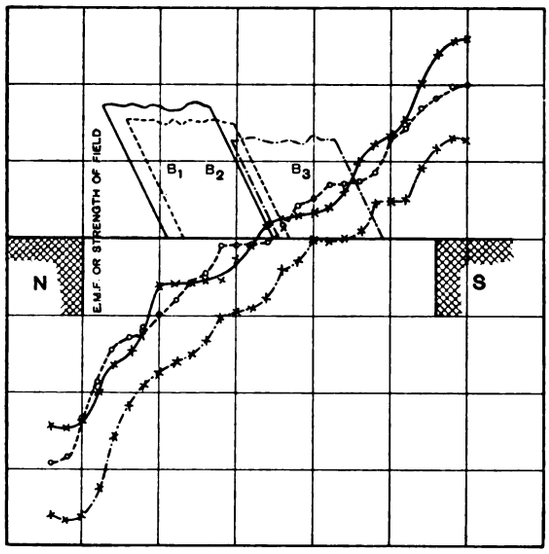
Full line curve, 7 amperes. Dotted line curve, 35 amperes.

FIG. 3.—Dynamo Curves with Thin Brush.

ordinate in the curves represents an E.M.F. generated in the armature coil of about half a volt when the total E.M.F. of the machine is 30 volts. The field is found to be affected by the change of current in the coil under the brush, and this effect is repeated at regular intervals corresponding to the distance between the centres of adjacent coils. The presence of this effect is clearly shown in the curves, causing successive ripples, of which the one under the brush is, as we should expect, the most marked. A decrease in the positive, or an increase in the negative, current in a coil causes a positive induced E.M.F. in that coil, and *vice versâ*; therefore, comparing these ripples with the curves of current change shown in the former article, a descent in the current curve should correspond to a positive distortion or excessive rise in the E.M.F. curve, and an ascent in the current curve to a depression in the E.M.F. curve. In some of the curves it will be seen that there is an indication of this correspondence.

When the brush was not in the correct position to avoid sparking, sudden sharp deflections were found to occur in the curves at points where the segments of the commutator leave the toe of the brush. These deflections are downward when the brush is too far backward, and upward when it is too far forward, as would be expected from the change (due to contact resistance) of the current in the coil leaving the brush.

When the thin brush is used (*see* Figs. 1 and 3), the ripples, in both dynamo and motor curves, are much more pronounced with heavy than with light loads, since the current change is greater. Again, the difference between the dynamo curves, at various loads, is not nearly so great as between the motor curves; moreover, in the case of the dynamo the curves are smoother than in the case of the motor. These results are probably both due to the same cause, namely, that the current and E.M.F. in the coils under the brush are changing in the same direction in a dynamo, but in opposite



Full line curve, 3 amperes. Dotted line curve, 18 amperes. Chain-dotted line curve, 35 amperes.

FIG. 4.—Dynamo Curves with Ordinary Brush.

directions in a motor. In comparing curves for different loads it should be borne in mind that the brush does not remain in the same position, being always adjusted to avoid sparking; this accounts for the crossing and recrossing of some of the curves.

Experiment shows that there is no appreciable difference produced in the character of the curves by exchanging the split brush for an ordinary one of the same thickness; accordingly none of the solid thin brush curves have been included in the figures. With the thicker brush the curves are comparatively smooth in all cases; this, of course, is chiefly noticeable in the heavy load curves, since they were originally the most rippled. The reason for this smoothing effect is, presumably, that whenever one coil has just come under the brush, or is just leaving it, there is an adjacent coil also short-circuited, which acts like the closed secondary of a transformer, and thus partly counteracts the self-induction of the first coil. Hence any sudden change of current in one of the shorted coils has a less effect on the main field, since its influence is counteracted by a corresponding change in the adjacent coil. The field, therefore, is steadier and the E.M.F. curve smoother with the thicker brush.

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TELEGRAPHY BY MAGNETIC INDUCTION.*

BY S. EVERSHED.

Although many practical trials of telegraphy by means of the mutual induction between two distant circuits have been made during the past ten years, this form of wireless telegraphy has of late been rather overshadowed by the more brilliant possibilities of telegraphy by means of Hertzian waves of high frequency, and the low-frequency electromagnetic system has hardly received the attention it deserves. It is probably not capable of such general application as Hertzian telegraphy, but it has a distinct advantage in employing electromagnetic waves of low frequency, the laws of which are simple and well understood, and the necessary apparatus for transmitting and receiving will not be too remote in type from dynamos and motors to enable us to readily understand the principles on which their design and workingshould be based. Moreover, with one limitation, to which reference will afterwards be made, our knowledge of the laws of magnetic induction is sufficient to enable us to determire precisely what conditions are requisite for communication with a place at any distance.

The author's attention was directed to the subject some years ago in connection with communication between light-vessels and the shore, and his magnetic induction telegraph was, as is pretty generally known, tried between the North Sand Head light-vessel and Dumpton Gap, and proved a total failure, owing to the almost complete absorption of the electro-magnetic waves by the media through which they were required to pass. During the time these trials were in preparation exhaustive experiments were carried out at Woodfield Works by the author, in conjunction with Mr. Oswald Cox, and the main principles of telegraphy by magnetic induction were investigated, and one or two fundamental formulæ worked out. It will not be inappropriate at the present time, when wireless telegraphy is coming into prominence, to put the conditions then arrived at before the members of the Institution as briefly as possible.

When we desire to convey energy through space from one place to another by electro-magnetic waves, we must provide a primary circuit at one place to emit the induction waves, and a secondary circuit at the other place to receive them. Every time a current is varied in any way in the primary a certain fraction of the energy linked with this circuit will appear in the secondary, to run down there into heat (as C^2R), unless there is a motor or other translational device included in the secondary. By maintaining an alternate current in the primary a continuous supply of energy is available in the secondary, and a suitable indicator in the secondary —that is to say, a motor adapted to convert part of the received electrical energy into energy of motion, either visible or audible— will enable the receipt of the energy to be detected. Break up the primary current into dots and dashes and you have a working telegraph. Of course there are other means of indication which are not in any ordinary sense motors. For example, electrolytic effects may give a direct indication of the secondary current, or a coherer may be used to give indirect indication by closing a local circuit. But the principles underlying the application of magnetic induction to wireless telegraphy will be better understood if we assume the indicating device to convert some part of the received energy into motion. It may be motion only capable of bringing two contacts together to close a local circuit, or capable of making audible sound waves in the air, or it may be directly visible; but in any case something is made to move; and the moving body being, presumably, attached to some support, either by pivots or an elastic suspension, cannot be moved without the expenditure of energy to overcome the mechanical friction of the pivots or the molecular friction of the suspension. If sound waves are set up there is a further expenditure of energy.

The secondary current being, of course, an alternating one, it is probable that the motion imparted to the indicating device will be oscillatory also. The ordinary Bell telephone will occur to everyone as typical of such an indicating device. The friction—resistance to motion—may follow any law with regard to velocity, it may even be constant (independent of velocity), but in every case examined by the author the frictional resistance has proved to be simply proportional to the velocity—at all events, at such frequencies as are likely to be used in practice. In what follows it will be assumed that when moving with velocity v, the moving body requires a force equal to rv to overcome friction, r being a constant for any particular moving system. Calling the amplitude of oscillation a, and if $p=2\pi F$, the mean power required to oscillate the moving part will be $=\frac{1}{2}ra^2p^2$, and at its maximum value the power spent in overcoming friction will be ra^2p^2, the oscillation being a simple sine function.

Having got an indicator, the first step towards it application to an induction telegraph must be to determine the value of the coefficient r, and to decide upon a value for the amplitude a, which will give indications of the necessary magnitude. These two data will enable primary and secondary circuits to be designed to give the required secondary power with any given primary power.

The Inductive Circuits.

There are two practicable ways of building such circuits. The first consists of running a pole line of sufficient length at each end of, and at right angles to, the imaginary line joining the two points between which communication is to be established. Each pole line being earthed at both ends, the circuits complete themselves through the earth, and form two circuits in parallel vertical planes. This is the system devised by Mr. W. H. Preece. It was in practical use long before any other system of wireless telegraphy was heard of, and, indeed, it is very largely due to Mr. Preece's early and continuous work in this connection that we have any wireless telegraphy to discuss to-day. The efficiency of this system, taking cost of materials as a measure of efficiency, depends on the average depth at which the current travels in returning through the earth from one earth pole to the other. Many experiments have been made by the Post Office authorities to determine the mean depth of the return path, but the author understands that the results do not indicate any definite law governing the relation between length of pole line and depth of return. In these circumstances it becomes impossible to accurately forecast what any proposed pair of lines will do. Moreover, leakage from one circuit to the other complicates matters.

The other method of forming the primary and secondary circuits consists in running a pole line completely round the boundary of a sufficient area of ground at each station. This, in effect, turns Mr. Preece's two vertical circuits into two horizontal circuits, and there is the immediate loss of one-half the mutual induction between them—an effect only compensated for if the area of the horizontal circuits can be increased. If the areas of the primary and secondary circuits are A_p and A_s respectively, and the distance between them is D (D being large compared with the diameters of the circuits), then the total induction threading the secondary,

$$B=\frac{2\,A_p\,A_s\,C}{D^3}, \qquad \ldots\ldots\ldots \quad (1)$$

when the circuits are in parallel planes normal to the line joining their centres; while in the case of the two circuits lying in the same plane,

$$B=\frac{A\;A_s\,C}{D^3}. \qquad \ldots\ldots\ldots \quad (2)$$

Another point to bear in mind when comparing the vertical and horizontal systems is that in the former a pole line is only used over half the whole length of circuit, the remainder being made up by the earth return. In the latter the pole line extends right round the circuit, and is on that account likely to prove more costly. However, horizontal circuits possess compensating advantages which may easily outweigh their drawbacks, and in the following formulæ for determining the volume of copper in the lines, areas of circuits and primary power required for signalling over any given distance, the circuits are supposed to be laid in a horizontal plane.

The expressions given in (1) and (2) show that circular circuits will give the maximum effect for a given length of pole line. But this is an ideal form which could hardly be contemplated in practice, and it will, therefore, be assumed that each circuit forms the boundary of a square area. Since each circuit will have to serve for both transmitting and receiving, it is clear that they must, if possible, be identical in size and shape.

Let

V_p, N_p, R_p	be the total volume of wire, number of turns, and resistance of the primary circuit.
V_s, N_s, R_s	the corresponding values for the secondary circuit.
a	sectional area of line wire.
ρ	specific resistance of line wire.
s	length of side of square circuit.
D	distance from centre of primary to centre of secondary.
C_p	value of primary current.
W_p	value of power spent in primary.
W_s	total electrical power in secondary.
B	total magnetic induction threading secondary.
E_s	impressed E.M.F. in secondary.
C_s	current in secondary.
M	mechanical power of indicator or motor in secondary.

All the cyclic quantities are assumed to be simple sine functions, and the letters denoting them stand for their maximum (crest of wave) values.

The whole of the power required in the primary circuit is assumed to be that wasted in heating the wires. To be strictly accurate, the power radiated into space, of which a minute fraction appears in the secondary, should be added; but at the low frequencies suitable for working the whole radiated power is very small compared with $C^2_p R_p$. To get the greatest possible conversion into mechanical energy in the secondary E_s must be in step with C_s, and the condition for maximum activity of a motor must be fulfilled. As is well known, this condition requires the back E.M.F. of the motor to be equal to one-half the impressed E M.F. The highest possible value for the mechanical power of the secondary indicator is, there-

* Paper read before the Institution of Electrical Engineers, Dec. 22, 1898.

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fore, $$M = \tfrac{1}{2} E_s C_s.$$

But $$C_s = \frac{E_s}{2R_s}\ ;\ \text{so that}\ M = \frac{E_s^2}{4R_s}.$$

Now $$E_s = pB = \frac{ps^4 N_s N_p C_p}{D^3}\ ;\ \text{and since}\ C_p = \sqrt{\frac{W_p}{R_p}},$$

$$R_p = \frac{4\rho s N_p}{a},\ \text{and}\ a = \frac{V_p}{4sN_p},\ \text{we have—}$$

$$E_s^2 = \frac{p^2 s^6 N_s^2 W_p V_p}{16 D^6 \rho} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

also, $$R_s = \frac{16\rho s^2 N_s^2}{V_s}\ ;$$

so that, finally,

$$M = \frac{E_s^2}{4R_s} = \frac{p^2 s^4 W_p V_p V_s}{16^2 D^6 \rho^2}. \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Here we have an expression for the power turned into audible, visible, or in any other way discoverable motion by an indicator considered as a motor—a motor which is only required to overcome its own mechanical friction, and working under the ideal conditions of maximum activity, negligible, electrical resistance and self-inductance, E.M.F. and current in step, and, lastly, *absence of any medium which can absorb* or distort the magnetic waves on their road between the two circuits. As might have been anticipated, the mechanical power does not depend in any way on the number of turns of wire into which V_p and V_s may be divided. The number of turns in primary and secondary will depend only on the E.M.F. of primary generator, and E.M.F. for which the motor is designed; these are questions entirely distinct from the mechanical work to be done, just as the bearing friction in an ordinary motor is quite independent of the volts and amperes of the machine. Formula (4) also indicates that the least volume of wire will be used if we make $V_p = V_s$; and in that case, if we put V_t for the total volume of wire used in the construction of the two circuits, (4) becomes

$$M = \frac{p^2 s^4 W_p V_t^2}{32^2 D^6 \rho^2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4A)$$

At this point it will be useful, by working out an example, to give an idea of the mechanical power which can be delivered at a distance of several miles by the expenditure of a reasonable amount of power in the primary circuit, and by means of a practicable weight of wire. Suppose we put 1,000 kilogrammes (about 1 ton) of copper wire into circuits, 1,000 metres square and 10 kilometres apart. Let the frequency be 100 $\sim$, and the mean power spent in the primary circuit be 100 watts. That is to say,

$$p = 628,\ s = 10^5 \text{cm.},\ W_p = 200 \times 10^7 \text{ ergs per second},$$

$$V_t = \frac{10^6}{8{\cdot}9} = 1{\cdot}1 \times 10^5 \text{ c.c.},\ \rho = 1{\cdot}7 \times 10^3 \text{ C.G.S. units},$$

and $$D = 10^6 \text{cm.}$$

If these values are put into (4A), we get

$$M = 0{\cdot}34 \text{ ergs per second.}$$

Now, as will presently appear, it is quite easy to obtain indicating instruments which will work with less than one-third of an erg per second; but it must not be forgotten that the value just given for the mechanical power available is under ideal conditions that can only be approached—never reached.

Transmitting Devices.

It is not necessary to discuss in any detail the apparatus required for producing the alternate or interrupted current in the primary circuit. An interrupted current may be derived from batteries by means of a rotary contact wheel driven by clockwork or by an electro-motor. For telegraphing over great distances the primary power must be considerable, and it will probably prove more economical and convenient to have a small alternator driven by an oil or gas engine. No particular difficulty is likely to be met with in designing a compact plant for the purpose.

Receiving Devices.

In every instance, so far as the author is aware, in which communication has been carried on by magnetic induction or by earth leakage, the ordinary Bell telephone has been used as a "sounder." It is well adapted for the purpose, as it enables exceedingly minute currents to be detected. This sensitiveness does not arise so much from the efficiency of the telephone as a current-detector as from the marvellous delicacy of the human ear, which is able to distinguish sound waves produced by motions so exceedingly small as to be absolutely invisible, even when magnified many times. In the course of the investigation already referred to the author made careful measurements of the magnetic and electrical quantities involved in the telephone, but up to the present he has been unable to devise adequate means for measuring what fraction of the electrical power supplied is converted into mechanical power. This conversion can be estimated for any given amplitude of the diaphragm from a knowledge of the change in induction threading the coils for different displacements of the diaphragm; obtaining in this way the back E.M.F. But the difficulty remains of determining the amplitude when an alternate current is flowing in the coils.

However, in the case of the telephone it is not essential to know the mechanical power in order to ascertain the conditions for working to a given distance. By measuring the alternate current required to produce readable signals it is possible to deduce with fair accuracy the distance over which Morse code signals can be sent. The author has measured the current flowing in a Post Office pattern Gower-Bell telephone while receiving Morse signals readable by a skilled operator in a quiet room—"readable" implying that the message could be read without difficulty. Two operators were found to agree very closely in their estimate, and it appeared that the current for readable signalling was nearly twice the minimum current which produced an audible sound. The current was determined by connecting the telephone to a circular ring of wire through which a measured induction was alternating. The resistance and self-induction of the telephone were separately determined, and the whole impedance was sufficiently large to enable the current to be estimated without reference to the back E.M F. of the vibrating diaphragm. The mean of several observations gave for the maximum (crest of wave) value of the readable current.

$$C = \frac{2{\cdot}9}{10^6} \text{ amperes.}$$

A current of one-half the above value makes a just audible sound.

When a telephone of this type is used as receiver on the secondary of an induction telegraph, the only condition to be fulfilled to get the best effect is that the resistance of the secondary circuit should equal that of the telephone. This is only another way of saying that the telephone is a very badly designed motor, with such an enormous combined resistance and inductive drop that the current is quite independent of its back E.M.F. A large component of the current—namely, that required to force the vibrations—is, of course, in step with the diaphragm, and, therefore, in quadrature with the back E.M.F.; in short, an idle* current in the sense that it does no mechanical work. Suppose this particular telephone is connected to the secondary of the two circuits which are given above as an example. To get maximum current we must either wind the telephone to equal the line resistance, or divide V_s into a sufficient number of turns to bring R_s up to the resistance of the telephone. The resulting ampere-turns in the telephone coils is the same in either case, and it will be simpler to choose the latter alternative, although in practice the telephone would, of course, be wound to suit the line. Using the same notation as before, and calling x the impedance of the telephone coils at frequency F, we have first to make

$$\frac{16\rho s^2 N_s^2}{V_s} = x\ ;$$

that is, $$N_s = \frac{\sqrt{V_s x}}{4p\sqrt{\rho}}.$$

Now $$C_s = \frac{E_s}{2x} = \frac{ps^3 N_s \sqrt{W_p V_p}}{8 D^3 x \sqrt{\rho}}\ ;$$

and, substituting the value just found for N_s, we find

$$C_s = \frac{ps^2 V_t \sqrt{W_p}}{128 D^3 \rho \sqrt{x}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Working out the value of C_s from the data already given, the frequency being now 400 $\sim$ per second—the rate adopted by the Post Office after many trials at different speeds—and the impedance of the telephone $x = 220$ "ohms" at 400 $\sim$, we find

$$C_s = \frac{12}{10^6} \text{ amperes;}$$

that is to say, a little more than four times (4·1) the minimum for readable signals; so that the weight of copper in the lines might be cut down to a quarter of a ton, or the distance increased by multiplying by $\sqrt[3]{4{\cdot}1}$, making the distance between the centres of primary and secondary circuits 16 kilometres (10 miles).

It is clear, therefore, that in the absence of wave-absorption an ordinary telephone without any modification will enable induction telegraphy to be carried on at considerable distances. In the absence of any measurements of the absorption of electromagnetic waves by the earth it is, of course, impossible to predict to what distance it will be possible to signal by means of a system working at 400 periods per second, but the author is inclined to think that at this speed absorption will rapidly damp out the waves as the distance increases.

* The author regrets to see that Dr. Thompson sanctions the inappropriate phrase "wattless current" for a current in quadrature with the E.M.F. Such currents are, alas! only too wattful,—they are never wattless. But they are distinctly idle, in that they never do any useful work.

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The telephone may easily be improved for signalling purposes. When articulation is not required the pitch of the diaphragm may be lowered with advantage. During the working out of the apparatus for the lightship telegraph Mr. Cox devised several form of telephone sounders in which the coil was rigidly attached to the diaphragm, and adapted to move in a powerful magnetic field. One or two instruments of this type were made, and worked well. Time, however, did not allow of our bringing any of them to perfection. But in whatever way the telephone may be improved as a motor, the most serious difficulty will always remain. To get an easily audible note, it is necessary to work at a fairly high frequency. At 100 periods per second one can just hear a low hum in a telephone, but it is not until the frequency reaches 200 or 300 that dots and dashes become at all distinct. At 400 periods the note is sufficiently piercing to enable an operator to read a message without any serious strain. Whatever form the telephone as a "sounder" may ultimately take, its suitability for induction telegraphy must depend on the degree of absorption met with in practice. If absorption is serious, audible indications must be abandoned, and an indicator working at a very low frequency will become necessary. What form such an indicator should take for Morse code signalling is by no means clear, but a simple form of vibratory indicator devised by the author in 1892 for use in connection with the light-vessel experiments may be described, as it illustrates very clearly the principles involved in all vibratory indicators of minute alternate currents, and possibly contains the germ of a practicable "speaking" instrument.

The essential parts of the author's indicator are shown in Fig. 1. A rectangular loop of fine wire, a, b, c, d, is fixed in an insulating block in a position which allows its end b—c to move freely in the air-gap of a magnet, N S. When the rectangle is traversed by an alternate current it vibrates up and down about its fixed ends a—d, and if the rectangle is tuned so that its free period of vibration is equal to the periodic time of the current, it becomes an exceedingly sensitive alternate-current voltmeter, the amplitude being strictly proportional to the impressed E.M.F. on the terminals of the rectangle.

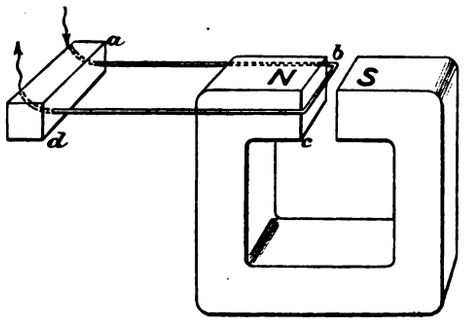

FIG. 1.—Vibrating Rectangle, with Magnet.

By combining the mechanical equation of motion with the equation of the electrical quantities concerned, the following simple equation is arrived at for the amplitude in terms of the molecular and other frictional resistances to motion, the condition of synchronism or resonance being assumed :—

Let a = amplitude at end b—c.
r = force required at end b—c to overcome frictional resistances at unit velocity.
R = electrical resistance of circuit, including rectangle.
L = self-induction of circuit, including rectangle.
E = impressed E.M.F.
$h = \mathrm{H}l$ = field in air gap × length b—c.

Then
$$a = \frac{\mathrm{E}h}{p\sqrt{(h^2+\mathrm{R}r)^2+r^2p^2\mathrm{L}^2}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Also, if i and v are instantaneous values of the current in, and velocity at the end of rectangle,
$$hi = rv,$$
and the maximum velocity is pa; so that, if C is the maximum value of current,
$$\mathrm{C} = \frac{rpa}{h}.$$

Also the maximum back E.M.F. $-\mathrm{V} = pah$; hence maximum power is
$$\mathrm{VC} = ra^2p^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

By differentiating (6) it is seen that a will have the greatest possible value when the field is adjusted until
$$h^2 = r\sqrt{\mathrm{R}^2 \times p^2\mathrm{L}^2}.$$

Writing R' for $\sqrt{\mathrm{R}^2+p^2\mathrm{L}^2}$, we have for the value of amplitude under most favourable conditions,
$$a = \frac{\mathrm{E}}{p\sqrt{2r(\mathrm{R}+\mathrm{R}')}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

The condition for maximum amplitude is clearly that for maximum activity also, and accordingly we find that when L=0 and $h^2 = \mathrm{R}r$, the back E.M.F. is equal to half the impressed E.M.F.

So much for the theory of this simple alternate-current synchronous motor. It is gratifying to add that its actual behaviour is, within the limits of observational error, strictly in accordance with theory.

By adding a fixed contact screw adjacent to the free end of the rectangle a local circuit will be closed whenever the vibrations are sufficient to make the rectangle touch the contact screw. Another and better arrangement is to have two rectangles connected to two separate secondary circuits in such a direction that they oscillate in opposite phase. The two rectangles being made, the poles of a local circuit can be made to act as a relay on coming into contact with each other. Two relays of this type were made by the author's firm in 1896 for use in the light-vessel trials, and a few months ago they were attached to the wireless telegraph erected by the Post Office for communicating between Lavernock and Flat Holm, in the Bristol Channel. They are in daily use as relays for closing a call-bell circuit. The primary current is derived from a small alternator with a very heavy fly-wheel on the armature shaft. The machine being driven by hand to a speed above the synchronising frequency, the exciting current is switched on, and the alternator allowed to come gradually to rest—passing slowly through the synchronising speed, so that the two rectangles of the distant relay have time to come to their maximum amplitude. The rectangles in these two relays are made of iridio-platinum wire 3 mils in diameter. They are each 4cm. in length, 2cm. in breadth, and their frequency is 16 periods per second. The twin-rectangle relay has one great advantage over the single pattern shown in Fig. 1. When the twin rectangles are properly tuned to unison it is almost impossible to bring them into

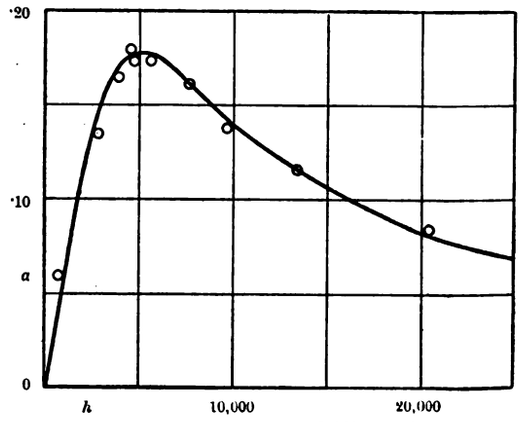

FIG. 2.—Curve connecting a and h for Iridio-Platinum Rectangle: a in centimetres, h in C.G.S. lines.

contact by shaking the instrument. Even when the contact points of the rectangles are separated by only 0·002 inch, it is difficult to make contact by shaking the relay. They may be oscillating over a large angle; appearing to overlap each other, but oscillating in unison and in the same phase, as the rectangles do when shaken, they do not come into contact. These relays were designed for use on board a light-vessel, and entire freedom from accidental contact due to shaking was, of course, essential.

Measurements of the value of the frictional resistances of rectangles made of copper, platinum, and iridio-platinum were made, and showed very little difference between them. The value of r was determined by means of a vibrator like Fig. 1, having its field produced by an electromagnet, so that h could be varied. The process consisted in observing the amplitude at synchronism for different values of h, and plotting the curve connecting them.

There being no self-induction in the circuit, the amplitude follows the law,
$$a = \frac{\mathrm{E}h}{p(h^2+\mathrm{R}r)}.$$

The impressed E.M.F. was provided by a secondary circuit of a single turn in which the total induction B could be measured. That is to say, $\mathrm{E} = p\mathrm{B}$; so that
$$a = \frac{\mathrm{B}h}{h^2+\mathrm{R}r} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

Having plotted the observed values of a and h, a curve is determined by means of equation (9) to fit the observed points as closely as possible. One of the curves is given in Fig. 2. It shows the relation between a and h for a rectangle of iridio-platinum wire 3·3 mils diameter and 2·9cm. long, having a frequency of 25 periods per second. The curve is drawn from the equation,
$$a = \frac{1{,}770h}{h^2+25\times10^6} \text{ cm.};$$
so that
$$\mathrm{R}r = 25\times10^6 \text{ C.G.S. units.}$$

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Now $R = 4{\cdot}28$ ohms $= 4{\cdot}28 \times 10^9$ C.G.S. units; hence

$$r = \frac{25}{4{\cdot}28 \times 10^3} = \frac{5{\cdot}85}{1{,}000} \text{ dynes.}$$

In the relays on the Lavernock-Flat Holm telegraphs the greater length of rectangle—4cm.—results in a lower value for r, namely,

$$r = \frac{4{\cdot}0}{1{,}000} \text{ dynes.}$$

The power required to work a 4cm. rectangle at any amplitude can now be calculated from the value for r just given, and the known frequency—16 periods per second—for, as we have already seen, the mechanical power expended is

$$M = ra^2p^3.$$

Let $r = \frac{4}{1{,}000}$, $a = \frac{1}{10}$cm., $p = 2\pi \times 16 = 100$;

then $M = 0{\cdot}4$ ergs per second ($a = 0{\cdot}1$cm.):

or, if $a = 0{\cdot}01$cm.,

$M = 0{\cdot}004$ ergs per second ($a = 0{\cdot}01$cm.);

and so on.

An amplitude of one-tenth of a millimetre is, however, far more than is necessary under favourable conditions. The author has repeatedly worked a twin-rectangle relay with less than 2 mils between the contacts, and a relay was purposely set up at Woodfield Works with the contacts 2 mils apart to ascertain how often accidental shaking made contact. The relay was tested every day by alternate current, to see that it was in working order, but in the course of a three weeks' trial no accidental contact occurred. Taking 2 mils—say, 0·005cm.—as the limiting value for the clearance between contacts, the mechanical power expended becomes

$M = 0{\cdot}001$ ergs per second ($a = 0{\cdot}005$cm.).

This must be considered as the limit of sensibility for this particular relay. When the clearance is reduced to less than 2mm. difficulties arise from the electrostatic attraction between the rectangles drawing them into contact, and when in contact the elastic force of the wires is insufficient to pull them apart again. It is clear, however, that the energy received in a secondary circuit can be detected by means of a synchronous vibrator of the kind described, in which frictional resistance has been reduced to 4×10^{-3} dynes. Returning to equation (4^a), and assuming the resistance of the rectangle is negligible compared with the least possible resistance of the secondary circuit, we can now write—

$$M = ra^2p^2 = \frac{p^3s^4 W_p V_t^2}{32^2 D^6 \rho^2}.$$

Hence,

$$a = \frac{s^2 V_t \sqrt{W_p}}{32 D^3 \rho \sqrt{r}}. \quad \ldots\ldots\ldots \quad (10)$$

When, as in the former example, $V_t = 1{\cdot}1 \times 10^5$ c.c., $s = 10^5$ cm., $W_p = 200$ watts, $D = 10$ kilometres, $\rho = 1{\cdot}7 \times 10^{-6}$ ohms, and, in addition, $r = 4 \times 10^{-3}$ dynes, the amplitude will be

$a = 0{\cdot}014$ cm. (about $5\frac{1}{2}$ mils);

so that, if the rectangle is used as a relay, and set to its maximum sensibility, it would be possible to work with a weight of copper amounting to

$$1{,}000 \text{ kilos.} \times \frac{0{\cdot}005}{0{\cdot}014} = 350 \text{ kilos.},$$

or about one-third of a ton.

Or, still using 1,000 kilos., the distance may be increased by multiplying by $\sqrt[3]{\frac{0{\cdot}014}{0{\cdot}005}} = 1{\cdot}42$, bringing up the distance to 14·2 kilometres—a value only a little less than the limiting distance found for readable signals with a telephone as receiver. A very small rate of absorption of waves would, however, tell enormously against the telephone, while the vibrating rectangle, working at so low a frequency as 16 periods per second, would not be appreciably affected.

It is interesting to note that when the telephone and the rectangle are worked under exactly the same conditions as regards primary power and distance and size of circuits, but at frequencies of 400 and 16 periods respectively, the total power available for the telephone is more than six hundred times as great as that available for the rectangle. Yet the rectangle gives a *visible* indication—for by means of a magnifying glass the vibrations are easily visible down to about half a mil. It has already been remarked that this synchronous vibrator may contain the germ of a "speaking" instrument. It has ample sensibility for practical purposes, and is not likely to be affected by a moderate rate of absorption. It is to be hoped that some means will be discovered for enabling it to be used for indicating Morse code signals, either directly or by employing it as a relay.

Absorption.

So far as the author is aware, the absorption of electromagnetic waves by the earth—considered as a solid conductor—has never been calculated or measured under the conditions assumed in this Paper. What is wanted is a complete series of observations of the absorption at different frequencies and over different distances, and it would be desirable that observations should be made in several different localities of widely differing geological character. The author hopes to be able to carry out at least a part of this investigation in the course of the next few years. Apart from absorption, it is clear that communication by magnetic induction can easily be established in those cases where the ordinary telegraph line or cable is impracticable. The author has endeavoured to illustrate the fundamental principles involved in the working of induction telegraphs, and if he has in any way cleared the ground for future investigators, and thrown a little light on matters relating to the design of appropriate receiving apparatus, the object of this Paper will have been fulfilled. In conclusion, the author desires to express his sense of the great obligation he is under to Mr. Preece and Mr. Gavey for their kindness in giving facilities for his investigations, and placing at his disposal the results of the many experiments carried out by them in connection with wireless telegraphy.

TRAMWAY CONSTRUCTION OVER CHILKOOT PASS.*

BY W. A. BURKHOLDER.

Building an aerial tramway over Chilkoot Pass, or rather, to speak more accurately, the building of an aerial tramway *up* the Chilkoot Pass from the foot of the canyon to Scales, at the summit of the mountain, is an engineering problem of expedients and frontier experiences, rather than of technical detail. To begin with, the work was of the variety best known as a "rush job," but to make matters more interesting, the contract was executed in the depth of an Alaskan winter, with labour mildly characterised as "unskilled," and in a country where the monotony of having different parts, if not the entirety, of one's anatomy frozen, was varied only by the excitement of death-dealing avalanches. Labour—spare the mark!—cost $3·50 to $5 a day and board. At times it was necessary to dig through 20ft. of snow before reaching the ground, and then, particularly during the last two miles of the line, the ground proved so hard that it was almost impossible to break it with dynamite, to say nothing of the difficulty, if not the impossibility, of thawing the explosive. It was at all times necessary to put the poles into the holes as soon as the latter were dug, or otherwise the holes would quickly fill with drifting snow. As to the weather, that at the foot of the summit is of a severity I cannot describe. It is with the greatest difficulty, at times, that one can stand up against the hurricane that blows there, and this, with a temperature perhaps far below zero, makes it almost impossible at times for human beings to exist there for any length of time. Both my cheeks were frozen one morning while making an inspection of the line, and a few days before the hard frozen bodies of two Indians were taken from the trail. It was below this point that occurred the great avalanche of February last, where nearly 60 adventurous gold-seekers were buried alive, and which was so fully reported in the daily Press at the time. Although the great avalanche crossed the pole line of the Dyea-Klondyke Transportation Co.'s tramway, it did not injure it beyond tearing down a few stretches of wire. Nevertheless, the work on the tramway, which was begun on June 15th last, was completed on March 20th, when it commenced operations. The original plans for the building of the tramway of the Dyea-Klondyke Transportation Company contemplated the erection of a power house, to be driven by steam, at Dyea, and an 18-mile transmission thence to Scales, at the foot of the pass. This transmission was to be at 5,000 volts, three-phase, with step-up and step-down transformers, and the equipment for it reached Dyea in January. On arriving on the ground, however, I advised against the transmission as proposed from Dyea, when the power house could be both installed and operated as cheaply and as satisfactorily at the mouth of the canyon as at Dyea. Some 11 miles of transmission line, as well as the raising and lowering transformers, and all attendant losses would be obviated should the change be effected, and, accordingly, the power house was located at the mouth of the canyon.

The generating station is a plain log building measuring 20ft. by 60ft., and the steam equipment place therein consists of a 16ft. by 64in. marine type boiler, and an 11in. by 12in. automatic engine, from which is belt-driven a Westinghouse 45 kilowatt two-phase generator, delivering 2,000 volts. The station contained no "frills," but the behaviour of the boiler is worthy of special mention. It was of the marine type, designed for burning coal under forced draught, but no coal was to be had. The only wood available was green hemlock, at $5·50 per cord, and while we did succeed in getting up steam, I have often thought that it was due to the sulphurous heat of the fireman's outbursts of wrath more than to any calorific virtue of the wood itself.

Canyon City is nine miles above Dyea, which is the seaport for those who go to Dawson and the Klondyke by the most direct route.

* From the *Journal of Electricity*, of San Francisco.

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The distance from Canyon City to the foot of the pass is a little over seven miles, and along this distance the pole line passes, thence up the canyon to Scales. The poles are of 30ft. spruce, cut from the mountain side, and measure from 6in. to 8in. in diameter at the top, to from 10in. to 12in. at the butt. In the canyon the line is run in the most direct route possible, the poles being set in holes blasted out of the solid rock, and so that the line runs from point to point along the side of the canyon. This pole line carries only the two-phase transmission circuit, consisting of four No. 6 B. and S. gauge hard drawn copper wires, supported on Locke triple petticoat glass insulators, on wood topped steel pins. The transmission line is barrelled twice in its length, and the poles also carry a telephone circuit.

The motor house at Scales contains a step-down transformer which reduces the line potential to 200 volts for driving a Westinghouse 15 H.P. induction motor (type "C"). The motor is belted to a shaft operating winding drums through clutches, so that one of the drums takes up the cable while the other pays it out at the same speed. The outfit is a regular mine hoist, and was, in fact, taken from the Sheep Creek Mine, near Juneau. The length of the cable, which is, of course, double, is about 4,000ft., and the greatest single span is approximately 3,000ft. in length. Loads varying from 1,200lb. to 1,500lb. are carried with ease up grades running as high as 30 per cent., and some parts of the tramway run along the side of the canyon from 500ft. to 600ft. almost vertically above the trail. It should be explained that the Dyea-Klondike Transportation Co. tramway, which is now being described, consists of a traction cable of $\frac{5}{8}$in. plow steel, supported at intervals as close as possible, on staunch overhanging pole structures. On these traction cables run, or rather underrun, two buckets, not unlike two coal conveyors joined together, and these buckets are hauled along the traction cable by means of a pulling cable, also of plow steel, but having a diameter of $\frac{1}{2}$in. It is this latter cable that is wound on one or the other of the two drums referred to, according to whether the buckets are being raised or lowered. The tramway, which is 4,000ft. in length, is used only for freight. Although employés have been over it often, and one young lady a Miss Edgerton, who is a Red Cross nurse, made the perilous trip in safety shortly after the completion of the tramway. She was the first and only woman who ever went over the trip, despite the full-page story in a New York Sunday paper describing, with thrilling attributes, the journey as made by one of its women reporters. The tramway is capable of handling 50 tons of merchandise daily, and the cost for the service is 10 cents per pound from Dyea to Lake Linderman, which is a cut from the rate of 40 cents which existed for the same service last fall. The rate for the 4,000ft. of the Pass alone is 1 cent per pound.

So great was the activity of the transportation companies during last winter, that by the commencement of the season this summer, three different tramways were in operation over the Chilkoot. In addition to the one described, the Alaska Railway and Transportation Company were operating a single 1in. cable between the top of the hill above Stone House to the top of the mountain overlooking Crater Lake. This cable has a length of about 7,000ft., and is run by a 40 H.P. gasoline engine. The third system is known as the "Bleichert system," and uses a steam plant for operating its tramway from Canyon City to Sheep Camp, and another for that section from Sheep Camp to the summit. These three systems were consolidated early last summer, and now only the Bleichert system is in active operation.

BOOKS RECEIVED.

"The Official Gazette of the United States Patent Office." No. 11. Vol. LXXXV. Published by authority of Congress. (Washington: Government Printing Office.)

"Kálkulos Sobre Las Kañcriás de Aqua." By A. E. Salazar. (Santiago de Chile: Hume I. Ka., Aumaka 357.)

"Small Accumulators: How Made and How Used." Edited by Percival Marshall. (London: Dawbarn and Ward.) Price 6d.

"Calvert's Mechanics' Almanack" for 1899. By W. Calvert. (Manchester: John Heywood.) Price 4d.

Proceedings of the Royal Society. No. 405. Vol. LXIV. (London: Harrison and Sons.) Price 1s. 6d.

ELECTRICITY WORKS ACCOUNTS.

Harrogate Municipal Electric Supply Works.

The municipal electricity supply undertaking at Harrogate commenced business on April 15, 1897, with about 90 consumers and an equivalent of 8,000 8 c.p. lamps connected to the mains. Our table therefore embodies the accounts of working for the period from the above date to December 31, 1897.

Of the authorised capital of £40,996 £25,235 had been borrowed temporarily at one-half per cent. above the bank rate of interest, but the Corporation were about to take the loan up at 3½ per cent.

At December last the total capital expenditure had amounted to £27,298, representing £99 4s. per kilowatt of generating capacity of plant. With 110 consumers and an equivalent lamp connection of 8,700 the output for the year was 62,886 units sold, for which an average revenue per unit of 5·976d. was obtained. The total costs at 4·17d. per unit represented about 70 per cent. of the revenue.

No reserve fund has yet been started, so that with the working profit of £468, and after paying £565 as interest on loans the deficit is £97. To this a sum of £254, representing the expenses of executing the provisional order, has been added as this expenditure is not chargeable to capital account.

Windsor Electrical Installation Co. (Limited).

Electricity supply at Windsor started near the end of 1896, the equivalent lamp connection being then about 2,700, with 60 consumers, and the plant capacity about 100 kilowatts.

The authorised capital of the Company amounts to £25,000. At December 31st last the total capital paid up (raised by the issue of £1 shares) was £19,970, while the total expended capital amounted to £20,469, representing some £73 per kilowatt of generating capacity of plant in the station. It was proposed to issue the remaining capital of £5,000 during the current year.

The equivalent 8 c.p. lamp connection to the mains at December 31, 1897, was 4,985, and the output for the year—52,095 units sold—realised a revenue of £1,558, representing 7·16d. per unit. In addition to this and such other items as meter rents £84, pupil's premium £33, and rents £52, the total revenue received has been augmented by what appears to be a by no means unremunerative department of the business—the installation work—this having realised a profit of £621, thus raising the total revenue to 10·6d. per unit sold.

The costs come out high, at 5·22d. per unit, generating costs at 8·56d. being somewhat abnormal, even for the moderate output of 52,000 units.

A working profit of £1,163 has been made, representing 7·09 per cent. of the mean capital. No payment to any reserve fund has been made, thus enabling an ordinary dividend of 4 per cent. to be declared, leaving a balance to carry forward of £604.

Neglecting the profit of £621 made by installation work, the working profit would stand at £542, and the ratio of the total costs to the revenue at 67·7 per cent.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Ayr (Municipal)	Nov. 11	Kens'gton & Knightsbr'ge (Co.)	Sept. 30
Bedford (Municipal)	Mar. 4	Kingston-upon-Hull (Municipal)	Aug. 19
Belfast (Municipal)	Sept. 23	Kingston-upon-Thames (Mun.)	Mar. 25
Birmingham (Company)	Dec. 16	Lancaster (Municipal)	Oct. 21
Blackpool (Municipal)	Oct. 7	Leeds (Company)	April 8
Bournemouth (Company)	June 3	Leyton (Municipal)	Sept. 23
Bolton (Municipal)	Dec. 9	Liverpool (Municipal)	Aug. 12
Bradford (Municipal)	May 20	Manchester (Municipal)	July 29
Brighton (Municipal)	May 6	Newcastle and District (Co.)	Dec. 2
Bristol (Municipal)	July 29	Newcastle-upon-Tyne (Co.)	April 29
Burnley (Municipal)	Sept. 16	Northampton (Company)	April 15
Burton-upon-Trent (Municipal)	April 15	Norwich (Company)	Dec. 3
Bury (Municipal)	Nov. 25	Notting Hill (Company)	Mar. 11
Cambridge (Company)	June 17	Nottingham (Municipal)	Oct. 23
Charing Cross (Company)	April 22	Oldham (Municipal)	Nov. 18
Chelsea (Company)	May 20	Oxford (Company)	April 1
Cheltenham (Municipal)	Oct. 7	Portsmouth (Municipal)	Nov. 4
Chester (Municipal)	Oct. 14	Preston (Company)	Oct. 28
Clerkenwell (Company)	Mar. 18	Reading (Company)	Sept. 16
Derby (Municipal)	Dec. 9	Richmond (Company)	Mar. 4
Dewsbury (Municipal)	Nov. 25	Scarborough (Company)	April 1
Dover (Company)	Mar. 11	St. James' & Pall Mall (Company)	July 1
Dundee (Municipal)	Nov. 4	St. Pancras (Vestry)	May 13
Eastbourne (Company)	July 22	Sheffield (Company)	Dec. 16
Edinburgh (Municipal)	Oct. 14	Shoreditch (Vestry)	May 27
Exeter (Municipal)	Aug. 5	Southampton (Municipal)	June 3
Glasgow (Municipal)	Aug. 12	Southport (Municipal)	Dec. 23
Guildford (Company)	May 13	Stafford (Municipal)	Oct. 21
Halifax (Municipal)	Nov. 18	Sunderland (Municipal)	Aug. 19
Hammersmith (Vestry)	June 10	Taunton (Municipal)	Aug. 5
Hampstead (Municipal)	Sept. 9	Tunbridge Wells (Municipal)	July 22
Hanley (Municipal)	April 8	Walsall (Municipal)	Nov. 11
Harrow (Company)	Sept. 9	Wandsworth (Company)	Mar. 18
Hastings & St. Leonard's (Co.)	April 29	Westminster (Company)	April 22
House-to-House Co. (Kensington)	Sept. 30	Whitehaven (Municipal)	Dec. 23
Hove (Company)	May 6	Wolverhampton (Municipal)	July 15
Huddersfield (Municipal)	Mar. 25	Worcester (Municipal)	May 13
Islington (Vestry)	June 24	Yarmouth (Municipal)	June 17

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	HARROGATE.		WINDSOR.	
Undertaking Worked by	Harrogate Corporation.		The Windsor Electrical Installation Co., Ltd.	
Date of Commencement of Supply	April, 1897.		November, 1896.	
System of Supply	Alternating current, transformer sub-stations.		Continuous-current, 3-wire.	
Chief Engineer	G. Wilkinson.		A. E. Farrow.	
YEAR ENDED	**1896.**	DEC. 31, **1897.***	DEC. 31, **1896.***	DEC. 31, **1897.**
QUANTITIES—				
Units generated	—	89,271	—	—
„ SOLD (TOTAL)	—	62,336	—	52,095
„ sold to consumers	—	61,292	—	—
„ sold for public lighting, &c.	—	1,043	—	—
„ used on works	—	4,151	—	—
UNITS SOLD PER 8 C.P. LAMP CAPACITY	—	7·25	—	5·95
Maximum supply demanded	—	132 kilowatts	—	98·4
Number of public lamps	—	1 arc, 1 (32 c.p.) glow	—	—
Number of consumers	—	110	60	—
Connections to mains in 8-c.p. lamps	—	8,700	2,770	4,985
CAPACITY OF PLANT IN 8-C.P. LAMPS	—	8,600	3,130	8,750
CAPACITY OF PLANT IN KILOWATTS	—	275	100	280
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	— / —	£40,996 / £149	£15,000 / £150	£25,000 / £89·4
Share	— / —	— / —	15,000 / 150	25,000 / 89·4
Loan (including Debenture charges)	— / —	40,996 / 149	— / —	— / —
RECEIVED (TOTAL)	— / —	25,235 / 91·8	10,478 / 105	19,970 / 71·3
Share	— / —	— / —	10,478 / 105	19,970 / 71·3
Loan (including Debenture charges)	— / —	25,235 / 91·8	— / —	— / —
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— / —	15,761 / 57·3	4,522 / 45·2	5,030 / 18·0
Share (unissued)	— / —	— / —	1,149 / 11·5	5,000 / 17·9
Share (unsalled)	— / —	— / —	3,373 / 33·7	30 / 0·107
Loan (including Debentures)	— / —	15,761 / 57·3	— / —	— / —
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	— / —	— / —	— / —	— / —
DEPRECIATION FUND	— / —	— / —	— / —	— / —
EXPENDED (TOTAL)	— / —	27,298 / 99·2	6,324 / 63·24	20,469 / 73·2
Lands and buildings	— / —	6,951 / 25·3	2,628 / 26·28	4,843 / 17·3
Plant	— / —	12,918 / 47·0	887 / 8·87	8,583 / 30·6
Mains	— / —	6,557 / 23·8	1,905 / 19·05	5,876 / 21·0
Miscellaneous	— / —	873 / 3·17	904 / 9·04	1,167 / 4·18
BALANCE OF CAPITAL ACCOUNT	— / —	−2,063[a] / −7·50	4,154 / 41·54	−499[b] / −1·78
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	— / —	£1,551 / 5·976d.	£231 / —	£2,295 / 10·58d.
Revenue from supply	— / —	1,529 / 5·890d.	33 / —	1,553 / 7·160d.
„ meters, &c.	— / —	10 / 0·039d.	— / —	34 / 0·157d.
„ public lighting	— / —	13 / 0·050d.	— / —	— / —
„ sale of lamps, &c.	— / —	— / —	196 / —	621 / 2·860d.
„ miscellaneous sources	— / —	— / —	2 / —	87 / 0·401d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	— / —	£1,083 / 4·174d.	£228 / —	£1,132 / 5·220d.
WORKS COSTS	— / —	807 / 3·110d.	87 / —	778 / 3·590d.
Generation of electricity	— / —	*702* / *2·703d.*	*87* / —	*773* / *3·560d.*
Fuel (including cartage, &c.)	— / —	236 / 0·910d.	27 / —	463 / 2·133d.
Oil, waste, water, stores	— / —	79 / 0·304d.	1 / —	83 / 0·383d.
Wages at station	— / —	364 / 1·402d.	36 / —	183 / 0·844d.
Repairs and maintenance at station	— / —	23 / 0·089d.	23 / —	44 / 0·203d.
Distribution of electricity	— / —	*96* / *0·370d.*	— / —	*5* / *0·023d.*
Wages, &c.	— / —	7 / 0·027d.	— / —	4 / 0·018d.
Repairs, renewals of mains, &c.	— / —	89 / 0·343d.	— / —	1 / 0·005d.
Public lighting	— / —	*9* / *0·035d.*	— / —	— / —
Attendance	— / —	9 / 0·035d.	— / —	— / —
Renewals	— / —		— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	— / —	276 / 1·064d.	141 / —	354 / 1·632d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	— / —	*27* / *0·104d.*	*15* / —	*63* / *0·290d.*
Management	— / —	*249* / *0·960d.*	*126* / —	*291* / *1·342d.*
Salaries	— / —	185 / 0·713d.	38 / —	177 / 0·816d.
Stationery, &c.	— / —	16 / 0·062d.	4 / —	27 / 0·124d.
Establishment charges	— / —	44 / 0·170d.	24 / —	31 / 0·143d.
Law charges, &c.	— / —	4 / 0·015d.	60 / —	56[c] / 0·258d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	— / —	£468 / 1·71%[c]	£2 / —	£1,163 / 7·09%
Sum carried to Depreciation Fund	— / —	— / —	— / —	— / —
Sum carried to Reserve or Sinking Fund	— / —	— / —	— / —	— / —
Net interest on loans (incl. Debenture charges)	— / —	565 / 2·07%[c]	— / —	— / —
BALANCE FROM LAST ACCOUNT	— / —	— / —	— / —	82[d] / 0·500%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	— / —	23[a] / —	1,257[e] / 7·66%
Deficit	— / —	*351*[b] / *1·29%*[c]	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	4% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	—	69·9%	98·6%	49·3%
Expenditure per kilowatt capacity	—	£3. 18s. 10d.	—	£4. 0s. 10d.
REVENUE PER KILOWATT CAPACITY	—	£5. 12s. 10d.	—	£8. 4s. 0d.
Expenditure per 8-c. lamp capacity	—	2s. 6¼d.	—	2s. 7d.
REVENUE PER 8-C.P. LAMP CAPACITY	—	3s. 7½d.	—	5s. 3d.
REVENUE PER 8-C.P. LAMP CONNECTED	—	3s. 6⅝d.	—	9s. 2½d.
Price charged for lighting, per unit	—	6d.	7d.	7d.
Price charged for power, per unit	—	—	—	—
Price charged for public lighting	—	6d. per unit.	—	—

HARROGATE.—REMARKS—* Period from April 15 to December 31, 1897. *a* Over-expended. *b* Including £254, expenses of executing the order, and not chargeable to capital. *c* Per cent. to capital at end of year, viz., £27,298.

WINDSOR.—REMARKS—* For the period from the commencement of supply in November to December, 1896. No record of the units generated, &c., available. *a* Includes £21 accruing as interest from money at deposit. *b* Over-expended. *c* Includes £31 to insurance. £16 to auditing. *d* Includes £59 law costs transferred to capital account, charged against revenue last year. *e* Includes £12 received as interest for money at deposit.

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ELECTRICITY IN STAGE-LAND.

The history of electricity in the theatre is both instructive and interesting, revealing as it does remarkably rapid progress from small beginnings to its present important position among affairs theatrical. Before and behind the footlights, though more especially in the second-named domain, the ornamental and useful possibilities of the electric current have gradually been appreciated and utilised to an increasing extent. In the apprentice days—or nights, should we say—of electricity in stage-land, its duties were more ornamental or fantastic than severely utilitarian. Corps de ballet were equipped with belts of now obsolete primary or secondary cells, lighting lamp-tipped magic wands; "chipped lightning," as we believe it was called, was a popular stage effect, produced by the sparks from a large Wimshurst machine; and the demoniacal flash that leaped from the sword of Mephistopheles when he slew Valentine was produced by an artfully-contrived induction coil, which, on one occasion at any rate, gave the unhappy man a shock that "greatly tickled the devil" and much amused the audience. These were amongst the many quaint uses to which electricity was first applied, at a time when the electric light as a main illuminant in the theatre was but little known and was at best a somewhat heroic experiment. But this was also a time when electricity was rapidly revealing its potential superiority as an illuminant, and when the shadow even of its advent as a motive power was dimly forecast. And despite the many seemingly insurmountable difficulties, and the lamentable failures which met the efforts of those who endeavoured to supersede with electricity older methods of lighting theatres, this form of illuminant has gradually come to be recognised by theatrical managers as the only safe and satisfactory one both for general lighting and for artistic stage effects. Stage scenery and properties are, as a rule, so highly inflammable that it is not surprising that the glow lamp bulb should be preferred to the wire-encased or naked gas flame, or the electric arc to

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the dangerous oxy-hydrogen "lime." An example of the completeness and even elaboration with which the electric light equipment of a theatre is now invested is to be found at the recently-opened Kennington theatre. At that house Messrs. Owen Lucas and Pyke have erected a self-contained steam-driven electrical plant of some 2,000 lamps capacity. An account of this installation will be found in an article we publish this week.

As with the outside prosaic world, the people of stage-land were more ready to realise the advantages of electricity for lighting than for mechanical power purposes. Indeed, the theatrical profession was and still is far behind the general public in this respect; for it appears to possess no engineering tradition whatever. Not merely electrical power, but every form of mechanical power is practically unknown in stage-land, where, with but few exceptions, all scenic constructional work is done by carpenters, and all operations are effected by hand. The stage has never been thoroughly engineered. In the larger cities of Europe, at some few of the principal houses, hydraulic power has been introduced for operating the stage floor and turn-tables; and this source of power has also been used to a limited extent at Drury Lane Theatre and in one or two other houses in the United Kingdom. But the vast majority of even large modern stages are quite unengineered, and the traditional methods to be found on them compare with modern engineering practice much as a rope-hauling crowd of ancient Assyrians would compare with an electric motor. The reason for this is probably to be found in the predominance of traditionary modes of constructing a stage, and the difficulty, to say nothing of the cost, of adapting stages built on older lines to the more modern ideal. Yet in sanitary, acoustic and other respects the theatre has been advanced to meet the latest requirements, so that it is not impracticable that its stage should be properly engineered and equipped with all the convenient appliances which the introduction of cheap electric power renders available. We publish in an article this week some account of the work that has just been accomplished by Mr. E. O. Sachs in the electrical operation of part of the stage at Drury Lane Theatre. Looking not merely at the electrical plant, but having regard to the solid construction of the stage, it will be seen how great and radical a change in stage structure the adoption of mechanical motive power, such as electricity, involves. Instead of a clumsy contrivance of timber beams we have a series of light steel girder-built arches, a form of structure that is well adapted to rapid yet silent motion and adjustment. Apart altogether from the use of electricity, this transition is in itself a decided advance, and it is surprising to learn that so late as the present year of grace its superiority has first been recognised. Turning to consider the advantages directly resulting from the use of electric motors, we may observe that (1) cheapness, (2) rapidity, silence and certainty in action, and (3) the enhanced safety secured, are among the most important features. The compactness of electrical plant is also often one of its advantages. As regards most of these points little need be said by way of defence; those who are in a position to compare electrically driven machinery with similar machinery worked by a group of men or by hydraulic power, will readily bear out our assertion that the first is the most convenient of manipulation and the readiest in regard to rapid adjustment. In the matter of cost, we understand that one of the principal inducements which led Mr. Arthur Collins to adopt electricity for the Drury Lane stage was the low cost of power as compared with hand or hydraulic working. When it is remembered that the actual time during which the motors consume power is very small, it will easily be seen what great economy must be effected by their introduction. The success which thus far has attended the electrical equipment at Drury Lane Theatre will go far to encourage the adoption of electric motive power in other houses. Indeed, we hear that several theatrical managers are already considering the matter with a view to extending its use to their own stages.

REVIEWS.

Jahrbuch der Elektrochemie. By Dr. W. Nernst and Dr. W. Borchers (Halle-an-S: W. Knapp. 1898.)

This is the fourth time that the Jahrbuch has appeared. The work has already established its position as a useful repertory of all that concerns the electro-chemist, and the present issue does not fall behind its predecessors. The editors have obtained the aid of three collaborators (Dr. H. Danneel, Dr. F. W. Küster and Dr. K. Elbs) in certain sections of the work, but the greater part of it remains as a monument to their own industry.

The book is composed of two main divisions. The first deals with the results of researches in electro-chemistry which may be regarded as purely scientific; the second describes such technical advances as have been achieved during the current year. In the former we notice a summary of the conclusions of Förster and Seidel concerning the conditions necessary to be observed to ensure the accuracy of the indications of the copper voltameter. Recognition of the possibility of the existence of cuprous copper in the ordinary cupric sulphate solution, is needful if irregular deposits are to be avoided. The precautions laid down agree generally with those which have been already arrived at in a purely empirical manner—a result not uncommon in research, but not cause for invidious comment on that account. The usual batch of determinations of conductivity in electrolytes agreeing nicely with predicted figures is not lacking. The quantity of work recorded is large; its quality not so easily to be appraised. Without carping, one may fear that true knowledge of the nature and principles of electrolysis may run some danger of being smothered beneath a mass of facts and pseudo-facts. It is necessary to be discriminating, "distinguishing fyttes which appal and disgust from fyttes which are simply inane," if we may risk a rough quotation. A short section on electrolytic analysis, sandwiched between the scientific and technical parts of the book, contains little of note save a description of Hollard's method of copper analysis which is an attempt to extend his useful process for the determination of copper to those impurities commonly found in the commercial metal.

In the technical part of the book there is much of highly practical interest. Many of the more notable articles and Papers which are abstracted have appeared as original matter or translations in *The Electrician* during the past year. A most elaborate *précis* is given of the experiments of Liebenow and Strasser on the Jacques carbon cell, from which the authors have drawn more favourable conclusions concerning that device than have most other investigators. There is a similarly prodigal devotion of space to the Borcher's gas cell. Dr. Elbs, who is responsible for this part of the book, displays some needless irritation at our *exposé* of that *chimæra bombinans* in CO. Such chastening as we administered was necessary, and we trust not unwholesome, and should be received in a gracious and docile spirit, not with partisan cries.

The chapter on accumulators is concerned chiefly with the description of mechanical improvements in plates and cells. There is no news yet of a workable secondary cell independent of lead for its action. Considering the flood of devices which have been invented for electric furnace work, the chapter on this subject is commendably short. That it might have been much longer is shown by the string of patents at the end. We have in previous years referred with approval to this useful list of patents. It is good as it stands, and in our judgment might have its range extended to include some

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of the barren and tedious contrivances which are allowed the privilege of description in the text. We admit freely that the task of discrimination is no light one, but we would suggest to the authors that they might next year be less lenient in their admission of the irrelevant and absurd. On p. 266 is a description of an ingenious attempt to induce the crystallisation of carbon in the diamond form, by the simultaneous application of heat and pressure, using means which are certainly novel and striking. Briefly, it consists in heating by means of the arc, a piece of carbon attached to a piston rod carried by a piston working in a vertical cylinder. When the carbon is at the highest temperature of the arc a charge of gunpowder is exploded in the cylinder, and propels the piston, so that the piston-rod carrying the carbon is driven with great violence into a small cavity in a steel block. The carbon is thus strongly compressed while at its boiling point, and is, in consequence, partly converted into microscopic diamonds. The chapter on the manufacture of aluminium does not contain mention of any great novelty, but gives an interesting estimate of the world's production for 1898, which is set down as 6,000 tons. A good deal of information is given regarding the working up of anode sludge and purifying the electrolyte in the copper refining industry. Incidentally occurs a significant comment which may be taken to heart by those who believe that the possession of a German patent implies any particular novelty in the invention. "Je bekanuter die Reaktion, desto leichter augenscheinlich die Erlangung eines deutschen Patentes in Klasse 40." Under the head of nickel is set down a most elaborate process of nickel smelting which should act like a charm, and indeed reads like a bad dream. The appended diagram is a work of much art.

The excellent work of Förster on the conditions necessary for the electro-deposition of nickel in plates of reasonable thickness, so that its refining becomes a practicable proceeding, is noticed. It was duly described in *The Electrician* shortly after its appearance. Naturally there is a good deal about calcium carbide and its manufacture. Useful information is given concerning the various industrial ventures which have entered this trade, but there seems little substantial improvement in furnaces or methods. One thing is clear—viz., that there is a very considerable market for carbide at a reasonable price, whence one deduces that there must be a greater amount of acetylene lighting that seems probable to a dweller in civilised regions; doubtless it serves for remote and desolate places—*e.g.*, country houses.

The section on the alkali and chlorine industry is comparatively meagre, not, as we think, from any oversight or neglect on the part of the authors, but because of the accomplished or impending collapse of the various impracticable schemes which have troubled this manufacture, and the steady, silent growth of the few good processes which have been devised in the years of struggle now almost past. The book closes with a short chapter on electrodes, diaphragms and such necessary instruments of electrolysis.

We have indicated our opinion of this work sufficiently clearly in running comment. We reiterate that it is a book of merit and usefulness; when it errs, the error is on the side of commission rather than of omission—an excellent fault in a work of reference.

Alternating Currents of Electricity and the Theory of Transformers. By ALFRED STILL, A.M.I.C.E. (London: Whittaker and Co. 1898.)

Notwithstanding the fact that the literature dealing with the theory of alternating currents and the alternating-current transformer has received many and important additions of late, a perusal of this little book by no means gives us the impression that it is redundant. As the author remarks in the preface, there was room for a small work "in which the principles determining the behaviour of single-phase alternating currents under various conditions are considered less from the scientist's point of view and more from an engineering standpoint than is usually the case," and we must admit that the author's treatment of the subject shows that throughout he has kept his objective, as thus defined, well in mind.

Analytical treatment is abjured—graphical methods being almost exclusively used from beginning to end. The first 19 pages are devoted to a consideration of magnetic principles, and very satisfactorily leads up to what follows on alternating currents. The effect of magnetic saturation on leakage is more clearly dealt with than is usual. A commendable feature of the book is the care that has been taken—in a work such as this, written for purely practical men—to show the effect of wave form, and when and where come in the limitations and errors due to assuming the electrical quantities varying as a sine function. Most of the cases likely to arise in practice, involving self-induction and capacity, singly and in combination, are dealt with by the aid of the never-failing clock-face diagram.

A problem instructive to students is that dealing with the result, under certain conditions, of shunting with an inductionless resistance a choking coil, which is connected in series with a non-inductive resistance. In consequence of the closing of the shunt to the coil the total impedance of the circuit is increased and the total current drops in consequence of a shifting in the phase relations. An analogous case in connection with a transformer is given further on in the book. *Apropos* of these effects we might mention another experiment based on the phase-shifting principle. If a choking coil provided with a few auxiliary turns of wire—distinct from the usual coil and normally kept open-circuited but capable of being short-circuited be included in a circuit having certain proportions of resistance and self-induction, the current flowing through the circuit is increased, though the pressure across the choking coil falls when the auxiliary winding on the coil is short-circuited.

In referring to Dr. Fleming's method of plotting the curve of magnetisation from the E.M.F. curve, we notice that the author criticises Dr. Fleming's diagram in this connection given in his 1896 Cantor lectures before the Society of Arts, but surely it is but a matter of convention whether a wave diagrammatically shown as displaced in phase to the left of another wave is to be taken as preceding or as following the latter in the absence of a definite origin being indicated on the abscissæ. In fact, in some of the diagrams representing phase relations in "The Alternate Current Transformer" Dr. Fleming diagrammatically denotes a lagging wave by a displacement to the left.

The author gives a very clear exposition of the experimental determination of leakage drop in transformers; on the other hand, more attention might usefully have been given to the treatment of the subject of transformers with large leakage for supplying arc lamps from constant pressure circuits. In discussing this case the assumption is made that an arc lamp is a non-inductive device. Not till a later section is any mention made of the large influence exercised by self-induction in the secondary circuit on the leakage drop in secondary pressure between various loads. The section on transformer core losses is well up to date, and includes a brief and useful summary of the result of recent investigations on the influence of wave form on these losses.

An index is provided in addition to the table of contents at the beginning of the book, which forms one of "The Specialists' Series."

Practical Telegraphy. By H. W. JENVEY, Electrician and Electrical Inspector, Victorian Post and Telegraph Department. Two vols. (Melbourne: Robt. S. Brain, Government Printer. 1898.)

Although not in all respects suited for the telegraph operator of this country, these two handy volumes may be cited as excellent samples of what such handbooks ought to be; and we are desirous of bringing them under public notice, if only to emphasise the fact that there is no such work provided for their staff by the British postal telegraph authorities. Mr. Jenvey has taken upon himself to educate his subordinates, a task which he has performed with infinite pains, and a great deal of skill; what is more, his efforts are so much appreciated that these volumes bear the imprimatur of the Postmaster-General of Victoria, and are published by the Colonial Government as "A Guide for the use of Officers" of the Department. They are essentially of the Blue Book order of publication, and appear to be distributed among the employés gratuitously. Vol. II., which is devoted to the description and explanation of Duplex and Quadruplex signal-

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ling, and to the higher branches of testing and measurements, would be a welcome addition to the technical handbooks of the mother country, the text being full, clear, and concise; the illustrations profuse and well drawn. Submarine telegraphy is, of course, left out of account; but when this is said, the book remains one of the best that could be put into the hands of an intelligent operator, or indeed of any student of the practical and technical aspects of overland telegraphy. Of the first volume, although it has gone through three editions, and has well deserved its popularity, we cannot speak in such unqualified terms. This, however, is chiefly due to the prevalence of working with "closed circuits," a practice which has long been out of favour in this country, and which consequently destroys the utility, for English readers, of a great deal that is described and illustrated in Mr. Jenvey's book. Making due allowance for this, the descriptive matter is always simple and to the point, leading the student gradually on from a working theory of the elementary stage to the more obscure problems that confront the expert electrician. The illustrations in this volume, however, suffer as they usually do at the hands of the draughtsman or the engraver. Where the author himself has made the drawing matters are generally pretty plain; but when a draughtsman has been left to draw the apparatus he has followed the common practice of sketching a pictorial front view and leaving out all the, electrically speaking, essential details. This is the case with Fig. 22, where not only the connections, but the lettering referred to in the text, are omitted. As a rule the tongues of relays are balanced midway between the stops, and, what is far worse, the Morse keys are in touch with neither the anvil nor the back stop. Fig. 32, for example, would be unintelligible to a novice, the current not being traceable in any direction. Even the diagram relating to Wheatstone bridge testing is by no means clear; but this is remedied in the second volume. On page 11 either Fig. 10 is wrong or the text is so, the circuit requiring both keys to be depressed. This is so stated at the beginning of the paragraph; but, later on, "key" is used in the singular, whilst the diagram flatly contradicts it. There is a strange slip at the top of page 40, where the letter F is probably meant for a D. We notice, too, that no mention is made of the use of a permanent magnet for restoring demagnetised needles. The process described in the text is effectual, certainly, but far more troublesome, we should say, than handling a horse-shoe magnet. We have only one other fault to find with these two useful volumes—and this by way of compliment—the index to each of them falls far short of what their contents entitle them to.

The Archives of the Rontgen Ray. August, 1898. (London: Rebman Publishing Company.)

The current number of the "Archives of the Röntgen Ray" reports, as usual, the doings of the Röntgen Society of London, and contains, as well, an interesting collection of data bearing especially upon the medical applicability of the rays. That energetic body, the Röntgen Society, has had read before it Papers by Mr. Apps, Dr. Macintyre, Mr. Swinton and some other enthusiasts, a distinct feature of the meetings apparently being the often excellent discussions which followed. Mr. Apps discourses upon a new induction coil—what could be more appropriate?—and criticises severely some statements recently put forward by M. Rochfort in connection with an apparatus introduced by him. As there are no illustrations to Dr. Macintyre's article upon "contact breakers," his contribution is not of that real practical use which it otherwise might have been; it may serve, however, to emphasise the existing want of more perfect means for interrupting the primary current in induction coils. What can have induced Drs. Wolfenden and Forbes-Ross to publish a "preliminary note" as to the "Action of Röntgen Rays upon the growth and activity of Bacteria and micro-organisms" is difficult to understand. At the present state of that question, with so much uncertainty rife, when, in fact, there is held in many minds the belief that X rays exert no action whatever upon micro-organisms, the results set forth in this addition to the literature of the subject can scarcely be considered helpful. We were unable to perceive that the authors had taken any special precautions in regard to the "earthing" of the cultures. What is really wanted at this time is a thorough and systematic examination of the whole question, and it is to be hoped that Drs. Wolfenden and Forbes-Ross will, in the near future, supply that want. The pin-hole camera has been turned to good account by Mr. Swinton, and on page 15 of the "Archives" there is a description of its useful application to X-ray problems.

Everyone who has treated Röntgen ray matters at all seriously knows of the early work done at Oxford by Mr. Porter, and will be glad to see here collected the curious results of his observations. This complete account of his work, got together, as he explains, at the request of the Röntgen Society, occupies some eighteen columns of exceedingly interesting reading. The "Archives" this time contains a description of "Some X-ray appliances," besides a few scraps of miscellaneous information and the usual "Notes and Abstracts"; there are also comprehensive articles upon "The Röntgen Rays in the Diagnosis of Pulmonary Tuberculosis," "Experiments on the Application of the Röntgen Rays to the Study of Anatomy," and so forth. Then come the "Plates," which are always good—seven beautifully executed photographic reproductions.

The "Archives of the Röntgen Ray" is keeping up its reputation for thoroughness in this respect, and the journal fills a very definite place amidst the scientific literature of the day.

Chemistry in Daily Life. Popular lectures by Dr. Lassar-Cohn. Translated by M. M. Pattison Muir, M.A. Second edition, revised and augmented. (London: H. Grevel and Co. 1899.)

The fact that this book has run to a second edition is proof sufficient that there is a demand among the general public in this country for information respecting those technical processes which conduce so much to the comfort of our everyday life, and this is a very satisfactory state of things. But why should Mr. Pattison Muir have thought it necessary in order to meet this demand to translate a series of lectures delivered by Dr. Lassar-Cohn at Königsberg? Surely the information might have been supplied from home sources. The lectures themselves are lucid, and the explanations given of the various processes, and the underlying scientific principiples on which they are based are all that could be desired. Starting with the air we breathe, Dr. Lassar-Cohn leads us on to the consideration of how the carbon consumed in the process of respiration is to be renewed, and so on to the question of food, and the properties of its various constituents, and he notes the beneficial effects of good cookery. The properties and chemical constitution of our food and drink being explained, the question of our raiment necessarily comes under consideration, and then we pass on to the explosives used in sport and war. Toilet articles are also dealt with, and the manufacture of glass, which introduces us to mirrors, photographic lenses and the Röntgen rays, and the work concludes with a chapter on metallic alloys and the alkaloids. The author has treated his subject in a manner eminently human and suggestive, and one rises from a perusal of the work with the feeling that chemical phenomena are intimately connected with our daily life, and that, whether consciously or not, we are always carrying on chemical operations.

Kalender fur Elektrotechniker. (1899). By F. Uppenborn. (Munich and Leipsic: R. Oldenburg. 1899.)

Some of the matter contained in the fifteenth edition of this well-known pocket-book has been omitted in the sixteenth, and its place has been filled by material of greater importance. Among the additions we notice a method of estimating the return-circuits of electric tramways from an article written by Herr F. Natalis in the *Elektrotechnische Zeitschrift* this year, and a reference to the system of measuring leakage-currents, described by Dr. Kallmann at the last meeting of the Verband Deutscher Elektriker. Some alterations in the conductor tables are also apparent. The list of historical dates concludes with 1891, the date of the Frankfort Exhibition. Surely some electrical events have happened since then of equal importance to that of the first publication of the *Kalender für Elektrotechniker* in 1884.

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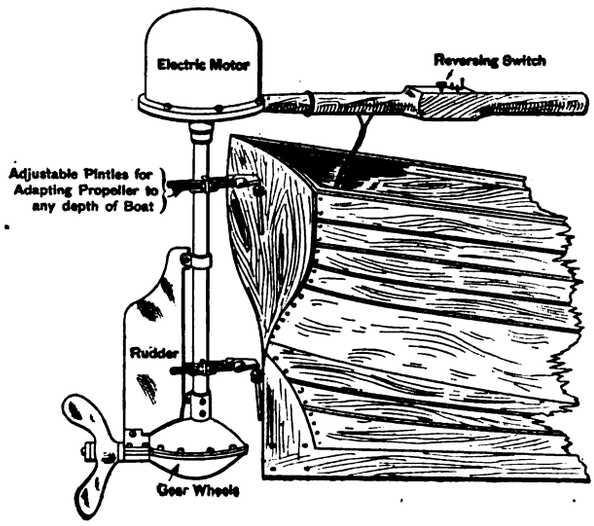
PORTABLE ELECTRIC PROPELLER FOR BOATS.

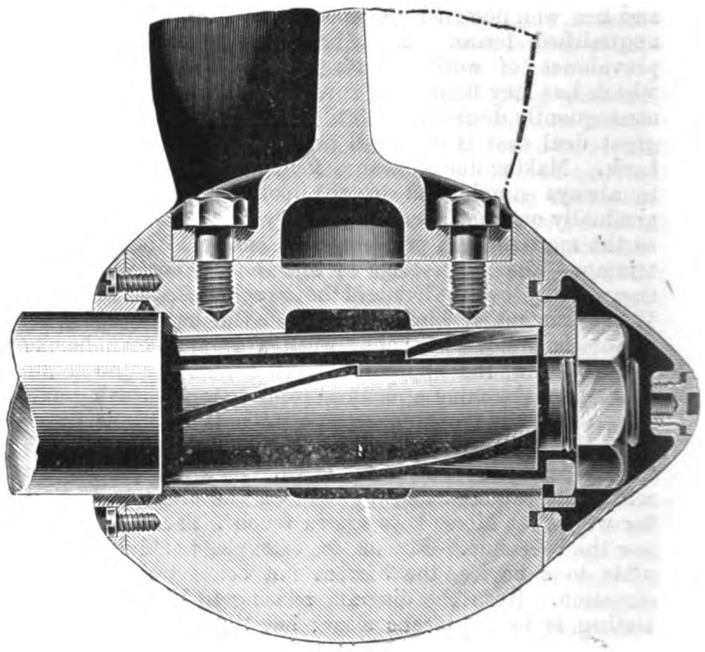
In connection with the correspondence recently published in our columns on the subject of electric canal haulage, Mr. E. A. McLachlan has sent us particulars of a portable electric propeller, which he can fit to any boats, although they may not have been originally designed for electrical propulsion. The apparatus, which is illustrated in the accompanying figure, was originally intended for river boats, but it is equally applicable to canal barges. To apply it, it is only necessary to unship the ordinary rudder, and attach the combined propeller and rudder, as shown. Storage batteries are placed on the floor of the boat, and connected by a twin flexible cable to the motor switch on the tiller handle. For ordinary pleasure boats a ½ H.P. motor is used, and in every case it runs on ball bearings, its spindle being vertical. The weight of this size of motor-rudder is only 35lb., and it is claimed that, with 20 storage cells of a suitable size, sufficient power can be obtained to drive a 16ft. sea dinghey with five passengers on board, at five



miles an hour for five hours. The 20-cell storage battery weighs about 180lb. As already mentioned, the apparatus is made in larger sizes, 5 H.P. being the maximum.

THE "BALLOT" SHAFT COUPLING AND PROPELLER.

The accompanying figure illustrates a novel system of shaft coupling, the invention of Mr. John Ballot. The coupling is adapted for fixing in position driving pulleys, flywheels, main shafts, screw propellers, and for many purposes where a coupling is required which is secure in every direction, and at the same time readily attachable and detachable. The shaft has formed upon it at the place where the pulley or flywheel is to be fixed three curved or cam-shaped projections, each of which extends in a helical longitudinal direction partly round the shaft. The one face of each of these projections is formed radial to the centre of the shaft, while the other face is formed with a curvature. The boss of the pulley or flywheel is, on the other hand, formed with three correspondingly shaped grooves or recesses extending in the same helical direction The projections and recesses consequently constitute an infinite series of a peculiar form of full and open screw threads of very steep or quick pitch, so that if the shaft be pushed longitudinally into the boss it will pass in with a screw motion. It will be found, however, that the longitudinal motion can at any point be arrested, if on holding the boss stationary there be applied more or less suddenly to the shaft a force in the circumferential direction, by which the curved surfaces of the projections will be firmly jammed or wedged against the corresponding curved surfaces of the recesses; and the frictional resistance to longitudinal motion produced by such jamming action will, with a sufficiently steep pitch of the screw, be greater than the force tending to produce a longitudinal motion. Thus, assuming the shaft to have been screwed into the boss of the pulley or flywheel until the helical projections of the former are situated entirely within the recesses of the latter, and the one part or the other then have a force applied to it in a circumferential direction so as to produce the before-mentioned jamming action, the pulley will be firmly fixed on the shaft for transmitting power when rotated by the shaft in that direction. If, on the other hand, a force be applied to the one or the other part in the contrary circumferential direction, the jam of the curved surfaces will be released, and as the radial surfaces of projections will then bear against the radial surfaces of the recesses, a screwing action will be produced, causing the pulley to be screwed longitudinally off the shaft. In order to enable the coupling to be employed for the transmission of rotary motion in either direction, longitudinal keyways are formed in the shaft and in the boss in such positions that



when the curved surfaces fit tightly against each other, as described, the grooves will be exactly opposite each other, so that keys can be inserted into them; but these keys will not be subject to the total strain exerted.

CORRESPONDENCE.

THE BRIGHTON BREAKDOWN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On looking through your issue of the 9th, I notice that Mr. Arnold Philip asks whether a pulsating current set up by an earthed armature has ever been actually observed. In one of the London supply stations some few years ago, an intermittent earth occurred on the armature of a direct-driven set, very much to the surprise of the attendant at a railway company's signal box in immediate proximity to the station, by the effect caused to their instruments. On shutting down the plant, the armature was tested, and no fault could be detected, but on revolving the machine an intermittent earth was found which put the armature to earth at every revolution. I know of several instances in direct-driven sets, where on an armature being short-circuited, the other units running in parallel have immediately dropped all their minimum cut-outs, entirely shutting down the station, and the cause was attributed to the dropping of the volts of the running machines and the fields ceasing to excite.—Yours, &c., INTERESTED.

London, Dec. 22, 1898.

Prof. Forbes' Power Transmission Schemes.—Prof. Forbes, writing in the *Journal* of the Society of Arts, gives two corrections to his recent Paper. The one is the fact, recently pointed out in our correspondence columns, that the copper-mortgage scheme was not new; the second is that the negotiations for the concession to utilise the water power of the Victoria Falls and Zambesi river were not dropped, but that a concession was actually granted to the African Concessions Syndicate in 1896.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *December 16, 1898.*

A Large Contract for Railway Equipment.—On December 15 the Third Avenue Railway Co. awarded to the Westinghouse Electric and Manufacturing Co. the contract for the complete steam and electric equipment for its entire street railway system. The Westinghouse Company will construct the steam engines, boilers and entire steam plant, besides the car equipment, the electric generators and all the electrical apparatus required. The total capacity of the station, which is located at 216th Street and Kingsbridge Road, in the upper part of this city, will be 64,000 H.P., and it is expected that the station will be one of the largest and most complete of its kind in the world. The entire equipment, which will be the most modern of all the lines operated by the railway company, will be supplied with power from this one station. Part of the electrical apparatus will be manufactured at the Pittsburg works of the Westinghouse Company and part at the works of the old Walker Company, in Cleveland. The engines will also be built at Pittsburg. It is stated that the new plant will be completed in about one year, and will involve an expenditure of between five and six million dollars. Work on the reconstruction of the roadbed on the Third Avenue line was commenced some weeks ago, and is rapidly being carried forward. It is too early yet to give further details regarding this interesting work. The company will instal 78·66 miles of electric conduit, of which at the present time 28·5 are being operated by cable power and 45·16 by horses. On the main Third Avenue line the present conduit will be utilised. The 125th Street and Tenth Avenue cable line will, however, be entirely reconstructed. The construction adopted for the new work differs radically from anything heretofore installed in America. The chief feature of novelty is in the employment under the track rails of a creosoted yellow pine longitudinal sleeper 5½in. wide and 6in. high laid in 30ft. lengths, the object of which is to secure an easy riding track. The yokes for the new construction are spaced 5ft. apart and are made up of three pieces riveted together, namely, a steel I-beam and two cast-iron side pieces. The yokes rest on a concrete bed 4in. in thickness. The track rail is laid in 60ft. lengths. It is 9in. high, and weighs about 107lb. to the yard. The insulators and conductors will be of the same type as those used by the Metropolitan Street Railway Co. in its conduit construction. The joints will be cast welded, and where the base of each rail rests on the yoke a spring is employed to give easy riding. It is estimated that 3,600 wheels pass over a given spot on this line in 24 hours.

An Electrical Exhibition Next Year.—The Electrical Exhibition Co., under whose auspices the electrical exhibition was held at Madison-square Garden in this city last May, will hold another exhibition at the same place during the same month next year, and all preliminary arrangements therefor have been completed. The show will be held under the auspices of, and in connection with, the twenty-second annual convention of the National Electric Light Association, which will be held in New York during the same month.

Electric Vehicles in a Snowstorm.—The recent severe snowstorm in this city gave the first opportunity for observing the behaviour, under trying climatic conditions, of the electric cabs and broughams now in operation in this city. To the surprise of even some of their most staunch upholders these vehicles gave better service through the trying night of November 26th than did horse-drawn vehicles. The cabs ran through the entire night, the last one coming in about six o'clock in the morning, at which time the snow had reached an average depth of about 8in., and much more where it had drifted. Other cab companies turned over orders to the electric service rather than fill them themselves. No very marked change in their running was noticed, although the mileage per charge of battery was, as a precautionary measure, greatly reduced, the vehicles being ordered in for fresh charges after covering 10 or 12 miles. The ease with which they ran was probably due to the large pneumatic tires, 5in. in diameter, which give a large bearing surface and reduce the tendency to cut deeply into the snow.

The Plans of the New Electric Light and Power Co.—The latest reports concerning the plans of the recently incorporated New York Gas, Electric Light, Heat and Power Co. are to the effect that it is negotiating to acquire the controlling interest in the various electric lighting companies in New York city and the Empire Subway Co., which controls all of the high-tension subways in Manhattan borough. It is stated that the new company, in order to obtain control of the subway company, has acquired an interest in the New York Telephone Co. This interest, it is stated, will enable the new company to use all the high-tension wires in the subways for light, heat and power purposes, the telephone company retaining the control of the low-tension subways for telephone purposes only. There is reason to believe that all of these reports have some foundation in fact, and it would not be surprising to find on January 1st next, all of the electric lighting interests in Manhattan and possibly in the entire city under one management. Everything points that way, and the truth of the above reports has been practically confirmed by those intimately connected with the enterprise.

THE USE OF ELECTRICITY IN THE SPANISH-AMERICAN WAR.*

BY THOS. G. GRIER.

The application of electricity in the army and navy for their various and many purposes is recent, but its progress is rapid. The object of this Paper is more to note the uses than to describe the details. The Fortification Board established ten years ago by the United States Government has developed complete and elaborate plans for the equipment of coast fortifications. In these plans electricity plays a very important part. Submarine mines connected by cable with harbour forts have been planted, electric light and power stations have been installed; search-lights, motors, telephones, telegraph instruments and many other devices have been used in preparing for the defence of our harbours. Range-finders for determining distances were extensively used; these instruments may be dependent upon electricity for their operation, as in the case of the Fiske range-finder, or may be operated mechanically. Just prior to our recent war with Spain 200 Lewis depression range-finders were ordered by the United States Government to equip our various fortifications. While these instruments are operated mechanically their efficiency in action depends upon the application of electricity in communicating the distance observed to the gun captain or commander.

To condense as much as possible, a brief summary of the applications can be given by describing the methods employed at Fort Wadsworth, which lies just below New York City. In this fort the fire commander directs the attack from a sheltered station equipped with a Lewis range-finder. There are also a position-finder station and four battery commander stations. The fire commander is in direct communication with all by means of telephones. In the position-finder's station, together with numerous other instruments, are a dial telegraph, electric clock and telephone. One of the guns is equipped with a dial telegraph, and another with a Sheehy teleotype, an instrument which indicates the azimuth or angle from a predetermined line, and gives the range or distance in yards the observed vessel is from the fort. All of the commanders' stations are, however, connected with the guns both by speaking tubes and telephones. Observations are signalled to the guns, and the course and speed of a ship are plotted upon a miniature representation of the harbour. By means of an electric clock placed at every station absolute uniformity of time is obtained, and the probable course and range of a vessel for several minutes can be plotted from these observations, and without even seeing the vessel the gun can be elevated for the range and trained for the proper angle, and by means of a stop watch the order to fire given so that the shot will fall upon the deck of a vessel whose course has been observed by men at a distance from the guns.

Fort Wadsworth has two 60,000 c.p. searchlights to sweep the harbour and guard against the approach of vessels on dark and stormy nights. An electric light and power plant forms a portion of the outfit, with a reserve storage battery to supplement the power station. The channel above the fort is mined, and should some of the vessels of a hostile fleet pass the guns of the fort the observer at the submarine station would be plotting the course of nearby ships, by means of range-finders or by information furnished him by the fort, and at the proper time fire the mine and sink the

* Abstract of a Paper read before the Chicago Electrical Association.

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remnant of the fleet. The mining of the harbours was an important part of our coast defences, and the greatest demand for electrical wires and cables was for "torpedo cables" for use in submarine mines. It seems that our coast defence department has for years requested that an appropriation be made for cable, but the appropriations have been so cut down that not more than 5 per cent. of the amount needed was carried on hand by the Government. When war was declared, each of the manufacturers of submarine cable in this country received orders for all they could make in thirty days, and some were kept busy for 60 days, producing, probably, 200 miles of multiple cable and 200 miles of the single conductor. This has been distributed from the Bay of Fundy to Florida. Some was sent to the gulf cities, and some to California, Oregon and Washington. One hundred and fifty miles of each size was under contract in the early part of August.

There are three different kinds of mines used in our harbour defence:—(1) Observation mines, which are fired from shore when a ship is judged, by observation, to be within effective range of the explosive; (2) Automatic mines, which are self-firing on being struck by a vessel; (3) Electrical contact mines, which, on being struck by a ship, give notice on shore, and the operator, by the throw of a switch, fires the mines. The methods of firing observation mines and electrical contact mines are similar. Automatic mines may or may not be fired by electrical means. Mines may be placed upon the bottom of the harbour, and in such cases are called ground mines, and if they are contact mines the contact mechanism is contained in small buoys anchored at a depth below low-water mark just sufficient for them to be an obstruction in the path of vessels. When the channel is deep, buoyant or floating mines are used. A buoyant mine is more effective, as it lies nearer the object of attack, and for an equal effect does not require as large a charge of explosive.

Mines in Boston Harbour.—The shape and material of mines or mine cases are various, and the kinds employed at different points not always identical. However, a general description of the mines employed in Boston harbour will give a good idea of the plan and design used in all other harbours. There were about 1,000 mines planted in Boston harbour, covering the main ship channel and ingress to the harbour where vessels of over 12ft. draft could go at low water. The regular Government mine consists of an upright iron case about the shape of a top, with a strap on the bottom for holding the cable. Galvanised steel rope secured by an anchorage of any kind, in many cases of old horse-car rails, maintained the mines in position. The cable containing the electric wires runs up separately from the cable holding down the mines.

As the demand was urgent and no mines of the Government pattern were to be had, the engineers in Boston used new ale barrels, a hole being bored in one end for the receipt of the contact mechanism and cable. The barrels were encircled with rope to make a sling to hold them down, a flat steel ring being put around the rope so the steel anchor cable attached to it would not cut through. These mines were of different sizes and held from 100lb. to 500lb. of explosive gelatin. Ordinary dynamite was used in some mines where there was not enough gelatin to be obtained. This was put in through a small hole in the top where the electric contact mechanism is placed. The contact mechanism is connected through high resistance and by a battery circuit, using the cable and ground return for its conductors to an indicating and circuit closing device located in the protected casement on shore. When a ship strikes a mine containing the device, deflecting the mine from its normal position, the battery circuit is closed; this operates an indicating mechanism which closes a break in the dynamo circuit and notifies the operator. To throw on the current for exploding a mine it is necessary to throw in a switch or plug after the first break is closed by the indicating device. This circuit can be closed without any contact from the vessel at the will of the officer in the casement.

The firing switchboards at Boston contained an ordinary knife switch suitable for 500 volts, with springs which hold them open at all times except when held closed by the operator. These switches, one for each group of mines, were mounted on slate boards and plainly numbered with large letters. A dynamo developing one ampere at 500 volts, driven by an oil engine, furnished the exploding current. All of the parts of the contact mechanism were of platinum or gold-plated brass to prevent any possibility of corrosion. The exploder consisted of a thin strip of platinum wire which was laid in a case of fulminate, which in turn was put in a case of dry gun-cotton; the remainder of the explosive was wet.

The mines were usually placed in groups of seven each, about 150ft. apart. These groups of mines in Boston harbour were strung clear across the channel, and in the main there were three lines. In this method, should a vessel be sunk by the first line of mines and the wreck not obstruct the passage for other vessels, the second line of mines would catch the next vessel and the third line the third vessel. Between the mines were small casks with contact devices connected to mines on either side. These were cheaper than mines, but were equally serviceable and made the line complete, so that no vessel could get through.

Our army in the field has its cable tents completely equipped with telephones and telegraph instruments. The telephone at Santiago and adjacent points before and after the siege was of great service, and cable tents now have their names lengthened into the title of cable and telephone tents. The special cable, used in the signal service by General Greely, is very light and very strong, weighs about 60lb. to the mile, and is furnished on reels in half-mile lengths—a two-conductor concentric cable. This outpost cable, as it is called, is carried by a scout on a reel fastened to his back like a knapsack. He carries a telephone, and one end of the cable being connected at headquarters enables him to communicate in whispers to his commander. An attendant accompanies the scout with extra reels, which are easily attached when the wire on the first reel has reached its limit. Telephones, in fact, are used everywhere—in forts, in camps, in the field, and on boardvessels.

Among the most recent applications of electricity that found a place in the army and navy was the "X-ray" apparatus. It was used in the field, in the hospitals, and on the hospital ships.

Aboard modern men-of-war the electric light is found to be absolutely necessary for the efficiency of the ship. Searchlights are used to observe the movements of other vessels to find buoys or landmarks on entering shallow channels, to pick up disabled boats or men overboard, to make landings, and for signalling. The incandescent lamps illuminate the entire ship, dispensing with oil lamps and candles; they are also used for night signalling. Electric motors are used in hoisting boats and ammunition, for removing ashes, for steering, for training gun turrets and many other purposes. Steam whistles are opened and closed by electrically-operated valves. The range for guns and the speed and direction of revolving shafts are indicated by the electric current, and guns are fired by an electric spark. Telephones and electric signalling devices aboard ship are extensively used.

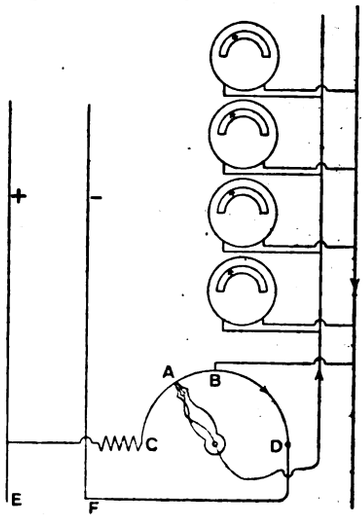

FIG. 1.—Principle of Helm Indicator.

This, in brief, covers the application of electricity ashore and afloat in the recent Spanish-American war. A description of the principles governing some of the signalling devices on board ship will materially assist in showing to what a great extent modern vessels depend upon electricity. The signalling and indicating devices used on vessels are: "helm indicators," "steering telegraphers," "speed indicator," "direction indicator," "range indicating system," "Fiske range finder," "azimuth telegraph" and "transmitter of orders." All of the devices consist of galvanometers, which indicate on their dials a difference of pressure, the dials being marked for the different offices the instruments perform, and with each instrument or system of instruments proper devices are used for altering resistances and consequently-changing pressures to accomplish the ends in view. A description of the principle applied to the helm indicator will explain the operation in general of all the others.

The object of the helm indicator is to indicate, at different parts of the ship, the position of the helm. The principle of operation is shown in Fig. 1. Attached to the helm and insulated from it is a metallic contact, A, which presses continually on an arc of resistance wire, C D. At the centre of this resistance wire is a permanent contact, B, which is connected by a wire to one side of a number of galvanometers located at various stations. E and F are the positive and negative wires of the electric lighting system. A dead resistance is inserted in the circuit connected with the arc of resistance wire C D, which reduces the current to about two

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amperes. As the pointer A is moved toward the left, or toward C, the difference of pressure between A and B becomes greater and the flow of current through the galvanometer is greater. The galvanometers are adjusted so that they take the same angle as the helm, or pointer A. In Fig. 1, when the pointer is on the left of B, its pressure, as compared with B, is positive. When B and A are both in the centre, or when the pointer A coincides with the fixed point of contact B, then the needles of the galvanometers come to rest at zero or the centre of the scale. When A is moved toward the right, or toward D, then the conditions are reversed, A becomes negative compared with B, and the current flows in the opposite direction of the galvanometer, bringing the needle toward the right. One of the instruments can be on the bridge, one in the captain's cabin, one in the wheelhouse and one in the conning tower.

The steering telegraph is the same arrangement of galvanometers, with a device for altering the resistance by hand. The captain sets the resistance from his station, having an instrument before him. The same indication appears upon an instrument in the wheelhouse, and by noting the helm indicator the captain is advised when his order is obeyed. The same thing is true of the engine telegraph, the transmitter for orders and the azimuth telegraph.

In the Fiske range finder, the general principle is the measurement of the resistance of a conductor in the form of a Wheatstone bridge, there being two arcs of wire at the ends of a base line, corresponding to two contiguous members of the bridge. Two telescopes are located at the ends of the base line and carry contacts which move over the resistance wire as the telescopes are turned to be pointed upon any object. In Fig. 2 let the arms *a b* of a Wheat-

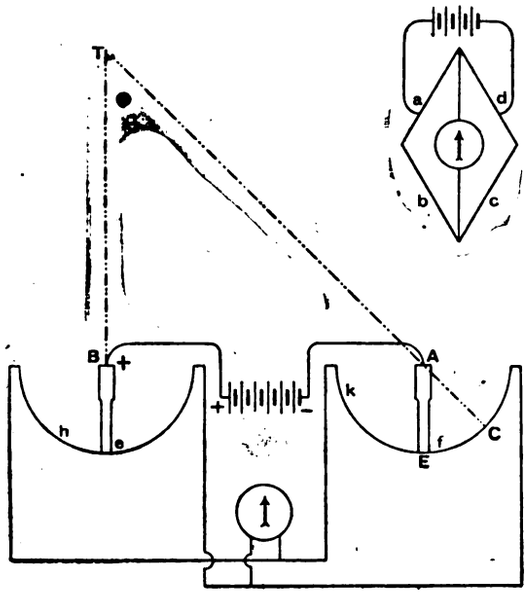

FIG. 2.—Principle of the Fiske Range Finder.

stone bridge be represented by arc *h*, while *c* and *d* are bent into arc *k*, both of these arcs being wires of conducting material. Let contacts *f* and *e* be attached to telescopes pivoted at A and B. When the telescopes are parallel, and when at right angles to the base line, the galvanometer will not deflect, and its point of rest is marked infinity. Now, let the telescopes converge and the angle of convergence is A T B, and presuming the telescope at B is pointing at right angles to the base line, the angle of convergence is measured by the arc C E. The bridge is out of balance—that is, the needle deflects, and the amount which it is out of balance will vary with the difference of position of the telescopes. The angles of convergence are not indicated upon the galvanometer or reading instrument, but the deflection of the needle is marked in yards.

The speed indicator is, in reality, a small alternating current dynamo, the current being great or small according to the speed of the shaft, and the strength of the current indicating upon an alternating-current galvanometer graduated in revolutions per minute. Six soft iron cores or inductors fastened to an iron ring on the shaft form the armature. These are rotated, the pole of a north and south magnet having two coils of wire at its extremities, the coils of wire being connected in series with the galvanometer.

The direction indicator simply tells in which direction the shaft is turning. A permanent magnet fastened to a ring on the shaft revolves in front of a soft iron bar, around which is a coil of wire that is connected to a galvanometer. The shaft revolving in one direction throws the pointer to one side, and when its direction is reversed throws it to the other side.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London :—

NOW READY.

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. The Author hopes that, besides Telegraph and Telephone Engineers, it may, perhaps, also prove of service to those in charge of cables for the transmission of light and power. The localisation of faults has been very fully investigated, including the different degrees in which the various methods are affected by the presence of a second fault or of general leakage.—*Extract from Preface.* Demy 8vo, fully illustrated. 10s. 6d., post free; abroad 11s.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition now ready.*

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"ELECTRIC MOTIVE POWER," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 280 illustrations. Price 10s. 6d., post free; abroad, 11s.

"WIRELESS TELEGRAPHY: SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES."—By Dr. O. J. Lodge, with many original illustrations. *Enlarged Edition*, 2s. 6d. net, 2s. 9d. post free.

"LABORATORY NOTES AND FORMS."—With the above title we have ready the New Edition of a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated. price 1s. 6d.; post free, 1s. 9d.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. Prospectus on application.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. A fine large paper edition with wide margins for notes can also be supplied. Price 12s. 6d.; post free, 13s.; abroad, 13s. 6d. *New Edition in the press.*

"THE ALTERNATE CURRENT TRANSFORMER," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *New Edition.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s.

"The Electrician" Electrical Trades' Directory and Handbook.—An important announcement in connection with the 1899 issue of the "Big Blue Book" will be found in an advertisement on another page of the present issue, to which our readers will please refer.

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TENDERS INVITED.

The *Glasgow* Corporation invite tenders for providing and erecting generating plant at one or other of their new electricity works, including two 200 I.H.P., two 400 I.H.P., three 1,100 I.H.P. and two 2,200 I.H.P. engines, with dynamos and condensing plant. Copies of specification, &c., may be obtained from the city electrical engineer (Mr. W. A. Chamen), 75, Waterloo-street, and tenders must be lodged with the town clerk (Sir J. D. Marwick), City Chambers, Glasgow, by *Saturday, Jan. 21.* Some additional particulars are given in an advertisement.

As announced elsewhere, the *London* County Council invite tenders for the manufacture, delivery and erection complete of four continuous-current dynamos, one motor generator, two switchboards with switches, measuring instruments and other work required for the proposed Victoria Embankment electric generating station. Tenderers may, on and after Jan. 4, inspect the drawings and obtain specifications, &c., at the engineer's department, County Hall, Spring-gardens, S.W. Tenders, addressed to the clerk of the council (Mr. C. J. Stewart), must be sent to the County Hall, by 10 a.m., Jan. 31.

The *London* County Council also require tenders for the erection of four gas engines at the proposed Victoria Embankment electric generating station. Specifications, &c., from the engineer's department, Spring-gardens, S.W., and tenders to the clerk by 10 a.m., Jan. 31.

The Committee of Visitors of the *Cumberland* and *Westmoreland* Asylum invite tenders for the supply and erection of an electric tell-tale clock, with 30 stations. Tenders to the Committee, Garlands Asylum, Carlisle, not later than 2nd Jan.

The Corporation of *Burnley* invite tenders for the supply and delivery of underground cables. Tenders to Town Hall, Burnley, by Jan. 10.

The *Edinburgh* City Council require tenders for the supply of switchboards and boosters for their Macdonald-road electricity station. Tenders to Mr. Thomas Hunter, W.S., City Chambers, Edinburgh, by *Jan. 9, and not Jan. 2* as previously announced.

The Commissioners of the Burgh of *Stirling* invite tenders for the following :—(1) Lancashire boilers, with mechanical stokers ; (2) engines, dynamos, pumps, steam pipes, &c., Green's economiser and tools ; (3) storage batteries ; (4) switchboard and boosters ; and (5) arc lamps. Tenders to Mr. Thomas L. Galbraith by Jan. 2.

The *Barrow-in-Furness* Corporation require tenders for wiring the Free Library. Tenders to the Town Hall by noon of Jan. 20.

The Gas committee of the borough of *Rochdale* require tenders for the erection of electricity station buildings. Tenders to town clerk by Jan. 17.

The Municipality of *Merbes le Chateau*, Belgium, require tenders for the electric lighting of the streets. Particulars from le Bourgmestre.

The *Roumanian* Post and Telegraph authorities require tenders for the supply of 10,000 large, 15,000 medium, and 2,000 small porcelain insulators. Tenders by Jan. 16.

The *Shanghai* Council invite tenders for a concession, for a period of thirty years, for the exclusive right of establishing and working a telephone system in Shanghai. Particulars of Messrs. J. Pook and Co., 8, Jeffrey's-square, London, E.C. Tenders to Mr. J. O. P. Bland, Shanghai, by noon of March 31.

The *Shanghai* Council also invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system. Particulars from Messrs. John Pook and Co., 8, Jeffrey's-square, London, E.C. Tenders to Mr. J. O. P. Bland by noon of March 15, 1899.

TENDERS RECEIVED AND ACCEPTED.

The *London* School Board have received the following tenders for the supply of electrical plant to the training ship "Shaftesbury" :—

Generating Plant.

Electrical and General Engineering Co. (*recommended for acceptance*)	£785 0
Laing, Wharton and Down	1,080 0
Spagnoletti and Crookes	1,023 16
L. G. Tate	990 10
Wenham and Waters	980 10
Joel and Potter (United)	970 0
Woods and Co.	959 10
Drake and Gorham	933 10
Westminster Engineering Co.	880 0
Foote and Milne	871 0

Storage Battery.

Pritchetts and Gold (*recommended for acceptance*)	£152 2
Chloride Electrical Storage Syndicate	242 10
D.P. Battery Co.	222 0
Tudor Accumulator Co.	215 0
E.P.S. Co.	178 19

Pritchetts and Gold tendered for the annual maintenance at £13, the E.P.S. Co. at £35. 7s., the Chloride Syndicate at £20, and the Tudor Company at £18.

The *Great Northern Railway Co. of Ireland* have accepted the tender of Messrs. Victor Coates and Co. for the electric lighting of the station and offices at Amiens-street, Dublin. Messrs. Dobson and Curtis (Limited) also tendered.

All the tenders received by the *Braila* Municipal Council for the erection of electricity works in the town were from German firms.

APPOINTMENTS VACANT AND FILLED.

The London County Asylum, Bexley (Kent), require a working foreman engineer to take charge, under the asylum's engineer, of the engineering appliances, including heating, electric light, laundry and cooking. Salary £12. 10s. per month, and quarters. Forms of application from clerk to Asylums Committee (Mr. R. W. Partridge), 21, Whitehall Place, London, S.W., and must be in by Wednesday, Jan. 11.

The Urban District Council of St. Anne's-on-the-Sea, Lancs., invite applications for the appointment of electrical engineer to design and superintend the erection of an electricity supply station and the laying of mains, and to afterwards take charge. Commencing salary £170 a year, advancing to £200 and beyond, proportionally to the success of the undertaking. Applications to Mr. Thomas Bradley, clerk to the Council, by 5 p.m. of Jan. 2nd. See also an advertisement elsewhere.

The Corporation of Eccles require a switchboard attendant. Commencing salary £62 per annum. For further particulars see advertisement elsewhere. Applications to town clerk (Mr. George William Bailey), Town Hall, Eccles, by Tuesday, Jan. 3.

The St. Pancras (London) Guardians require an engineer with knowledge of electricity. Salary 50s. per week. Applications to Clerk, Vestry Hall, Pancras-road, N.W., by Jan. 2.

Mr. J. R. Blaikie has been appointed resident electrical engineer at the electricity works of the Newington (London) Vestry. Mr. Blaikie, who was selected out of 77 candidates, has for some time past been chief assistant at the Bristol Municipal electricity works.

BUSINESS NOTICE.

Mr. W. C. C. Hawtayne has removed to 9, Queen Street-place, London, E.C. The telegraphic address, "Hawtayne, London," and the telephone number, "5288 Bank," will remain the same as previously.

BANKRUPTCIES, LIQUIDATIONS, &c.

The meeting of the creditors of Lionel Riley, trading as L. V. Riley and Co., engineers and electricians, at various addresses in London, was held at the Guildhall Tavern, London, E.C., on Wednesday. The debtor estimated the net trade value of his stock at £135. 17s. 10d., and book debts reckoned as good at £175. 5s. 2d. The list of creditors are almost exclusively associated with the engineering trades, and the amounts are not very large. The debtor made an offer of 10s. in the £, to be paid in sums of 3s. in March, 3s. in June, and 4s. in September, the security for the payment being his own promissory note. A discussion ensued mainly upon the value of the guarantee, and dissatisfaction was expressed at the length of time asked for by the debtor, who subsequently agreed to reduce the period to six months. The meeting was adjourned to Jan. 4 to enable debtor to procure some more definite guarantee for the payment of the proposed composition. The failure is attributed to loss in equipping and opening works at Holloway, and "to a wrong system of pricing out prime costs, &c."

Creditors of the United Ordnance and Engineering Co. (Limited) must send particulars of their claims to the liquidator (Mr. W. E. Davies), Broad Sanctuary Chambers, Westminster, S.W., by Feb. 3.

The creditors of Thomas King, engineer, St. Peter-street, Maidstone, Kent, include :—

A. C. Hands	£174	Young and Marten	£19
Kemster and Co.	86	W. H. Willcox and Co.	18
Electrical Co.	85	Edison-Swan Co.	17
E. P. S. Co.	61	Woodall and Son	17
Robertsons and Co.	47	Fletcher, Russell and Co.	17
G. Farmiloe and Sons	40	J. Yates	16
Barry, Henry and Co.	36	Lambeth Brass and Iron Co.	15
Veritys (Limited)	32	National Telephone Co.	15
General Electric Co.	27	W. B. Haigh and Co.	15
J. Goldsmith	25	J. Smith and Sons	14
J. Miller and Co.	23	Siemens Bros. and Co.	13
Foster Bros.	22	Evered and Co.	12
Indiarubber Co.	21	Lumby, Son and Wood	11
Fieldings (Limited)	20	G. Braulik	10
J. B. Garnham	19	T. P. Cook and Co.	10
Hodges and Todd	19	John Russell and Co.	10
International Electric Co.	19	J. Hayward and Co.	10

The total liabilities are £2,497. 19s. 6d. (unsecured £2,103. 13s. 5d.), assets £1,109. 11s. 11d.

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It has been resolved to wind up the Midland Motor Carriage Syndicate (Limited) voluntarily, and Mr. W. T. Smedley, 7, Newhall-street, Birmingham, has been appointed liquidator.

The application for the discharge in bankruptcy of W. R. Smith, electrical engineer, St. Andries, Hitherfield-road, Streatham, London, S.W., willbe heard on Jan. 16, at Wandsworth.

A first meeting of creditors of J. E. Liardet, engineer, 16, Hyde Park-gate, London, W., will take place on Jan. 6, and the public examination on Feb. 10, at Bankruptcy Buildings, London, W.C.

It has been resolved to wind up the B. C. Electric Syndicate (Limited) voluntarily, and to appoint Mr. A. E. M. Davis liquidator. Claims must be sent in to Mr. Davis, 1 and 2, Great Winchester-street, London, E.C., by Jan, 23.

Fixtures and Glassware Catalogue.—The ninth edition (1898-99) of the electrical fixtures and glasswork catalogue of the General Electric Company is to hand, and forms pages 551 to 838

FIG. 1.

of the company's main catalogue. From this mass of nearly 300 large quarto pages of text and illustrations it is difficult to select any particular items for special mention. The simple arrangement of the catalogue enables intending buyers to see at a glance what the company has to offer in each section of the book, and as the

FIG. 2.

illustrations are in the main direct photographs from the manufactured articles, and where this is not the case are guaranteed to be drawn direct from the originals. The General Electric Co. may be congratulated upon having done all that is possible to save the time of the contractor and to minimise the labour of their own supply departments. In Fig. 1 is shown a new arc lamp cradle and carrier made of wrought iron with copper cap to take a 14in. globe and to fit a 4in. spigot. This fitting is designed for the tops of lamp columns. Fig. 2 is a strong, well-made, watertight fitting suitable for street lighting, made up with a cast iron top, white enamelled inside, and a 15in. enamelled iron reflector. This fitting will carry one 100 c.p. or a group of three to five lamps and is constructed for a ½in. iron barrel. These are but two out of hundreds of illustrations in the catalogue, but we have said sufficient to induce those of our readers engaged in contracting work to obtain a copy of the catalogue. This is certainly one of the most complete and useful compendiums of electric light fittings and accessories ever offered to the trade. The General Electric Co. may be congratulated upon having brought their list up to a very high degree of excellence and completeness. We are promised shortly the full catalogue of the company's goods, of which the list under review forms an important part.

Telephone Apparatus.—Mr. G. A. Nussbaum has sent us his catalogue of the telephones and accessories made by the Société Industrielle des Téléphones, of which company he is sole agent in this country. One product of the Société's workshops is well known and very largely used in this country, viz., the Ader receiver. The catalogue is well illustrated, and a large number of instruments are described and priced. Among others we may mention a practical double head-gear receiver, which might be appreciated by electrophone users, and a neat military telephone set, which appears to supply all that is needed for military purposes in a very small compass.

Lead Seals.—Messrs. Marshall and Co. have sent us a price list and sample card of lead seals. These seals may be found useful for sealing standard electrical instruments, meters, and by electrical inspectors generally.

Seasonable Presents.—At a season of the year when gifts are especially the order of the day we make no apology for suggesting that few presents are more welcome than a good fountain pen; for, whether it be used for private or business purposes, it is one of the most convenient of pocket companions either a busy or an idle man can possess. Speaking of fountain pens brings us naturally to the firm which stands *par excellence* as pioneers of this class of trade, Messrs. Mabie, Todd and Bard, of 93, Cheapside, E.C., and 95, Regent-street, W., London, and Manchester, who have forwarded their latest list of "Swan" pens, specially designed for New Year's gifts. The Swan fountain pen is not only an ornamental present, but a very useful one, and as this make of a popular article is designed to meet the requirements of everyday use, it is safe from the annoyances of many so-called fountain pens. The fact that this particular type of pen is not made in low-priced qualities, and is yet the pen in most general use, is, to a considerable extent, a safeguard to users that they will, in buying a Swan pen, obtain a serviceable and reliable article. We can say from experience that the Swan pen is a useful travelling companion, and one which we should find some difficulty in replacing. It certainly forms a most acceptable present, and, as such, we commend it to those in doubt or difficulty as to what to buy. It can be sent to any destination by registered letter post.

Calendars, &c.—We have received for another year the pocket diary sent out by the Brush Company.

The Eastern and Eastern Extension Telegraph Companies have forwarded the usual handy paper-knife calendar and map of cable routes, which forms a highly useful adjunct to the desk and office.

We have to acknowledge the receipt of the much appreciated large-size blotting-pad and diary from the Electrical Power Storage Co. In addition to particulars of the E. P. S. accumulators, postal and other useful information is given.

There are to hand from the Accident Insurance Co. a hanging calendar, with monthly tear-off sheets and a small pocket calendar.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Dec. 21 to Dec. 28, with the ports of destination:—

Argentina—Buenos Ayres, £2,059. *Australasia*—Adelaide, £500; Melbourne, £2,393; Sydney, £1,120. *Belgium*—Ostend, £7. *Canary Islands*—Las Palmas, £31. *Ceylon*—Colombo, £60. *China*—Shanghai, £145 (telegraph cable). *East Africa*—Mombasa, £23. *Egypt*—Alexandria, £86; Port Said, £30. *France*—Boulogne, £21; Marseilles, £18. *Germany*—Hamburg, £110. *Holland*—Amsterdam, £40; Flushing, £85. *Hong Kong*, £175. *India*—Bombay, £13; Calcutta, £384; Madras, £27. *Japan*—Nagasaki, £453; Yokohama, £813. *Malta*—£657. *Russia*—Libau, £100; Reval, £212 (telegraph material); St. Petersburg, £30. *South Africa*—Algoa Bay, £234; Cape Town, £289; Durban, £199; East London, £311; Port Elizabeth, £496. *Straits Settlements*—Penang, £107; Singapore, £61. *Sweden*—Gothenburg, £33. Total, £11,322 (for eight days) against £6,917 for three days last year (Dec. 22 to Dec. 24).

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MUNICIPAL, FOREIGN AND GENERAL NOTES.

Asylum Lighting.—Messrs. Wallis-Jones and Dent have been appointed consulting engineers for the electric lighting, &c., of the Newport and Monmouthshire County Hospital.

Barmouth.—The Urban District Council have assented to the application of Mr. D. Davies for a provisional order for the town.

Birmingham.—The Corporation propose to introduce electric light into the Council House, at an estimated cost of about £2,000. The present gas fittings and pendants are to be adapted.

Buenos Aires.—The Municipality has sanctioned the transfer of the undertaking of the Metropolitan Tramway Co. to the German Electrical Company, which will equip the tram lines on the overhead trolley system. The City of Buenos Aires Electric Light and Power Co. has obtained the contract for supplying current to the Belgrano Electric Tramway Co. and the Anglo-Argentine Tramway Co. The lines of the latter company are to be converted to the overhead trolley system.

Croydon.—From March 25 the Town Council have decided to adopt the maximum demand system of charging for current, the first hour charge being 6d.

Dewsbury.—The Town Council have decided to construct electric tramways in this town at an estimated cost of £19,750. The scheme has been prepared by the electrical engineer (Mr. O. M. Jonas)

Electric Power Schemes.—The local authorities of the towns in Lancashire and Cheshire affected by the proposed schemes for the supply of electricity "in bulk" are already organising opposition to the bills to be presented to Parliament in the ensuing session. A meeting has been called for Jan. 10 by the Lord Mayor of Manchester to decide upon a course of action.

Electrical Progress in Brazil.—According to the recent report of a travelling representative of the Philadelphia Commercial Museum "the electrical goods trade of Brazil is growing by leaps and bounds," as a few years ago electric lighting, traction, power, &c., were unknown. Now nearly every place within 300 miles of the coast is either lighted electrically or the subject is under consideration. Many of the mining companies and mills in the interior have light and power plants in operation, several of the large plants having been shipped by British firms. Imports of electrical plant and apparatus are large and constantly growing, and the supplies are controlled almost exclusively by English and Belgian firms, but American houses execute a fair share of the orders for electrical machinery. Arc and incandescent lamps, fittings, carbons, cables, electric bells, batteries, &c., are in demand in the districts along the line of the Central Railroad, between Rio and Sao Paulo and Rio and Bello Horizonte. This latter city is the new capital of the State of Minas Geraes, and is a growing city of nearly 30,000 inhabitants. The towns of Sabara, Sete Lagoas, Curvello, Caethe, Ouro Preto, La Fayette, and about 10 other small towns are lighted electrically. The report states that: "At Juiz de Fora there is an electrical plant installed, and an agency in that town for sundries would do well in supplying not only Juiz de Fora and the adjoining town of Marianna Procopio, but also the towns on the lines of the west of the Minas and Leopoldina Railroads. Along the line from Rio to Sao Paulo are also many towns in which it might be advantageous to have agents. A competent salesman, familiar with the Portuguese language, travelling through this section, could do wonders in the way of securing orders and appointing responsible agents. This may also be said of nearly all the interior cities, as attention, so far, has seemingly been paid only to the large cities on the coast, and even there not to the extent the trade possibilities deserve."

Epsom.—Electricity supply works are to be erected by the District Council, and tenders are to be invited for supply of plant.

Glasgow.—The Tramways committee, on Wednesday, adopted the recommendation of its sub-committee that the present tramway system should be converted to the overhead trolley system as soon as possible. The entire conversion is planned to be completed by 1901.

Govan.—Owing to the National Telephone Co. having made arrangements with the Town Council for placing its wires underground, the company proposes to open a telephone exchange on the twin-wire system within the Burgh in connection with the company's Glasgow system.

Huddersfield.—There are at present 781 customers of the electricity department, and the equivalent number of 8 c.p. lamps connected is 52,784. The increase in the electrical undertaking has resulted in a rise in the assessment from £750 in 1894 to £1,800.

Kingston-on-Thames.—The General Purposes committee of the Town Council are considering the proposals of the Drake and Gorham Electric Power and Traction Syndicate to construct electric tramways in the district on the overhead trolley system. A company, with a capital of £100,000, would be formed to carry out the work, and electric current would be taken from the Corporation electricity works.

London Underground Electric Railways.—The following bills relating to London underground electric railways have been deposited at the Private Bill Office:—

Great Northern and Strand Railway Bill to incorporate a company to construct an underground railway from Wood Green to the Strand. The line to be worked by electricity or other motive power not being steam. The proposed capital is £2,400,000, in £10 shares, with borrowing powers up to £800,000. The promoters include the Right Hon. W. L. Jackson, Sir Andrew Fairburn, Mr. L. C. Probyn and Sir Henry Oakley, who are named as first Directors.

The North-West London Railway Bill to incorporate a company to construct an underground railway from the Marble Arch to Cricklewood, to be worked by electric power. The proposed capital is £1,750,000 and borrowing powers. The first Directors include Sir Robert Head, the Hon. C. M. Knatchbull-Hugessen, Mr. N. S. Russell and Mr. J. S. Brookfield.

The Central London Railway Bill seeks an extension of time for the completion of that railway.

Newcastle (New South Wales).—The Municipal Council received six tenders for the erection of electricity supply works, the tenderers being Messrs. Edge and Edge; Gibson, Battle and Co.; R. Thompson; Morrison and Cearby; Rodgers Bros., and the Brush Company. Mr. R. Thompson offered to erect the building and supply the necessary plant and apparatus for an aggregate sum of £8,499. 16s. The tenders are at present under the consideration of the consulting engineer (Mr. Norman Selfe).

St. Olave's (London).—The District Board of Works have authorised the London Electric Supply Corporation to lay distributing mains in Stoney-lane and low-tension distributing mains in Duke-street and Tooley-street.

St. Pancras (London).—The Workhouse Infirmary, Dartmouth Park, is to be lighted electrically.

S. A. R. Telegraphs.—The total receipts from the telegraph and telephone services for nine months to Sept. 30 last have been £69,546, against £71,319 for the same period of 1897. The telegraph service shows a decrease of £3,918, and the telephone service an increase of £2,145. 20,085 cablegrams, value £50,473, were sent, against 23,300, value £55,934, in 1897.

Southampton.—Major P. Cardew held an inquiry last week into the circumstances connected with the fatal accident to Walter Day, an electrical jointer in the employment of Messrs. W. T. Glover and Co., who was killed on the 12th inst. while engaged in jointing a cable. After the town clerk had narrated the facts of the case Mr. J. Brooking, electrical engineer and manager for Messrs. Glover and Co. in Southampton, gave evidence and stated that they had been working day and night to get the mains ready. Since the accident the joints had been taped over. He had traced back the cable to what he imagined to be the low-tension pipe. The two pipes, high and low tension, were nearly alike, and there was no external mark to tell which was the high-tension pipe. Had he known the leakage was in the high tension cable he would not have allowed Day to repair it without first having the current switched off. He did not remember having made temporary joints on a high tension cable before. He mentioned to Mr. Shepherd (clerk of the works) that he did not like putting in a temporary joint, but, on being pressed, he thought it better to do so. He was aware of the Board of Trade regulations, and did not think that they were strictly adhered to in this case. It was possible to make a temporary joint as safe as a permanent one, but only by using extra thicknesses. He had the joints made, as he thought, very safe, and had extra material, although not so much as he thought. Mr. John Shepherd (clerk of the works for the laying of the mains) stated that when he was told of the leakage he was apprehensive of danger. He had seen the joints made, and was satisfied with them. Mr. F. H. Chaplin, borough electrical engineer, believed that an undertaking had been given to supply current to several consumers on the 7th inst. Owing to this need temporary joints were made in that particular box and two others. There was a current of above 2,000 volts going through the high-tension cable on the day of the accident. He held the opinion that the reason of the joint being forced against the brickwork was owing to the vibration from the railway tunnel underneath. The current was complete as far as it went, and he tested the high-tension cable with a current of 2,300 volts. He thought that when the box was complete the joints would be secure. Mr. E. Manville, consulting engineer to the Corporation, said, in reply to a question from the inspector, that the work was very much behindhand, and the Corporation had pressed the contractors to complete it, and no doubt it was due to the non-completion of the work that the temporary joints were made. Although they were temporary joints, they ought to have been fit for the work they were to do. He maintained that if they had had proper metallic shielding an accident of that sort could not have resulted. Major Cardew will present his report in due course.

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West Ham.—The applications for electric current have been so promising that the Town Council have decided, on the recommendation of the borough electrical engineer (Mr. J. J. Steinitz), to put down two additional 800 kilowatt steam alternators, and to carry out other extensions of the electricity works, which will increase the capacity of the station to the equivalent of 80,000 8 c.p. lamps connected. The total estimated cost of the extension is £47,600, for which borrowing powers are to be sought from the Local Government Board.

Weston-super-Mare.—At a special meeting of the District Council on Wednesday the agreement for the transfer of the Weston-super-Mare provisional order to the Electrical Power Distribution Co. was approved.

Wrexham.—There is, after all a probability that the scheme for the construction of electric tramways in this town will receive the sanction of the Town Council, as the General Purposes committee have withdrawn their report recommending the Council to oppose the scheme, the Chairman of the committee intimating at the same time that some of the members had altered their minds on the subject. The Lighting committee are collecting information as to the desirability of establishing electricity works.

COMPANIES' MEETINGS AND REPORTS.

Smithfield Markets Electric Supply Co. (Limited).

The first ordinary general meeting of this Company was held on the 23rd inst., under the presidency of Mr. J. BROWNE MARTIN.

The SECRETARY (Mr. G. M. Powell) read the notice calling the meeting.

The CHAIRMAN, in moving the adoption of the report, said it would be known to the majority present that about a year ago their Company purchased the undertaking called the Smithfield Electric Construction Co. When they came into possession they found that the machinery and other appliances connected with it had had a good deal of wear, and had not been kept up to date. They therefore at once proceeded to set matters straight, and employed the services of an eminent engineer, Mr. Cooper. Acting upon that gentleman's advice they overhauled all the machinery and, where necessary, supplemented it with other machinery, and also decided to put in accumulators which would effect a saving of about £500 a year. Nearly every shop in the new fish market had now been connected, and they had received instructions from the Corporation for the lighting of the old fish market, which would be re-opened as a meat market early next year. This would considerably increase the output of their Company. He might mention that when they first took over the business an arrangement was in existence to supply electricity on what was termed the "lump sum" system—that was, that any customer who was willing to pay a certain "lump sum" per annum had electricity supplied to him, whether a large or small quantity, for that sum. He thought it would appeal to everyone that in such circumstances as these there would not be the care and supervision in using electricity which consumers would exercise when they had to pay by meter. The Directors, therefore, decided that they must in future supply in the ordinary way, by meter. In making a change there was always a great deal of criticism, and, with all their care, attention and courtesy they lost a very large number of customers at the outset, but those who left them had not only returned but in several cases had induced others, who were not on previously, to take current. The shareholders were aware that the Directors had applied for several Provisional Orders, and he felt there was no doubt that they stood a very fair chance of getting one or more of them. He thought it must appeal to the citizens of London that if there was to be a second company introduced into the City, their Company should get the preference over any other. They were the only company, excepting the City of London Electric Co., which held any Provisional Order from the City. He thought it right to inform them that they were also applying to the Holborn and St. Luke's districts, which were both exceedingly valuable electric lighting areas. His colleague and himself were very confident that their company would ultimately be of very much larger dimensions than it was now. They were neither of them new to the electric lighting industry, and the companies which he was connected with, which began in a very small way, were now very large and paying well. The Directors would like to tell them a good deal more but in the interests of the Company it was not advisable "to give the show away." He concluded by moving the adoption of the report and accounts.

Mr. ERNEST SCHENK seconded the motion.

The CHAIRMAN, in answer to a question, stated that they had a very much larger plant than was required for present purposes, and they were quite able to supply a largely increased quantity of current without any additional capital.

Mr. EDENSOR asked whether it would be possible to give the shareholders some information how a prospective profit of £3,750 had been turned into a loss of about £700.

The CHAIRMAN stated that it was not a loss of £700.

Mr. EDENSOR said that after paying the debenture interest there was a loss, if not of £700, yet of several hundred pounds.

The CHAIRMAN said that this was all explained by what he had referred to—the change in the system of charges. They were obliged to make this alteration, or they would simply have dwindled on without making any way. He saw no reason why their Company should work on any different lines to those of other companies. They were supplying current at, he believed, less than any other company, but they could see that even at this price they could make an ample profit.

Mr. EDENSOR said he thought the explanation was satisfactory, but he considered it rather misleading to mention an estimated profit of £3,750 without first finding out whether the machinery was antiquated and a proper one to work with.

The CHAIRMAN said that he had not stated that the system was antiquated; he had meant to say that it was in bad order.

Mr. EDENSOR asked whether this could not have been found out first.

The CHAIRMAN replied that if machinery was kept bright and clean it was very difficult to find out until it was worked for some time whether it had been properly used or not. The Directors took all the precautions possible to find out these things; they took the best expert opinion they could get, but until they had positively worked the machinery, they could not find out that a great many of the bearings and other things required alteration. It was only through the efforts of Mr. Cooper (the consulting engineer) that they ultimately located the defects. In working machinery, particularly like theirs, there was very great wear and tear unless everything was true, and they found that it was of no use to patch things.

Mr. V. B. D. COOPER stated that the defects in the machinery to which the Chairman had referred were chiefly that the arrangements of the plant were not such as suited the particular load and the particular hours during which their load was employed; they were not so much inherent defects in the machinery itself. If they had had a more continuous load than they found they had the machinery would have been much more adapted to it. The changes made would be productive of economy and be more suited to the work they had to do. The storage battery about to be erected would be far more economical. Another alteration they had made had reference particularly to the distribution of the load, and would also be more economical.

Mr. EDENSOR said it seemed to him that the Directors had been misled, and that they had made statements in the prospectus leading those who read it to believe that they were getting a good working concern giving a certain amount of profit. The explanation just made had, however, proved to him that the thing was not in a condition in which it ought to have been brought before the public. He also wished to know how many shops were now connected.

The CHAIRMAN replied that he would rather not answer the question.

Mr. EDENSOR said that he saw no harm in the information being given. The prospectus stated that 175 shops were connected at that time.

Mr. COOPER pointed out, with reference to the last speaker's remark, that his (Mr. Cooper's) explanation had led him to suppose that the Directors were misled, that the change in their load was due to the policy which was considered necessary of insisting on supplying every customer at a remunerative price. If the load had remained the same as it was when they took the concern over the machinery would have been just the thing for it; but when they found that it was desirable to discontinue supplying those people who were using the light by contract, and in a very wasteful manner, it was necessary to make the changes he had alluded to.

Mr. WHITEHEAD inquired whether the Directors maintained their belief in the fairness of Messrs. Fuller, Horsey and Co.'s valuation of £86,566 for the going concern turned over to this Company. He also wished to know what portion of the £86,000 odd was goodwill, and whether the Directors would in future balance-sheets show this item separately. Their Company had only 15 years' concession, at the end of which he believed the Corporation had the right to take over the plant. Anything in the shape of goodwill they had paid for would then become valueless; and it seemed to him, therefore, that they ought to write off a large portion of this goodwill, or at the end of the concession their £5 shares might be worth only £2.10s. He noticed in the prospectus that there were two estimates of the cost of current, one being 3½d. and the other 3⅜d. He wished to know whether they were working at this cost. Was the sum to be received from the cold air store company likely to reach £2,500, as stated in the prospectus? Did the £5,788 which they received by the sale of current for the year ended September 30th last include the value of the current supplied to the cold air store company? Was the cold air store company a public or private one?

Mr. PROUD said that he was induced to subscribe to the company on the faith of the statements in the prospectus. If he were not mistaken, he believed the prospectus contained a statement that the Company made a large profit from supplying electricity by contract, and that that profit would enable them to pay a dividend of something over 4 per cent. He wanted to know who was responsible for issuing a misleading prospectus, as he regarded it, which led him to become a shareholder in a company whose shares he could scarcely sell. He maintained that the promoter of the company, and those who supported him, should be made to disgorge.

Mr. SCHENK (a Director) said the Chairman had asked him to reply. The Chairman had asked that the question as to the number of shops connected might not be pressed. They had nothing to be afraid of, and personally he would not mind publishing the fact. The shareholders would be glad to hear that they had substantially more customers on now than on the day the prospectus was published. As the result of the changes they had found it necessary to make, they had lost a large number of customers, and they ran the station for at least six months at a loss and they had to do so. As a result, however, of having faced the difficulty they were now running at a substantial profit. One shareholder had stated quite erroneously—no doubt, he was mistaken—that a statement was made in the prospectus that they were making a large profit by the sale of electricity by contract. No such statement, however, was made in

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the prospectus. He thought that they had had to pay for mismanagement in the past; they received no complaints now. They never said in the prospectus—for which as Directors they were responsible, as they had to sign it—that they were making a profit on contracts. They stated in the prospectus that on the basis of contract sales for the previous nine months, they were selling at that time (the time the prospectus was published) something like 800,000 units a year, and they estimated a reduction down to 600,000 units a year as the result of adopting the meter system. He would not mention exactly the number of units sold in the year, but it was less than that. He might, however, say that the figures for the present quarter showed that the estimate of 600,000 units a year on which the 4½ per cent. was based was almost precisely borne out. He had not anticipated anything in the nature of a strike among their consumers, who were only asked to pay the Company what they were now paying, which they were satisfied to pay, and what was actually the lowest price charged by any other electric lighting company in London. It was only by comparison with their previously absurdly low rate that the altered price looked high. As to the question whether the estimate of the cost of production given in the prospectus had been borne out, he ought first to explain that they had two or three conditions to deal with in making up their accounts which no other company in London was affected by. In the first place they had to make a present to the Corporation of 50,000 units a year for lighting the avenues of the market.

A SHAREHOLDER: That is not stated in the prospectus.

Mr. SCHENK, continuing, said that he did not think that it was material; they could quite well afford to do it, but it was a point to be borne in mind in making up the price of the unit. The Company also maintained the customers' installations free. The total cost per unit supplied for the whole of the twelve months to September, 1898, was 3·37d., of which market maintenance, &c., would account for the ·37d. It therefore came out that their total cost for the last twelve months had been 3d. per unit. The cost in the case of the Notting Hill Co. (and figures were not particularly interesting unless they were comparative)—whose output might reasonably be compared to their own, and whose shares stood at a very good premium—was for that year 3·12d. In the present quarter—the December quarter—when they were themselves making up for lost ground, he was able to inform them that their cost of production—making allowance for the lamps and the maintenance of the market—was positively less than that of any other company in London, and was less, of course, than the estimate given in the prospectus. He said this with the more satisfaction in view of the remark of one of the shareholders who had wanted to sell his shares. If they could only produce their electricity at less than any other company in London there could not be very much mismanagement. The Directors had been asked whether they maintained their belief in Messrs. Fuller, Horsey and Co.'s valuation of £86,000 odd, and how much of it was goodwill. Now that they had had twelve months' experience he had greater confidence than when he signed the prospectus that the property was worth the £86,000 odd as a going concern.

Mr. EDENSOR said he thought that this statement was quite satisfactory.

Mr. SCHENK, in further reply, stated that their revenue did not include anything from the cold store excepting £575, which they received for the first instalment of one quarter of that year; there was nothing to pay for the previous nine months. At the present time he thought that the Cold Storage Co. might be described as private; but in due course he thought it would be public; but the people behind it were sufficiently well known and substantial for this Company's purposes. He had no hesitation in saying that they would be able to pay a dividend on the ordinary shares next year; he believed that they would be able to do so out of their ordinary business alone, but they had certain developments on hand. If they got the Provisional Orders to which reference had been made, they would require to raise a large sum of money, and he might state that whatever price their shares might stand at the whole of the money they required would be forthcoming.

The motion was carried, and a vote of thanks to the Chairman and Directors terminated the meeting.

Automatic Telephone Co. (Limited).

The annual general meeting of this Company was held on Friday last. Mr. MAX MARGOWSKI presided.

At the outset Mr. J. D. GIBBS stated that it was incumbent upon him to make some explanation with regard to the action that he took against some of his co-Directors. Owing to the fact that certain sums were due to the consulting engineer, Mr. Gustave Selegmann-Lui, for salary and for patents, he thought there ought to be sufficient money in the coffers of the Company to meet such demands. However, the money was not there, because the signatories to the memorandum and articles of association considered they were not bound to pay up the 3s. a share which other shareholders had paid. The speaker joined Mr. Alexander in commencing proceedings to ascertain whether signatories were not bound to pay the 3s., which would put the Company into a position enabling them to discharge all their liabilities. The proceedings had not yet led to any result. He was unwilling to say anything which would cause bitterness amongst the shareholders towards the Directors.

Mr. ALEXANDER (another Director) also spoke, emphasising the statement that when the books were laid open to their inspection they found that the signatories' shares were not paid.

The CHAIRMAN, in a long speech, which was frequently interrupted, observed that the new Company had been formed, not for the purpose of watering the capital or increasing the number of shareholders, but with the object of securing the services of Mr. Seligmann-Lui. An agreement was arrived at, under which it was stipulated that no public issue should be made, but that all the subscriptions should come from the shareholders, and unless £10,000 was subscribed Mr. Seligmann-Lui would not join the Company. However, he (the Chairman) secured this gentleman's services. He was sorry to say that the shareholders subscribed to the amount of only 9,000 shares at 5s. each. Furthermore, the Company had a liability of £2,000. In order to carry the scheme through, he, as Managing Director, became responsible for no less than 34,900 shares. Out of the £10,000 he became responsible for £8,000. He had subscribed to the Syndicate 98 per cent. of the working capital and now he held 80 per cent. in the new company. Having become responsible for so large an amount, he had a clause inserted in the articles that not more than 1s. a share should be called up. In these circumstances he had found it necessary to form a "pool." He then went on to refer to the friction on the Board, and finally moved the adoption of the report.

For something like an hour there was a scene of the wildest disorder, shareholders putting to the Chairman innumerable questions. Amid the disorder it was impossible to follow the speakers.

Eventually an amendment for the adjournment of the meeting to February 1st next was carried by an overwhelming majority.

The CHAIRMAN demanded a poll, and with much vehemence expressed his intention of proceeding with the meeting.

Shareholders contended that no poll on a mere adjournment could be taken, and the great body of the proprietors then left the room.

NEW COMPANIES, STATUTORY RETURNS, &c.

A.B.C. ELECTRIC ARC LAMP AND INCANDESCENT MANTLE CO. (LIMITED).—This company was registered on Dec. 19, with a capital of £60,000, in £1 shares, to enter into an agreement with F. Fanta for the acquisition of certain patents and patent rights relating to improvements in electrical apparatus, and to develop and turn to account same, manufacturers of and dealers in electrical apparatus of every description, and also as engineers, machinists, motor-car builders, &c.

ABERDEEN ELECTRICAL CO. (LIMITED).—This company was registered in Edinburgh on Dec. 21 with a capital of £10,000, in £1 shares, to acquire, take over as a going concern, and carry on the business of an electrical engineer now carried on by Richard G. Botting. The first subscribers are: J. Edwards, G. England, G. Rainst, J. McBain, W. Ironside, Alex. Ledingham and R. G. Botting (engineer). The first Directors are: J. Edwards, G. England, W. Ironside and Alex. Ledingham.

BUCK AND CO. (LIMITED).—This company was registered on Dec. 20 with a capital of £2,000, in £1 shares (of which 1,000 are £5 per cent. Cumulative Preference), to carry on the business of electricians, electrical, mechanical and metallurgical engineers, suppliers of electricity, founders and smiths, cycle and motor-car builders and designers, electro-platers, &c. The first subscribers, with one share each, are: H. T. Underwood, J. H. Bailey, W. R. Whitehead, W. G. Brown, Mrs. C. J. Buck, E. A. Hill (electrical engineer), and Albert G. R. Buck (electrical engineer). The first Directors are: H. T. Underwood and Albert G. R. Buck.

HART ACCUMULATOR CO. (LIMITED).—This company was registered on Dec. 23 with a capital of £40,000, in £1 shares, to acquire and take over the business now carried on by the Hart Secondary Battery Syndicate (Limited), to enter into an agreement with the Hart Secondary Battery Syndicate (Limited), S. W. Hart and E. J. Clark, and to carry on the business of electricians, electrical and mechanical engineers, and the general business of an electric lighting, heating and power company. The first subscribers are: Samuel W. Hart, G. A. Bacon, J. G. Abraham, G. B. Kidd, L. W. Spratt, G. Hay and E. H. White.

KIDDERMINSTER AND DISTRICT ELECTRIC LIGHTING AND TRACTION CO. (LIMITED).—This company has been registered with a capital of £100,000, in £10 shares (5,000 Preference) to carry on the business of electrical engineers and contractors, electricians, suppliers of electricity, manufacturers of electrical apparatus, mechanical and chemical engineers, tramway and light railway proprietors, carriers of passengers and goods, &c., and to generate, produce, and supply electric light, heat, &c. The subscribers are:—Emile Garcke, George Stevens, Charles H. Dade, Charles H. Gadsby, W. Howard Smith (engineer), C. Walmsley, and Henry M. Sayers (engineer).

PEARSON FIRE ALARM SYSTEM (LIMITED).—This company has been registered with a capital of £150,000, in £1 shares, to acquire the benefit of three inventions, known respectively as the Pearson Automatic Fire Indicator, the Pearson Automatic Box Telegraph Fire Alarm Apparatus and the Pearson Automatic Railway Signal, and to carry on business as manufacturers of fire inductors, fire extinguishers, fire engines, &c. The first directors are Hon. L. Holland, H. Gamman and R. Pearson.

ALLIANCE ELECTRICAL CO. (LIMITED).—The statutory return, to Oct. 27, has been filed. The capital is £1,000, in £1 shares, of which seven have been taken up and paid for in full.

CRYSTAL ELECTRIC LAMP AND ROSE AND BIRD (LIMITED).—The statutory return, to Nov. 24, has been filed. The capital is £50,000, in £1 shares (of which 10,000 are Preference). 39,750 Ordinary and 6,000 Preference have been taken up, and 39,743 of the former and 1,000 of the latter have been issued as fully paid. The full amount has been called on the remainder.

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CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Oct. 13, 1898). Price of silver 27⅞d. per oz. (Dec. 23). Consols (2¾ per cent.) 110⅛—110⅝ for money, 110⅝—110¾ for account; 2½ per cent. 104—104¼ (Dec. 22). Stock Exchange Settling Days: Stocks and Shares Continuation Day, Jan. 11; Ticket Day, Jan. 12; Pay Day, Jan. 13; Mining Share Carry-over Day, Jan. 10.

AMAZON TELEGRAPH CO. (LIMITED).—The coupons due 31st inst. of the £122,400 Five per Cent. Debentures will be paid by Messrs. Barclay and Co., 54, Lombard-street, E.C.

CAPE ELECTRIC TRAMWAYS (LIMITED).—An interim dividend of 3 per cent., free of income-tax, has been declared payable to all shareholders on the register on the 31st inst., and to holders of Coupon No. 3 attached to share warrants to bearer. The transfer register will be closed from the 2nd to the 7th Jan. inclusive.

DOUGLAS SOUTHERN ELECTRIC TRAMWAYS (LIMITED).—The annual meeting of this company was held on Tuesday. The Chairman (Mr. J. T. Hutchinson) moved the adoption of the report, which stated that during the last season of 132 days, 40,963 miles were run, 94,173 passengers were carried, and the total receipts were £4,135. 15s. 2d., from which £689. 5s. 10d. was paid to the Marine Drive for tolls. The whole of the promotion expenses (£600) had been written off, and £300 had been paid to the Douglas Head Marine Drive Co. as damages for failure to complete the line in 1896. £302 odd had been spent on the permanent way. These three extraordinary items reduced the profit on the year to £90. 13s. 2d., which brought the balance in hand up to £350. 19s. 7d. Although no dividend could be recommended on the subscribed capital of £41,045, the Directors hoped that, with a fine season, next year would be a profitable one.

ELECTRIC CONSTRUCTION CO. (LIMITED).—The holders of this company's Six per Cent. Second Mortgage Debentures agreed on the 21st inst. to accept an offer to pay off the debentures on Jan. 1.

KELVINSIDE ELECTRICITY CO. (LIMITED).—The ordinary general meeting of this company was held at Glasgow on Wednesday. The Chairman (Mr. J. Reid) moved the adoption of the report, and said the past year had been one of increased activity, and the Directors were glad to be able to report that the district of Kelvinside which their order covered had awakened to the desirability of having the electric light introduced. The number of consumers had increased 45 per cent., and, though the full benefit had not yet been felt of those lately added to the number, the revenue of the company would soon feel the addition. Last year they were supplying a considerable amount of electricity for power and heat, the contract for which terminated last year, and that circumstance made the increase in consumption rather less than might have been expected. The works costs continued to show the same very low proportion. The Directors were glad to be able to say that the company had now turned the corner. A small profit on the year's working was shown by the accounts, and they felt confident this would be largely increased as the company proceeded. In the report reference was made to the question of their negotiations with the Glasgow Corporation for the sale of the undertaking, and the shareholders could rely upon the Directors carefully safeguarding their interests. In the event of negotiations not coming to a satisfactory conclusion, they could confidently look forward to the undertaking being a highly remunerative one. Lord Kelvin said he had a strong feeling that they had a valuable property in the generating station and the underground conductors, and there was reason to expect that with the great increase of population in the district, and the number of new houses of the best class that were being erected, in respect to the consumption of electricity for light, the future of the company would be very good, and that although up till now profits had not been earned, they had every prospect of a large dividend-paying business. He had visited the station, and anyone could see that there was space for a great deal more machinery, and for doing more remunerative work than was being done. They had a slight balance this year on the right side, and he believed the state of things would be different in the course of a few years. And he for one would prefer to wait five or 10 years, or whatever time was necessary, for the full development of the profit-earning capacity of the company, to parting with it unless on terms of a throughly satisfactory character. They had underground wires with capacity for double or treble the present amount of dividend-paying work. The increased expenditure required for engines and dynamos was considerable, but the prospect of remunerative business for the outlay was exceedingly good. They had here, if they were to begin afresh just now with their provisional order, a central station building, and they had only to put in some more machinery, and to make arrangements for increasing the voltage of the supply to 200, to make it an exceedingly good property, not to be lightly parted with. The report was then adopted. The engineer (Mr. Munro) made a statement as to the position of the company, in course of which he said that the total number of lamps now connected to the station was 13,000, as compared with 9,000 last year. It was impossible to absolutely forecast variations of demand, but if the sales increased in proportion to lamps connected, the revenue next year ought to be at least a third more than that of the present year.

JUNGFRAUBAHN GESELLSCHAFT.—This company has been formed in Bern, with a capital of 4,000,000fr. (£160,000), and takes over the Jungfrau electric railway from the concessionaire, Herr Guyer-Zeller. The new company has also borrowing powers to the extent of 4,000,000fr.

MEXICO ELECTRIC TRAMWAYS (LIMITED).—Coupons (No. 1) of the Five per Cent. Debentures are payable at the offices on and after Jan. 2.

NEW ITALIAN ELECTRICAL COMPANY.—The business of the Tecnomasi Italiano, Ing. B. Cabella and Co., has been converted into a limited liability company, with a capital of about £80,000.

SIEMENS AND HALSKE ACTIEN-GESELLSCHAFT.—The Directors of this company have declared a dividend of 10 per cent. for the year ended July 31, 1898.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
*Birmingham Tramways.	Dec. 24	4,145	+ 969	...	...	...
Blackpool Corporation...	„ 22	120	+ 26	38	16,183	+ 2,397
Blackpool and Fleetwood Co.	„ 24	132	...	24	14,258	...
*Bristol Trams & Carriage	„ 23	2,730	+ 3	25	74,488	+ 8,403
City & South London Ry.	„ 25	1,134	+ 79	26	25,968	+ 851
Dover Corporation	„ 24	146	+ 59	38	7,004	...
Dublin United (Southern)	„ 23	664	+ 264	51	22,933	+ 7,546
Liverpool Overhead Rly.	„ 25	1,439	+ 98	26	39,818	+ 3,257
*Sheffield Tramways.....	„ 25	1,312	+ 237	51	52,724	+ 2,749
*South Staffs. Trams.....	„ 23	635	− 29	51	32,188	+ 17

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Dec. 21.		Price Wednesday, Dec. 28.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Week Ending Dec. 28. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.					£ s. d.			
6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	11	11½	11	11½	—	—	—	—
6,000	10	6/3.5/16	Do. 4½ per Cent. Cumulative Pref.	10⅝	11¼	10⅝	11¼	4 4 0	—	..	..
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp. ..	11½	12⅛	11⅛	12⅛	2 16 0	February & August	..	..
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6¼	6	6½	3 9 3	" "	—	—
£34,000	5	2/6	Chelsea Electricity Supply Ordinary	9	10	9	10	3 0 0	March	9½	..
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	113	115	113	115	3 18 3	June and December	—	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red)	103	105	103	105	4 15 3	..	..	..
50,000	10	5/0	City of London Elec. Lighting Ord. 40,001 to 90,000	22	24	22	24	5 4 2	February & August	23½	22¾
10,000	10	1/9	Do. Ordinary 90,001 to 100,000	21	23	21	23	..	..	22¾	..
40,000	10	6%	Do. 6% Cumulative Pref.	15½	16½	15½	16½	3 11 9	January and July ..	15½	..
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	127	132	127	131	3 16 1	June and December	..	..
30,000	10	..	County of London & Brush Prov. Ord. (fully paid)	12½	18½	12½	13½	—	—	..	—
10,000	10	..	Do. (£8 paid)	10	11	10	11	..	—	—	—
20,000	10	6/0	Do. 6% Cumulative Preference	14½	15½	14½	15½	4 0 0	March & September	—	—
15,660	5	2/6	House-to-House Electric Lighting Supply Ord.	9	10	9	10	2 0 0	..	..	—
12,000	5	3/6	Do. 7 per Cent. Preference	9½	10½	9½	10½	3 6 8	March & September	9 1/16	—
15,000	5	10%	Kensington and Knightsbridge Ord.	13	14	13	14	3 18 7	..	..	—
10,000	5	6%	Do. 6% 1st Pref.	7½	8½	7½	8½	3 12 9	January and July ..	..	—
110,000	3	—	London Electric Supply Ordinary	3	3½	3	3½	—	—	—	—
48,050	5	—	Do. Preference	6	6½	6	6½	—	—	6 1/16	6 1/16
62,400	10	5/0	Metropolitan Electric Supply Ordinary	17½	18½	17½	18½	3 4 10	April and October ..	17⅛	17⅛
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	121	117	121	3 14 9	June and December	..	—
6,452	10	6/0	Notting Hill Electric Ordinary	17	18	17	18	3 6 8	March	—	—
275,000	1	—	Rand Electric	¾	1½	¾	1½	—	—	—	—
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb	88	93	88	93	5 8 1	—	—	—
150,000	$100	$2	Royal Electric Company of Montreal Shares ...	150	155	150	155	5 3 3	—	—	—
130,900	100	4½%	* Do. 4½% 1st Mort. Debs.	104	106	105	107	4 5 10	April and October ..	—	—
31,980	5	5/0	St. James and Pall Mall Electric Ordinary	16	17	16	17	4 14 2	February & August	16¼	..
20,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	" "	..	—
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.)	105	108	105	108	3 15 6	June and December	..	—
65,000	5	..	South London Electric Supply Ordinary (£3 paid).	2¾	3	2¾	3	..	..	—	—
79,900	5	5/0	Westminster Electric Supply Ordinary	15½	16½	15½	16½	3 18 9	March & September	—	—
18,848	5	5%	Yorkshire House-to-House	7½	8	7½	8	3 2 6	February and July ..	—	—
18,626	5	5%	Do. (£4 paid)	5½	6¼	5½	6¼	3 18 5	February and July ..	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Dec. 21.		Price Wednesday, Dec. 28.		Rate per Cent. Yielded.	Dividend Due:	Business Done During Week Ending Dec. 28.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS								
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	101	105	101	105	3 17 0	January and July	..	..
25,000	10	..	Amazon Telegraph	3	4	3	4	..	..	..	..
£125,000	100	5%	Do. 5 per Cent. Debentures	92	95	92	95	5 5 3	..	..	..
£905,560	Stock	15/0	Anglo-American	64	67	65	67	4 10 5	Feb., May, Aug., Nov.	..	..
£3,047,220	Stock	30/0	Do. Preferred	115	116	116	117	5 3 8	.. ..	116½	115
£3,047,220	Stock	5/0	Do. Deferred	16	16½	16¾	17¼	..	..	17 7/16	16 7/16
120,000	10	5/0	Brazilian Submarine	15½	15¾	15½	15¾	4 15 3	Mar., June, Oct., Dec.	15⅝	..
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	111	115	111	115	4 8 0	June and December	..	..
10,000,000	$100	$12½	Commercial Cable Capital Stock	180	190	180	190	4 4 3	Jan., Apr., July, Oct.	..	..
£1,332,523	Stock	4%	* Do. 4 per Cent. Debenture Stock	104	106	104	106	3 15 6	.. ..	105½	..
16,000	10	8/0	Cuba Submarine Ordinary (Deferred)	10	11	10	11	6 7 3	February and August	10 1/16	..
6,000	10	10/0	Do. Preference 10 per Cent.	16½	17½	16½	17½	5 14 3	.. ..	..	..
12,981	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October	..	..
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	.. ..	..	..
£80,000	50	4½%	Do. 4½ per Cent. Debentures	105⅞	108⅞	105⅞	108⅞	4 5 0	January and July	..	..
60,710	20	3/0	Direct United States Cable	11½	12	11¾	12¼	5 6 1	Jan., Apr., July, Oct.	..	..
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	103	106	103	106	4 6 8	.. ..	..	..
£4,000,000	Stock	..	Eastern Ordinary	173	178	173	178	3 19 0	Jan., Apr., July, Oct.	176½	174
£1,295,000	Stock	17/8	Do. 8½ per Cent. Pref. Stock	104	107	104	107	3 5 5	.. ..	105¼	104½
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	124	128	124	123	3 2 6	May and November	124	..
£89,900	100	5%	* Do. 5 per Cent. Debentures, 1899	101	104	101	104	4 17 0	February & August	..	..
£500,000	Stock	8/9	Do. Provisional Certificates 50% paid	54	57	54	57	..	..	..	..
250,000	10	2/6	Eastern Extension	17½	18	17½	18	3 17 9	Jan., Apr., July, Oct.	17 15/16	17 7/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	129	125	129	3 2 4	February & August	..	..
£16,200	100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900 (reg.)	101	105	101	105	4 17 1	January and July	..	..
£64,400	100	5%	Do. (Bearer)	102	105	102	105	4 17 1	.. ..	..	..
£35,100	100	5%	*Eastern and S. African 5 p. c. Mor. Deb., 1900 (reg.)	101	105	101	105	4 17 1	.. ..	..	..
£46,500	100	5%	Do. (Bearer)	102	105	102	105	4 17 1	.. ..	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	104	107	104	107	3 15 8	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	104⅞	107⅞	104⅞	107⅞	3 15 2	May and November	..	..
180,227	10	1/9	Globe Telegraph and Trust	12½	12¾	12½	12¾	4 0 9	Jan., Apr., July, Oct.	12⅝	12 5/16
180,042	10	6%	Do. 6 per Cent. Preference	16¾	17½	16¾	17½	3 9 7	.. ..	16¾	16½
150,000	10	5/0	Great Northern of Copenhagen	28½	29½	28½	29½	3 7 10	January, April, July	..	..
£150,000	100	5%	* Do. 5 per Cent. Debs., 1883 Issue Series "B"	100	103	100	103	4 17 10	March & September	..	..
£97,800	100	4½%	Halifax and Bermuda Cable 4½% 1st Mort. Deb. (red)	101	104	101	104	4 7 0	June and December	..	..
17,000	25	12/6	Indo-European	55	58	55	58	4 6 2	May and November	..	..
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	109	112	109	112	5 7 7	March & September	..	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red)	105	108	105	108	3 14 3	June and December	..	..
11,889	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October	..	..
3,881	£100 Cert.	6%	Submarine Cables Trust	134	139	134	139	4 6 9	.. ..	..	..
15,609	10	..	West African Telegraph	..	..	..	..	..	..	..	..
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	101	103	100	103	4 18 6	March & September	..	..
30,008	2½	..	West Coast of America	½	¾	½	1	..	..	..	..
£150,000	100	4%	* Do. 4 per Cent. Debentures	103	106	103	106	3 16 6	June and December	..	..
88,321	10	1/8	West India and Panama	1⅝	1¾	2	2½	..	May and November	2½	1⅝
34,563	10	6/0	Do. 6 per Cent. 1st Preference	10	10½	10½	10¾	5 11 7	.. ..	10¾	10½
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	8½	9⅛	8½	9⅛	6 6 4	.. ..	9⅜	..
£80,000	100	5%	* Do. 5 per Cent. Debentures	106	109	106	109	4 12 10	January and July	..	..
64,289	15	5/0	Western and Brazilian Ordinary	12½	12¾	12½	12¾	4 13 2	May and November	..	..
33,129	7½	3/9	Do. 5 per Cent. Preferred Ordinary	8	8¼	8	8¼	4 8 2	.. ..	..	..
33,129	7½	1/3	Do. Deferred Ordinary	4	4¼	4	4¼	..	..	..	..
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	107	110	107	110	3 13 1	June and December	..	..
1,168,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	..	..	..	..	6 7 10	Feb., May, Aug., Nov.	..	..
£158,100	100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	98	103	98	103	5 16 6	March & September	101½	..
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	2¾	3¼	2¾	3¼	6 3 1	August	..	..
224,850	10/0	1½d.	Consolidated Telephone Const. & Manufacturing	1/16	1/16	1/16	1/16	6 7 0	July	..	..
28,000	5	4/0	Monte Video Telephone 6 per Cent. Preference	..	..	..	..	7 5 6	October	..	..
484,527	5	3/0	National	5¼	5¾	5¼	5¾	5 4 4	February & August	5¾	..
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	12	14	13	15	4 0 0	.. ..	..	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	12	14	13	15	4 0 0	.. ..	..	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	5¼	5¾	5⅝	5⅞	4 8 11	.. ..	..	..
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	100	103	100	103	3 6 8	June and December	..	..
171,504	1	0/4	Oriental	⅞	1	⅞	1	6 13 4	April and October	..	..
58,000	5	6/0	United River Plate	4½	4¾	4½	4¾	6 6 5	July	..	..
£151,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	104	107	104	107	4 15 5	June and December	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	2	1/2½	Brush Electrical Engineering	1⅝	1⅞	1⅝	1⅞	3 4 0	..	1¾	..
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2½	2⅝	2½	2⅝	5 1 1	..	..	..
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	111	115	111	115	3 19 0	February & August	..	..
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	104	106	102	105	4 7 0	June and December	1 1/16	..
£20,000	5	5/0	Callender's Cable Construction	9¼	10¼	9¼	10¼	6 8 7	.. ..	..	..
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	111	114	112	115	3 19 10	November and May	..	..
300,000	1	9⅛	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	..	..	..
50,000	1	..	Chadburn's Ship Telegraph Ordinary	1⅛	1⅜	1⅛	1⅜	..	..	..	..
50,000	1	7½	Do. 6 per Cent. Cumulative Pref.	1	1⅛	1	1⅛	4 16 0	..	1⅛	..
32,098	3	..	Crompton and Co. (Nos. 1 to 32,098)	1⅞	2⅛	1⅞	2⅛	..	..	..	..
£52,850	100	5%	* Do. 5% First Mort. Deb. (red.)	91	96	91	96	5 5 10	January and July	..	..
99,261	5	2/1½	Edison and Swan United ("A" Shares) (£3 paid)	2	2½	2½	2¾	6 1 9	February & August	..	..
17,189	5	3/1½	Do. (£5 paid)	4	5	4	5	6 0 0	.. ..	..	..
£194,023	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	97	99	97	99	4 0 10	June and December	..	..
17,400	5	5%	Edmundson's Electric Corporation Ord (fully paid)	5	5½	5	5½	4 10 11	Half-yearly	..	..
110,000	2	1/2½	Electric Construction Co. (Limited)	2½	2¾	2½	2¾	4 12 0	February & August	2 5/16	..
25 000	2	2/9½	Do. 7 per Cent. Cumulative Pref.	2¾	3¼	2¾	3¼	4 6 2	August	..	..
£111,100	Stock	4%	Do. 4% First Mortgage Deb. (red.)	105	107	105	107	3 16 2	..	..	..
91,196	1	..	Elmore's Patent Copper Depositing	¼	½	¼	½	..	..	..	..
12,500	10	8/0	Henley's Telegraph Works Ordinary	20½	21½	22	23	5 13 1	February & August	22½	22⅜
3,000	10	7/0	Do. 7 per Cent. Preference	18	19	18	19	3 13 8	.. ..	..	..
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 3	.. ..	..	..
60,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	4 8 11	.. ..	..	..
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	102	106	102	106	3 15 6	March & September	102½	..
37,350	12	12/0	Telegraph Construction and Maintenance	37	41	37	41	4 6 2	March and July	40	39
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	104	107	104	107	4 14 9	January and July	..	..
£°0,000	5	4/0	Willans and Robinson Ordinary	7⅜	8¼	7⅜	8¼	4 17 0	April and October	..	..
£30,000	5	3/0	Do. 6% Cumulative Preference	6⅜	7¼	6⅜	7¼	4 2 9	.. ..	..	..
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	106	108	105	108	3 18 8	May and November	105¾	..
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	..	Blackpool and Fleetwood Tramways	19	21	19	21	..	..	..	..
25,000	10	6%	Bristol Tramways and Carriage xd	21½	22	119	121	3 6 1	..	..	..
25,000	10	6%	Do. (£7. 1s. paid)	18⅜	18¾	1⅛	18¾	1 14 1	..	..	..
£90,410	Stock	4%	Do. 4% Debenture	121	123	121	123	3 5 1	..	..	..
80,000	10	..	British Electric Traction Ordinary	15½	16½	15½	16½	..	..	..	..
10,000	10	2/4 1/16	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm.pd.)	13	13½	13	13½	4 8 11	..	..	..
£35,250	10	3/0	Central London Ordinary	9½	10½	9½	10½	2 18 6	June and December	10⅛	..
178,303	10	1/9⅜	Do. (£6 paid)	5½	6½	5½	6½	2 16 6	.. ..	..	..
£630,000	Stock	2½%	City and South London Railway Con. Ordy.	65	68	65	68	2 19 4	January and July	67½	..
22,500	10	..	Do. Ordinary (£4 paid)	3½	4	3½	4	..	..	..	..
9,251	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	3 4 6	January and July	..	..
£187,701	Stock	4%	Do. 4% Perpetual Debenture	134	138	133	135	2 19 7	May and November	..	..
20,000	10	6%	Imperial Tramways Ordinary (old £6 shares) xd	17	17½	116	117	3 16 11	March & September	..	..
10,000	10	6%	Do. 6% Preference	15½	16⅛	15½	15½	3 17 5	.. ..	..	..
£70,000	Stock	4½%	Do. 4½% Debenture	117	118	117	118	3 16 3	.. ..	..	..
37,500	10	3%	Liverpool Overhead Railway Ordinary	10 7/16	10⅝	10	10½	3 4 2	February & August	..	..
10,000	10	5%	Do. 5% Preference	14½	15½	14½	15½	3 5 7	.. ..	..	..
125 000	Stock	4%	Do. 4% Debenture	108	110	108	110	3 13 1	January and July	..	..
20,000	5	3/3½	New General Traction 6% Cumulative Pref	4⅜	5½	4⅜	5½	..	..	..	..
£540,000	Stock	3%	Waterloo and City Ordinary	111	114	111	114	2 13 4	June and December	..	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

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CONTENTS OF THE CURRENT NUMBER.

NOTES	351	1898	370
Meetings of Scientific Societies	354	Electricity Supply Works Costs in 1898 and 1897	372
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe	355	Lamp Connection Diagrams. Illustrated	379
Salisbury Electric Supply Works. Illustrated	356	Electric Lighting Notices for 1899 Session	382
Eccles Electric Supply Works. Illustrated	359	Patents Expiring in 1898	383
The Water-Power Installation at Paderno. By G. Semenza. Illustrated. Continued	361	New Electrical Joint Stock Companies for 1898	384
Waterloo and City Railway Power Station. Illustrated	365	Public Companies Wound Up, Dissolved, &c., in 1898	384
Improvements in Magnetic Space Telegraphy. By Dr. O. Lodge, F.R.S. Illus. Continued	366	Correspondence	385
Electricity Works Accounts	368	Trade Notes and Notices	385
		Companies' Meetings & Reports	392
		New Companies, &c.	392
		City Notes	392
		Companies' Share List	394

NOTES.

OUR issue this week, being the first in the year, contains the usual mass of statistical and other information relating to electric supply undertakings. We may first refer to the annual large sheet supplement Table of Electricity Supply Works of the United Kingdom, which is now made more complete than ever. Indeed, so numerous have these undertakings become, and so copious is the information which, with the kind assistance of the engineers and other officials, we have been able to collate, that to avoid unwieldy dimensions we have decided to print on both sides of the sheet. Those requiring copies of the Table, mounted on linen, will, as usual, be able to obtain these early in February. We take this opportunity to thank those who have contributed to make this Table a success, and we hope they will be adequately rewarded by the completeness and usefulness of the information now available.

APART from the length of this table, perhaps the most noticeable feature this year is the large increase in the number of electric supply undertakings which return a "declared pressure" of 200 volts, or over. These now number 87, of which about half do not give an alternative supply at 100 or 110 volts. We are glad to note also a considerable improvement in the motor connections; last year only five stations returned their motor load at over 100 H.P., while this year 18 have more than 100 H.P. in motors connected to their mains. There is still, however, considerable room for improvement in this respect.

AMONGST other matters relating to electric supply undertakings there will be found a list of the electric lighting notices under the Board of Trade, which confirms the evidence of our supplement Table as to the continued rapid expansion of this class of works. The financial aspects of electricity supply are well brought out in an article comprising a number of instructive diagrams and statistical tables. In this article the mass of figures embodied in our weekly analyses of electricity works accounts have been carefully and minutely systematised, with the result that the comparative performances and progress of a large number of representative works have been set out in a form that lends itself to handy reference.

WE may also direct the attention of our readers to a number of descriptive articles which we publish this week. The technical accounts of the recently-opened electric supply works at Salisbury and Eccles are especially appropriate to the special character of this particular issue. As representing some of the more interesting features of Continental practice, and thus affording an instructive comparison with home methods, Prof. SEMENZA's description of the Paderno installation will, we are sure, be welcomed by our readers.

THE Revenue Returns just issued for the third quarter of the financial year show a very satisfactory improvement, including a handsome increase in telegraph receipts amounting, for the whole period, to £40,000. There are indications that the trade of the country is at present in the growing phase; and of this no surer sign can be found than the steady rise in telegraph revenue which is the infallible barometrical indicator of national well-being. We may confidently anticipate, therefore, that the POSTMASTER-GENERAL will be able to report on April 1 next the unusual occurrence of a surplus in the Telegraph Account; and should this be the case he will have no difficulty in obtaining the funds which, according to the *Standard* of Monday last, he is at present in need of to carry out further extensions, whether for telegraphic or for telephonic purposes.

WE do not stand alone in complaining of the narrow scope of the latest batch of New Year's honours, nor in noticing the scanty recognition doled out to science and intellectual attainments. Political and military claims must naturally and rightly take precedence of the claims of art, literature and science; but there remains some ground for surprise that

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such meagre acknowledgment of these peaceful fruits of civilisation has been exhibited in the latest list of recipients of these honours. The reason is certainly not to be found in any lack of eligible candidates; for even in the comparatively restricted circle directly associated with electrical science and its applications, we could name not a few whose services for the nation have not been duly recognised thereby. To cite only one instance, when will this country follow the example of other nations in doing honour to the excellent services of DAVID HUGHES? We have pleasure, however, in recording that among this year's honours are a C.B. for Mr. JASPER BADCOCK, of the Post Office, and a K.C.B. for Prof. W. C. ROBERTS-AUSTEN.

WE referred last week to the abandonment of the rental system of charging by the Smithfield Markets Electric Supply Co. Another "system" of charging has taken its departure at Norwich, where until recently there had been in operation a curious method of registering current by means of meters which worked at only half-rate before sunset and after 8 p.m. This system was ingeniously contrived, and it attracted considerable notice from electrical engineers; but we do not know of any instance where it has been imitated. The Norwich Electricity Co. have decided to adopt a uniform tariff of 5d. per unit in future, in place of the former scale of 7d. after sunset and before 8 p.m. and 8½d. at other times of the day.

PARTAKING in the extensive opposition to the General Power Distributing Company's Bill for the wholesale supply of electricity in the Midlands and South Yorkshire, the TOWN CLERK of Nottingham has sent a letter to the newspapers, in which he states that "Parliament is now asked to go back upon the legislation of the last quarter of a century, and to introduce into our localities those elements which have been destructive of the wise and peaceful administration of our commercial affairs in the past." He further adds that "the establishment in our midst of a company with the powers asked for by the Bill would land us in all the difficulties, perplexities and friction of the times when the gas and water were controlled by private companies."

THIS reference to the gas and water companies may be adroit, but it is not convincing; moreover, it is really quite beside the mark. It is not proposed that the General Power Distributing Company, nor any of the similar concerns, should have a monopoly like that of the gas or water companies; but that they should be permitted to supply cheap power, in healthy commercial competition with the local authorities who are professing such alarm. If the companies cannot supply as cheaply as the authorities themselves can do, these latter need not be alarmed; but if the companies can supply more cheaply, surely it is the prime duty of the local authorities to see that the ratepayers and others in their districts speedily obtain the benefits of the cheaper supply. Are great industrial interests to be placed in jeopardy because, forsooth, municipal bodies shrink from the "difficulties, perplexities and friction" a new combination of circumstances would impose upon them?

NOR is it fair on the part of the TOWN CLERK of Nottingham to represent the proposed legislation as "going back upon the legislation of the past quarter of a century." On the contrary, it is the most natural and logical step forward, as dictated by the engineering and social developments of electric supply during the last decade. It is equally preposterous to stigmatise these schemes for wholesale supply by companies as "elements which have been destructive of the wise and peaceful administration of our commercial affairs in the past." We are surprised at the confession that wise and peaceful administration has been destroyed; but it passes comprehension what particular piece of legislation on behalf of anything analogous to the schemes under discussion can have done this thing. Surely the one and only new element introduced lately into the relation of local authorities with electrical enterprise is the practice of municipalisation. It would not surprise us if *that* proved, indeed, an element "destructive of wise and peaceful administration."

THE doctrine is a mischievous one that, because local authorities have acquired works for any specific purpose, such as electrical supply, the protection of those works and of the capital invested in them demands the suppression of all private enterprise and independent progress in the same direction. It is a doctrine the effects of which must in the long run recoil most disastrously upon the very communities whose governing bodies adopt it. In our opinion, the fact of such a doctrine being advanced, in defence of the arbitrary protection of municipal capital, points clearly to the mistake in risking that capital in works of a commercial and progressive character—is, in fact, the *reductio ad absurdum* of municipal trading.

A NUMBER of important electrical patents will expire this year unless applications for prolongation are made and granted. Among those of particular interest, in the list which appears in another column, we may give the first place to No. 3,379 of 1885, which is the famous Zipernowsky-Déri transformer patent, now the property of Mr. MARTIN RUCKER, in connection with which extensive litigation was threatened last year. Since the meeting of the Municipal Electrical Association, at which it was decided by the interested owners of central stations to combine in resisting Mr. RUCKER's claims, we have heard no more of the matter. Probably this gentleman has been advised that to devote capital to fight the matter out would be an even more risky speculation than an investment in cycle shares. It is interesting to note that the patent in question was amended as recently as April 3, 1897. In addition to this patent claiming an alternate current transformer system with transformers in parallel, there is another patent by the same two inventors in conjunction with O. T. BLÁTHY, which has been kept alive since 1885 by payment of the necessary fees. This second patent refers to the construction of transformers.

ANOTHER alternating patent which will have run its allotted span this year is that of S. Z. DE FERRANTI, dated Dec. 11, 1885. It describes some useful and some necessary adjuncts to the alternating-current transformer system. The first of

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these is the use of electromagnetic switches to automatically switch parallel transformers in or out according to the current required from them, the second is the high pressure main known now as the "Deptford" type. A claim is made for the combination of fuses or automatic cut-outs in the branches of the high-pressure circuit to which the transformers are connected, and finally the system of leakage indication by means of electrometers connected between each main and earth is described. Mr. FERRANTI has one more 1885 patent with a broad claim, namely, for a switch "so arranged that the continuous movement of the handle stores up energy in the spring bridge-piece and afterwards liberates it . . ."

ALTHOUGH the early alternating-current patents claim a large share of attention, there are other electrical patents dating from the same year of equal importance commercially. Mr. DESMOND FITZGERALD'S "lithanode" was patented in 1885, also the COWLES electric furnace. Three important patents of Mr. DELANY'S for multiplex telegraphy will expire in 1899 in the usual course of events, a motor-suspension patent of Mr. FRANK J. SPRAGUE'S, and, finally, a patent granted to JAMES BROCKIE and BENNETT PELL for improvements in arc lamps.

THE Publisher desires to call attention to the closing up of the Handbook and Directorial Divisions of the "Electrical Trades Directory and Handbook for 1899." Owing to the work of compilation proving exceptionally heavy this year, he will be glad to receive entries intended for insertion in the new edition as promptly as possible. The issue for 1899 will contain much new matter of interest and importance to the electrical and engineering industries, in addition to the old well-known features brought quite up to date.

Cable Interruptions.—	Date of Interruption.
Para—Maranham	Nov. 15. 1898

Erratum.—On page 338, column 2, line 27, in our issue last week, *for* "increased" *read* "decreased."

King's College (London).—The Lent term commences on Thursday, January 19th. Particulars of the courses of instruction are given in an advertisement elsewhere.

Electric Lighting in the Vatican.—On Sunday last the palace of the Vatican was for the first time lighted throughout by electricity. The cathedral of St. Peter is also shortly to be equipped with electric light.

Appointment.—Mr. John Aldworth, manager of the Isle of Man electric and other tramways, has been appointed to succeed Mr. Baker as manager of the Nottingham Corporation tramways. By this arrangement Mr. Baker will be enabled to take up his duties with the London County Council at the end of this month.

Gibraltar - Malta - Alexandria Cable.—The third cable of the Eastern Telegraph Co., between Gibraltar, Malta and Alexandria is now being laid by the Telegraph Construction and Maintenance Co.'s c.s. "Anglia," the shore end having been laid at Gibraltar on Tuesday. It will be remembered that the section connecting Porthcurno with Gibraltar was laid in the autumn of 1898.

Trolley Ropes.—A correspondent, signing himself "Pro Bono Publico," has written to us suggesting that the example set at Bristol should be followed on all trolley lines, viz., that the trolley rope should be attached to the trolley standard after the trolley arm has been reversed, the ropes being unhooked from the standards only when it is required to reverse the position of the arm.

Electrically-Driven Type-setting Installation.—The type-setting department of the *Newcastle Daily Journal* has just been equipped with an installation of Langdon-Davies alternate current motors, by Messrs. Ernest Scott and Mountain. This is stated to be the first installation of the kind in the northern counties. The motors are used for operating a set of the latest pattern of "Linotype" type-setting machines.

Supply Interruption at Ayr.—A report has only just come to hand of an interruption to the electrical supply at Ayr on the 29th ult. A short-circuit occurred on one of the circuits, and the consequent blowing of its fuse interrupted the supply to a considerable portion of the town. The local report is to the effect that the failure was due to a fuse blowing in a sub-station, causing a short-circuit and blowing the main works fuse. This, it is to be hoped, is not quite accurate.

The Wright System in America.—The Edison Electric Illuminating Co., of Boston, announces that, after having experimented for some months with the Wright maximum demand indicator, it is prepared to supply electric current on this tariff system. The price charged has hitherto been 1c. per hour for a 16 c.p. lamp, with discounts of 10 to 15 per cent., and it will now be 1c. per lamp per hour for the first annual 400 hours of maximum demand, and after that 0·4c. per hour.

"Electric Fluid" in Liverpool.—Judging by a paragraph in the *Liverpool Express*, headed "The Dangers of Electric Lighting: Startling Incident," it would appear that a most virulent form of "electric fluid" is in use in that city. In the evening of January 1, "a portion of the apparatus connected with the main in Tithebarn-street burst out into a flame, and the explosion created some alarm in the neighbourhood. The electric fluid ran along the pavement to a considerable distance, and a large stone flag was shattered." The occurrence appears to have been a slight gas explosion in an electric lighting conduit, of the usual character. Nobody was injured and the supply was not interrupted.

The National Telephone Co.'s Reconstruction Bill.—We referred in our issue of Dec. 2nd to three bills which are to be introduced in Parliament this session by the National Telephone Co. Of these, two relate to the acquisition of additional powers by the company, and the third seeks sanction for a scheme of reconstruction. Further particulars of the latter are now to hand. The share capital of the new company is to be £6,000,000 with power to raise a further £3,000,000 by the creation of debenture stock. Of this capital £4,000,000 is represented by the share capital of the existing company, and £1,669,471 has already been raised by debenture stock out of an issue of £2,000,000. The preamble of the Bill states that telephone messages at the rate of 450,000,000 are now passing annually over the company's system. A conversation is estimated as two messages.

Obituary.—We regret to announce the death of Dr. Eugene F. A. Obach, which took place on the 27th ult. at the house of his brother, at Graz, in Styria. Dr. Obach was born in 1852, at Stuttgart, and was thus 46 years of age at the time of his death. He studied at the polytechnic of his native town, and subsequently lectured on chemistry at the Veterinary School. Thence he went to Leipzig University, where he graduated as a Ph.D. in 1875. He entered the employ of Messrs. Siemens and Halske, as assistant to Dr. Werner Siemens, in the spring of the same year. In 1876 he came to England and joined the staff of Messrs. Siemens Bros. and Co. at Woolwich, as chief of the experimental department. He was the writer of several useful monographs and papers on electrical subjects. He also displayed considerable inventive ability, and his tangent galvanometer and dry cell are well known.——We regret to announce the death of Mr. Henry H. Beit, A.I.E.E., a partner with Mr. T. Scott Anderson in the firm of Scott Anderson and Beit, Sheffield. Mr. Beit was in partnership with Mr. Scott Anderson just a year, having previously served as a pupil and then as engineer. For some

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time past Mr. Beit had been ill, but a fatal termination was not anticipated. He was educated at Rugby, and was only 26 years of age.

Municipal v. Company Working of Electrical Undertakings.—"The beginning of the New Year," says the *Journal of Gas Lighting*, "brings into prominence the seething antagonism between municipalities and electricity supply companies, which began to be acute last year. It is a pleasing trait of our modern 'progressive' municipalism to hold that what is sauce for the municipal goose in the shape of competition in electricity supply, is by no means sauce for the gander of private enterprise. It is perfectly right and proper for the Vestry of Marylebone or of Bermondsey to enter into competition in this business with a company, but by no means the same for a General Power Distributing Co. to offer a cheaper supply of electricity to consumers in the area supplied by a local authority. Thus baldly stated, the municipal attitude appears illogical in the extreme; and it is no wonder that the leading electrical journals are poking fun at it. What Parliament thinks of the question will be shown before the session is out; but the action of the House of Lords in passing the General Power Distributing Co.'s Bill is rightly regarded in municipal circles as boding ill for the maintenance of their 'monopolies.' Of course, in such emergencies there is always somebody who undertakes to 'agitate' the matter on behalf of the threatened interest. Hitherto the sacred cause of Progressive Municipalism against private electrical enterprise has been worked for all it is worth by the journal called *London*, as we have had previous occasion to notice. The style of this periodical, however, is somewhat crude, not to say loud; and in its pronounced taste for highly-flavoured personalities, it has suggested the cheap evening newspaper rather too pointedly to win the respect of the grave and severely respectable personages who serve the public of this country by means of its municipal institutions."

Storage Battery Competition.—As a sequel to the motor-car trials mentioned in *The Electrician*, Vol. XLI., p. 578, the Automobile Club de France announces a competition for motor-car accumulators, to take place in Paris in April, 1899. Tests will be made on the life of the cells, and on their useful efficiency, and account will be taken of the "frequency, importance and facility of operations for maintenance," and of the weight of the cells per capacity and per output. Entries can be made up to Jan. 31, at a fee of 500fr., and up to Feb. 28 on payment of a double fee; in addition to this owners of batteries will have to pay 1fr. per kilowatt-hour metered to their cells. Each battery submitted must be capable of furnishing 120 ampere hours when discharged at 24 amperes, without its terminal pressure dropping below 8·5 volts, and must not weigh more than 110 kilogrammes. The reason of fixing the pressure and not the number of cells is to enable batteries other than lead-lead to compete. Discharge tests will be made for five hours every day, the current being varied according to a specified curve between 20 and 100 amperes every 20 minutes (the 100 ampere discharge will only last half a minute in each cycle), this being followed by 10 minutes' repose. While these discharges are taking place, the cells will be jolted about in imitation of the treatment they are liable to on ordinary roads. The daily charge will be given for a maximum of eight hours, but any competitor may stop the charge to his battery when he likes. The charging current will start at 30 amperes and gradually diminish to 15 amperes. Between the charge and discharge (an interval never exceeding two hours) owners of the batteries may clean them and renew the strength of the electrolyte, but no plates may be changed. Once a week a test discharge, without jolting, of a steady 24 amperes for five hours will be made. During this time, if the voltage of any battery drops below 8·5, it will be removed from the circuit, and after four cases of such misbehaviour it will be considered as worn out so far as the tests are concerned, and the tests mentioned will be systematically continued until all the batteries are worn out—but not longer than six months.

Electricity in the Spanish-American War.—At a meeting of the New York Electrical Society held on the evening of December 14th, Eugene Griffin, Colonel of the First Regiment of Volunteer Engineers and first Vice-president of the General Electric Co., gave an address entitled "Ideas Underlying the Organisation of a Volunteer Engineer Corps: the Work Accomplished by it in Porto Rico and the Opportunities for Further Usefulness." Col. Griffin, our New York correspondent writes, spoke of the reluctance of the War Department towards the question of organising a corps of 2,500 men. The work of the volunteers was compared with that of the regulars, the conditions of ordinary military service being in this case, he said, slightly reversed, the volunteers being professionals and the regulars, to a certain extent, amateurs in engineering work. There was very little electrical work done in Porto Rico by the First Regiment of Volunteer Engineers under the speaker's charge, although more electrical work might be expected in any future war. He suggested the organisation of a permanent torpedo militia of electrical engineers and the immediate preparation of thorough reports on the experience already gained in order that the knowledge thus obtained might be available for future emergencies. Mr. F. W. Roller, who was chief engineer of the United States gunboat "Nashville," addressed the meeting, giving some valuable data on the experience obtained with electrical apparatus on shipboard. He stated that electric apparatus of the signalling variety, that is, where small powers are used, was, as a rule, a failure at the time when it was most wanted, namely, during an engagement. The heavy concussions, the severe service and the lack of opportunity for keeping it in repair are the causes for this. Engine-room telegraphs and other signalling devices, as at present designed, are much too delicate. The electric range-finder also proved itself a complete failure, owing not so much to the delicacy of the apparatus as to inherent defect in attempting to find the height of a very long triangle with a very short base. Electrical apparatus of the type using large powers, namely, dynamos, motors, incandescent lamps and the searchlight, proved to be a great success during the war, the searchlight being one of the most useful pieces of apparatus in the navy. It was the searchlight that, shining up the narrow entrance of Santiago harbour, prevented Cervera from coming out by night. The Ardois signalling system was, as might be expected, much more satisfactory than oil lamps bent to a halyard and run up in the rigging for every signal. Electric firing mechanism proved itself superior to percussion. Mr. Roller gave some figures as to the excessive steam consumption on machines on which he had made tests. One duplex pump showed a steam consumption of 327lb. of water per horse-power-hour, another even running up to 343lb. One dynamo engine made the poor showing of 132lb. He advised that all new electrical apparatus, especially motor-driven steering gear and auxiliaries, be tested first in the merchant marine before any attempt was made to apply it to naval work.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

TUESDAY, January 10th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read with a view to discussion: "High Speed Engines," by J. H. Dales.

RÖNTGEN SOCIETY.

8 p.m. General Meeting at 11, Chandos-street, Cavendish-square. Paper to be read: "The Present Position of the Röntgen Rays in Military Surgery," by J. Battersby.

THURSDAY, January 12th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting, when the Discussion on Dr. Lodge's and Mr. Evershed's Papers on Induction Telegraphy, will be concluded.

FRIDAY, January 13th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students Meeting, when Dr. Archibald Barr will deliver an Address on "The Application of the Science of Mechanics to Engineering Practice."

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Dieletric Strength of Insulators.—Thomas Gray publishes the results of experiments made to test the dielectric strength of glass, hard and soft vulcanised rubber, mica, various cardboards and papers, oils and air. They were tested by means of a Westinghouse dynamo running at 8,000 revolutions per minute and connected with step-up transformers designed to raise the mean voltage as high as 100,000 volts should that be necessary. The specimens of "crystal glass" examined showed a dielectric strength of 285,000 volts per cm. in a thickness of 1mm., but with four layers making up a thickness of 4mm, the dielectric strength was only 200 kilovolts per cm. Hard rubber showed the same falling off in the dielectric strength when several layers were used. The various substances tested may be arranged in order of strength as follows: mica 2,000, hard rubber 500, soft rubber 450, "micanite," consisting of mica flakes held together by varnish, 400, paper 400 to 600, fuller board 200, Empire cloth 150, olive oil 70, air 50 kilovolts per cm. These are only rough average values. The papers are of special interest, as they provide cheap and effective insulating materials. American linen paper ranks high with 640, bond paper with 600, and tissue paper with 510. The oils were very troublesome, as their dielectric strength was found to vary with every considerable E.M.F. applied.

[Gray, *Phys. Review*, November, 1898.]

Photometer Records.—In the ordinary photometric process, there occurs between successive settings a considerable interval, in which the reading of the bar is taken and recorded, either by an observer or an assistant. Various expedients for reading the bar are resorted to, as, for example, the use of a hand-mirror to reflect a beam of light from one of the sources, or the turning on of a glow-lamp. These methods are not free from objections. The sudden influx of light produces in the observer fatigue of the retina and of the muscles of the pupil, and there is a consequent loss of visual sensitiveness. Further, when it is the question of the photometry of a fluctuating source, the infrequency and irregularity of the readings is a drawback. In arc-light photometry, more especially, the illumination of the photometer disc is a shifting quantity. C. P. Matthews obviates these difficulties by mounting a wooden cylinder parallel to the photometer bar, and puncturing it by means of a steel pin attached to the handle of the photometer carriage. A ratchet-wheel turns the cylinder by a definite amount as each record is made, so that the records can be identified afterwards. The measurements are then made, either by bringing the pin into coincidence with each puncture and reading the bar, or the cylinder is covered with paper ruled in a divided scale and the readings are taken from the paper direct. When time-variations are to be studied the cylinder is worked on the chronograph principle.

[Matthews, *Phys. Review.*, November, 1898.]

Photographic Studies of the Arc.—Some capital photographs illustrating the course of events in the alternate-current arc have been obtained by N. H. Brown. They were taken either by moving the plate across the back of the camera and letting the image draw itself out, or by placing a slit in front of the moving plate, so as to get the complete history of a definite part of the arc. The photographs show that the lighting up does not take place across the whole arc space at the same instant, but that it starts first from one side and then from the other. The slit photographs show that there are really two light-fronts, one from each carbon. The positive light-front starts about $\frac{1}{1000}$th of a second before the negative one, and travels across at the rate of about 500in. per second, while the negative light front moves at the rate of about 300in. per second. This is generally in accordance with the known fact that the steepest potential gradient is close to the positive carbon, and suggests a movement of ions as in electrolysis. But it is not at all certain that a complete explanation can be attained along these lines. For the differences of temperature between the carbon and the intervening gas, and between the two carbons themselves, must have some determining effect upon the flame. The light-front is not necessarily composed of projected particles. It may be a heat wave in which radiation plays an important part.

[Brown, *Phys. Review*, November, 1898.]

Charge of Röntgen Ray Ions.—When Röntgen rays traverse a gas, the molecules of the gas are ionised, and the gas becomes a conducting medium for an electric current. By measuring the current passing through a gas exposed to Röntgen rays and acted upon by a known E.M.F., we may determine the value of the product nev, where n is the number of ions in unit volume of gas, e the charge on an ion, and v the mean velocity of the positive and negative ions under the E.M.F. to which they are exposed. J. J. Thomson describes some fascinating experiments undertaken with a view to determine e. His method is founded upon Wilson's discovery that when Röntgen rays pass through dust-free air a cloud is produced by an expansion which is incapable of producing condensation under ordinary circumstances. The ions act, in fact, as nuclei for the deposition of the moisture. The cloud is produced between an aluminium plate exposed to X-rays and covered with moist blotting paper, and a water surface. The rate at which the cloud settles down gives v, and also indicates the size of the drops, which may be calculated from the known laws of bodies falling through a gas. Knowing the size of the drops, and the mass of water deposited, the number of drops per unit volume is known. This number is n, the number of ions, provided all the ions are caught. The author shows how this can be insured. Thus, only e remains to be found. It is calculated from n, v, and the total quantity of electricity passed in a given time. This is the method in bold outlines. For details and corrections the original Paper should be referred to. The mean of the results for air is $e = 7{\cdot}8 \times 10^{-10}$ electrostatic units. Allowing for that part of the cloud which is formed independently of the rays, the value for hydrogen is the same as for air. It is important to notice that the above value for the charge on the ion produced by X-rays is of the same order as that carried by the hydrogen ion in electrolysis, and by the ions whose motion causes the spectrum lines which exhibit the Zeemann effect.

[Thomson, *Phil. Mag.*, December, 1898.]

True Resistance of Cells.—The chief difficulty in the way of finding a definite value for the resistance of an electrolytic cell lies in the polarisation. There are other complications, due to the absorption of ions in the metal of the electrodes, and to convection currents, but these can, by proper arrangement of the apparatus, be reduced to vanishing point. Polarisation sets in so instantaneously that even Kohlrausch's method of measuring resistances by means of a telephone and rapidly alternating currents suffers under the errors due to it. K. E. Guthe, therefore, proposes to employ direct currents, and to eliminate polarisation by determining its exact amount. This is done with the aid of Wiedeburg's theory of polarisation, which is so far the closest in accordance with facts. The author shows that the apparent resistance is always too large. Denoting the apparent resistance by ρ, the true resistance by r, the polarisation by P, and the current by I, we have

$$\rho - r = \frac{P}{I}(1 - e^{-kI}),$$

which shows that the difference is enormous for very small currents, and disappears with very strong currents. This explains the constancy of Haagn's results, as he operated with large currents. The author uses a pendulum apparatus for obtaining a constant time interval for the current, and after allowing for polarisation as above, the true resistance r is found to be constant within the limits of observational error.

[Guthe *Phys. Review*, November, 1898.]

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SALISBURY ELECTRIC SUPPLY WORKS.

A combined water-power and steam-power electricity works was inaugurated on December 19th, at Salisbury, by a local electric light company, the ceremony, as announced in our columns, being performed by the Earl of Pembroke. Notwithstanding the comparatively small size of this undertaking, it possesses many features of exceptional interest, these being somewhat out of the usual beaten track of electricity works construction. A technical description of these new works will, therefore, probably be of interest to our readers.

Not many years ago the electrical profession was exhorted by Mr. Preece and other leading engineers to make use of the water power running to waste in the rivers, streams and rills of this country. Mr. Preece backed up his exhortation by a practical example that has afforded many instructive and interesting lessons, viz., the municipal water-power station at Worcester. Some of the more enthusiastic, but less practical, advocates of water power predicted an appreciable decline in the use of steam and gas power, but these individuals overlooked the fact that, save in a few exceptional localities, the streams in this country do not afford satisfactory and remunerative conditions for running a town lighting station. Neither have we the immense volumes of water flowing over a moderate fall, as at Lachine Rapids, on the St. Lawrence River, nor the smaller volumes flowing from immense altitudes as in the waterfalls of Switzerland and the Rocky Mountains. England, therefore, is by natural circumstances precluded from becoming a country of great water-power undertakings. Tidal power, by the way, is often advocated by the layman; but even the novitiate engineer can soon figure out that, to mix the metaphor, "the game is not worth the candle." We expect nothing important from tidal power. There have not been wanting in the past, however, successful attempts to utilise the water power of rivers in electric light undertakings, of which Worcester, Buckingham, and most recently Salisbury, afford instructive examples.

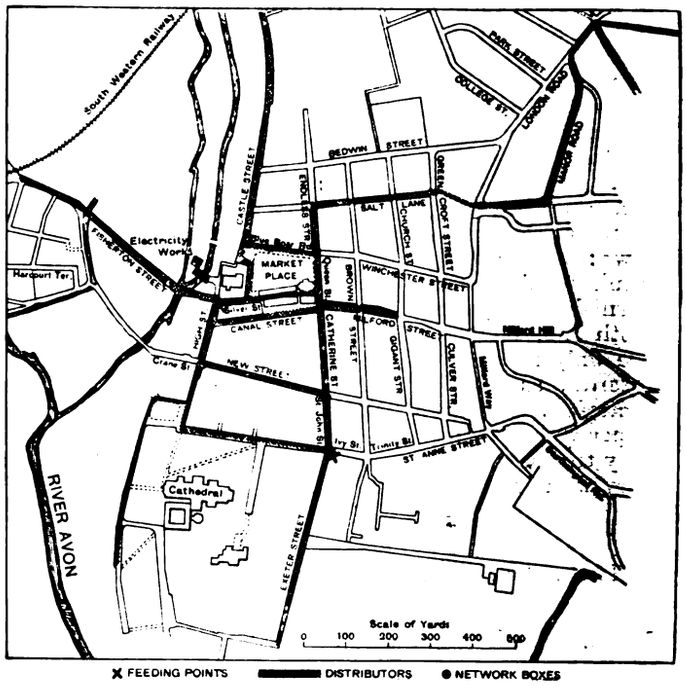

FIG. 3.—Map showing the System of Mains, Feeding Points and Network Boxes, &c., of the Salisbury Electric Supply Works.

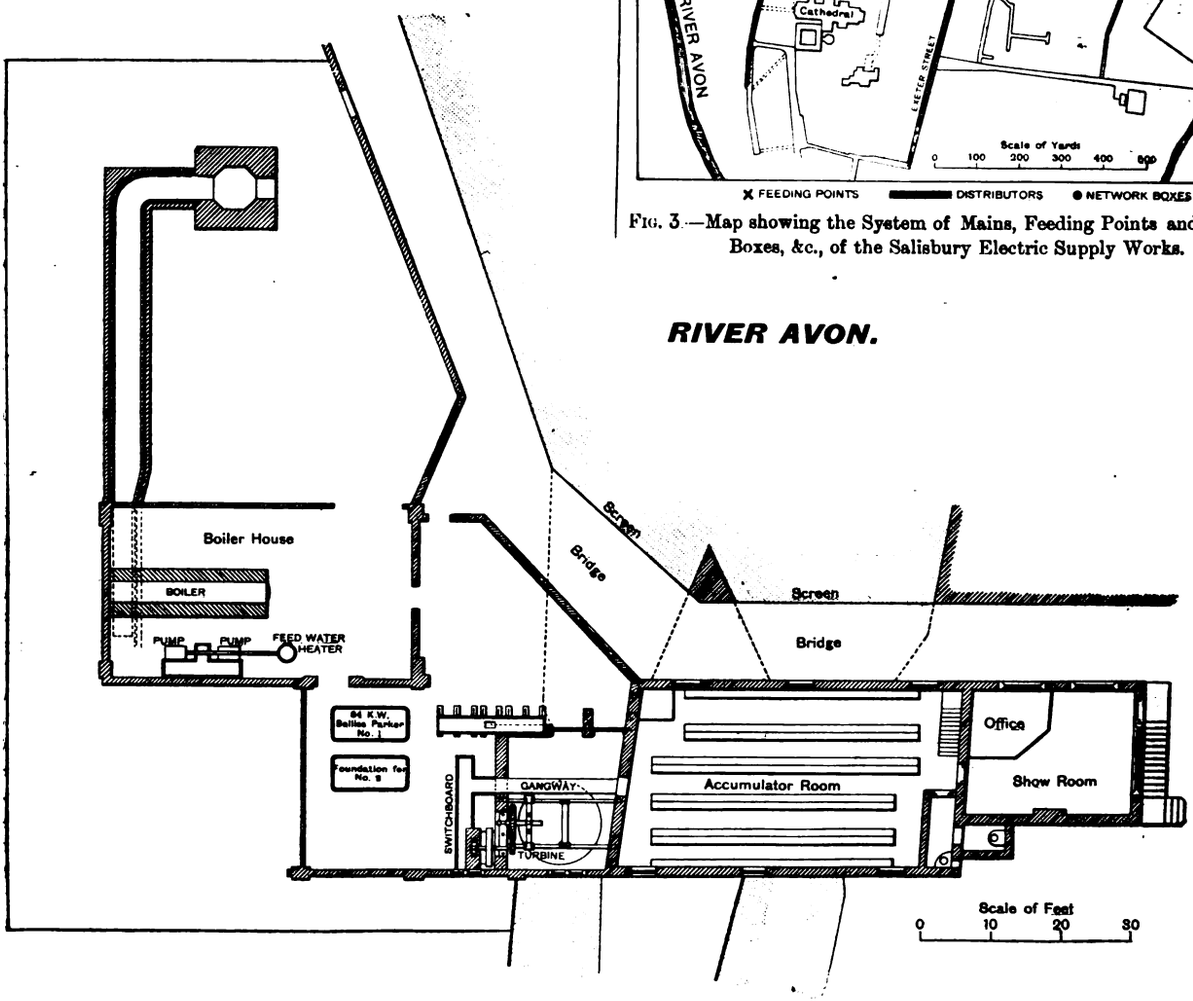

FIG. 1.—Salisbury Electric Supply Works. Plan of Station.

In 1894 a few enterprising gentlemen started an electric light company in Salisbury. They secured an option to purchase the old Town Hills and adjoining land as a site for the works, and in due course obtained a Provisional Order. As is usual in a country town, it was found very difficult to raise the necessary capital, and, as the Board of Trade threatened to rescind the Order, the Company approached Messrs. Edmundson's Electricity Corporation (Limited), of West-

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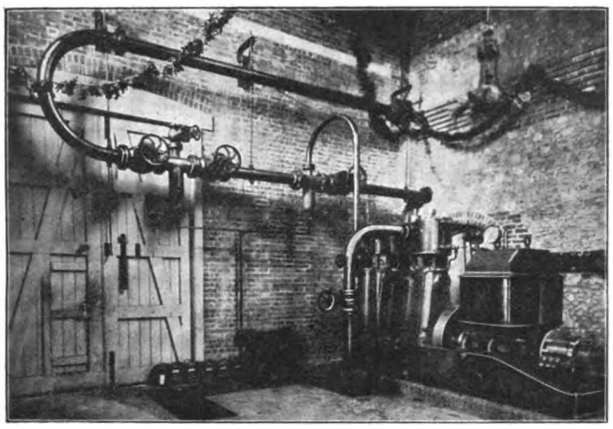
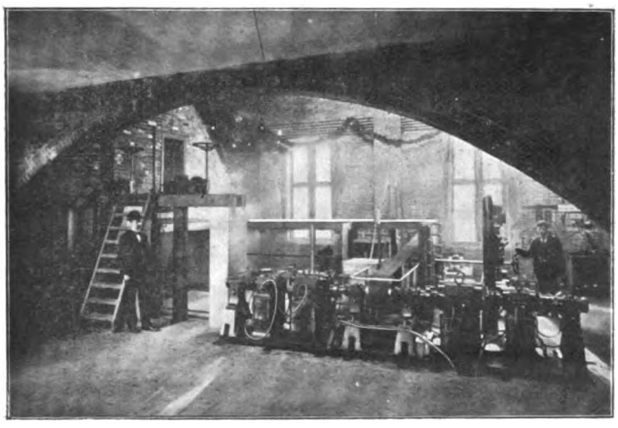
minster, who undertook to find a portion of the capital required if the remainder was procured locally. Only a small further sum was subscribed locally, but Messrs. Edmundson, having in the meanwhile largely increased their capital for the express purpose of dealing with such contracts, eventually undertook to put down the works, finding nearly all the capital required. The works in Salisbury have throughout been designed by Messrs. Edmundson and carried out by them, and they have every reason to be proud of the result. Mr. L. A. Hards, who acted as their resident engineer, is now engineer to the Salisbury Company. A better position for a supply works than the old Town Mills it would hardly be possible to secure, it being not more than 100 yards from the centre of the city; the site is about half-an-acre in extent, and was the



Salisbury Electric Supply Works. View of the Steam-driven Generating Plant.

property of the Dean and Chapter of the Cathedral for seven centuries. The old Town Mills is on the site where a mill probably already stood when the city was moved in the thirteenth century from its first position on the top of a neighbouring hill to its present situation at the junction of the Avon and the Nadder, the former of which now supplies part of the energy for supplying light to the city.

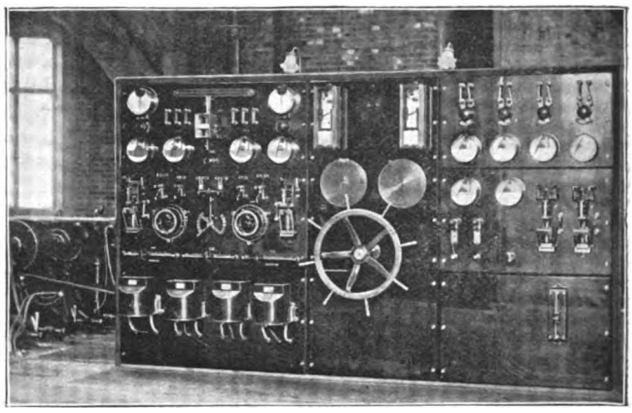
The present mill buildings are only about 150 years old, and were fitted with four undershop wheels, which were used for flour and snuff grinding. One of these had previously



Salisbury Electric Supply Works. Interior of Power Station, showing Water-driven Machinery.

been removed, and an iron eel trap grating fitted in place. Fig. 1 shows the plan of the works. The east end is a new two-storied building, used as an office and show room, with a store and workshop below. The next building is the old four-story mill, having on the ground floor the eel trap, tank and storm water gate at one end, also further storage room at the other end. On the first and second floors are the accumulators and the upper floors are empty. The engine room is a new building containing the turbine, engines and dynamo. The boiler house is at right angles, and the triangular-shaped room between is intended to hold the condensers when the load on the steam plant warrants the cost of adding these. The whole of the engine and boiler house are built of fire-proof materials, the roof being iron, glass and tiles, the walls are built for the most part of flints set in cement. A siding of the South Western Railway adjoins the Company's property; and some day, no doubt, this will be used, but for the present, as the coal consumption will be small, fuel will be carted to the works. The chimney is octagonal, 100ft. high and 6ft. diameter inside.

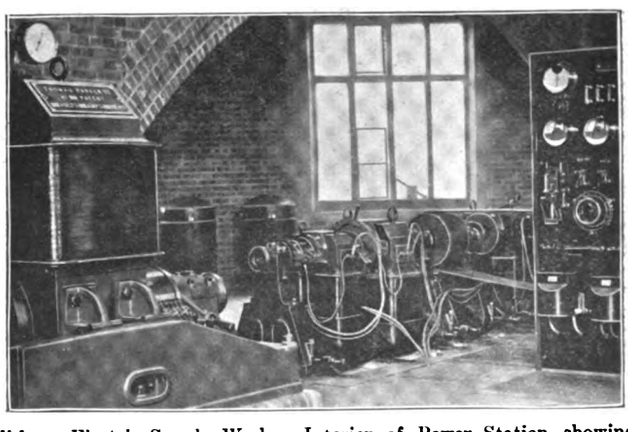
There are at present in place a 60 H.P. vortex turbine dynamo, one Babcock and Wilcox boiler of 1,218-heating surface, two Worthington feed pumps, one of Joseph Wright's excelsior feed heaters, and a Bellis-Parker set of 84 kilowatt output, 160 ampere and 460 volts. Space has been left and all pro-



Salisbury Electric Supply Works. View of the Switchboard.

vision made for adding another boiler and engine set when required, but it is probable that so much useful work can be obtained from the turbine, that these will not be required for another year. The steam pipes are on the usual ring main principle, and the feed pipes, &c., are in duplicate. A galvanised iron tank capable of holding 2,000 gallons is supported by an arch high up in the boiler house to supply the feed heater.

The station is at present being run from the turbine, which was made by Messrs. Gilkes, of Kendal, the wheel is 8ft. 6in.



Salisbury Electric Supply Works. Interior of Power Station, showing arrangement of the Plant and Switchboard.

in diameter, and is capable of giving 60 H.P. with 5,883 cubic feet per minute working under a 7ft. head. It runs at 26 revolutions per minute and drives the dynamo at 850 revolutions by gearing and belting. The turbine is fitted with movable guide blades for adapting the entrance orifices to any quantity of water below the full supply. The hand wheel for adjusting is placed conveniently in the centre of the switchboard. As the vanes of the turbine are very massive an electric motor is to be fitted to give the switchboard attendant a quicker and easier control. The whole of the regulation is

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carried out by this wheel, there being no use in inserting resistance in the field of the turbine-driven dynamo as the wheel only runs the faster to make up for the weaker field.

This turbine drives two machines coupled together, each capable of giving an output of 100 amperes at 230 volts, a machine being connected each side of the three-wire system. On the ends of the dynamos are coupled the boosters, to add ths extra pressure for charging the accumulators. The armatures of the boosters are wound on a sleeve and slipped on to the end of the spindles of the dynamos. In the event of the turbine being out of use, this machine can be used as an ordinary balancer booster combination by the removal of the belt.

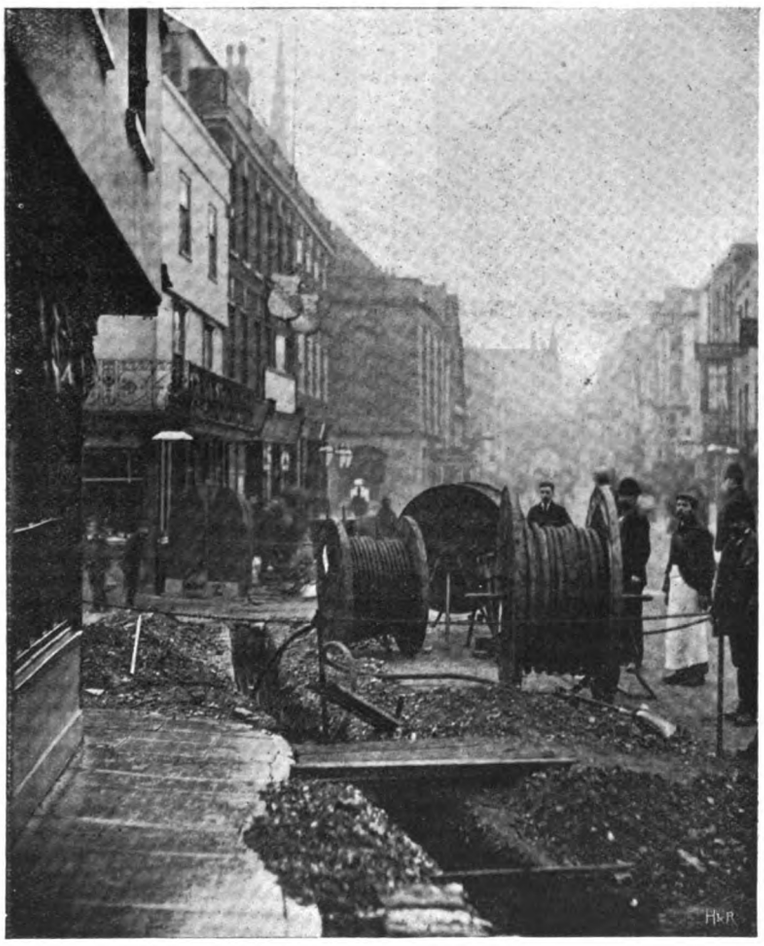
The switchboard, which was made by Messrs. Thos. Parker (Limited), to Messrs. Edmundson's designs, is very compact. It is divided into three parts. On the left-hand are the switches, ammeters, auto-cut-outs, &c., for the combination dynamo and booster, also the battety regulating switches and ammeters, the throw-over switches, zero indicators, &c. On the right-hand panel are the feeder, ammeters and duplex cut-outs, the dynamo-ammeters, auto-cut-outs, fuses, &c. The centre panel carries the recording voltmeters, recording ammeters on the earth connection to the neutral wire, cut-outs, switches, &c., for testing the insulation of the main. Through the centre of this panel projects the spindle of the gear for opening and closing the blades of the turbine, and an indicator is fixed, showing the position of the blades and also the level of the top and bottom water, so that at a glance the attendant can see the position of affairs. Two Kelvin large dial voltmeters—one on each side of the system—are fitted on the side wall, so that they can be seen when standing in front of the switchboard or any part of the engine room. The pressure at the consumers' lamps is 210 volts. Thomson-Houston meters are fitted on the output of the dynamos and on the battery circuits; these latter read forwards when charging and backwards when discharging, and, therefore, give the energy lost in the cells.

There are 230 accumulators of the D.P. type, having 715 ampere-hour capacity, or 80 amperes at 420 volts for nine hours, or 119 amperes for four hours.

At present the turbine runs for about 18 hours daily—in the morning for charging and in the evening with the cells to supply the light required. The water power varies very considerably, but even in the driest weather of last autumn there was always about 15 H.P. available, the average amount being from 25 to 30 H.P.; and when the river is flowing full there is 50 to 60 H.P. With the aid of a large battery this power can be fully utilised.

The mains are of Messrs. Callenders' jute-insulated lead-covered and armoured type, the feeders being concentric and the distributors three core. The lengths laid are:—

Feeder No. 1, 117 yards.
Feeder No. 2, 711 yards.
Sub-feeder, 567 yards.
Distributors 892 yards, 0·100 sq. in. section.
Distributors 584 yards, 0·075 sq. in. section.
Distributors 5,285 yards, 0·05 sq. in. section.



Laying Callender Cables for the Salisbury Electric Supply.

Already considerable extensions of the mains have been made owing to the demand for light in the residential districts of the city. In August last, the Corporation advertised for tenders for street lighting. They had previously been paying about £902 a year for gas, some of the lamps being extinguished at 11 p.m. during part of the year. The estimated extra cost of all-night lighting was £136, making the total £1,038. The electric light company quoted for 16 arc lamps (and 25 incandescents after 11:30) and 245 incandescents burning all night for £704, but the gas company reduced their price to £575 for all-night lamps and secured the contract for three years. Taking into account a number of additional lamps which are to be fixed, the advent of the

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electric light company is said to have saved the city some £500 per annum.

Salisbury is a city of about 16,000 inhabitants, and to have secured the equivalent of 2,500 8 c.p. lamps, connected since the supply was started in July, is auspicious of a successful career. With a regular and ample supply of water-power the running expenses should be small, and we shall look forward with interest to the publication of the result of the first year's working.

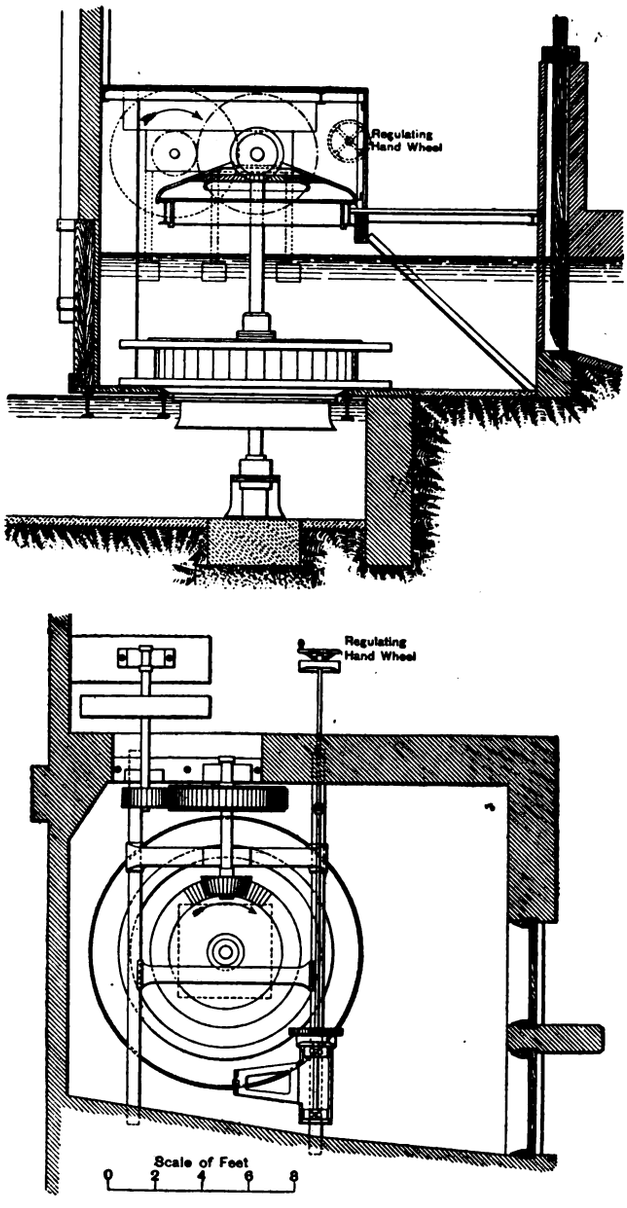

FIG. 2.—Elevation and Plan of the "Vortex" Turbine at Salisbury Electric Supply Works.

The following is a list of the principal contractors and sub-contractors, &c., who have supplied plant for this undertaking—

Dynamos and balancers...	Thomas Parker (Limited).
Engines	Belliss and Co.
Turbines	Gilbert Gilkes and Co.
Boilers	Babcock and Wilcox Co.
Feed Pumps	Worthington Pumping Co.
Switchboard	Thomas Parker (Limited).
Accumulators	"D. P." Battery Co.
Cables	Callender's Cable and Construction Co.

We are indebted to Messrs. Edmundson's Electricity Corporation (Limited) and to the principal contractors for the particulars embodied in this article, and to the first-named corporation for the photographs and drawings with which it is illustrated.

ECCLES ELECTRIC SUPPLY WORKS.

The history of the electric light question at Eccles dates from 1883. Eccles is a borough of some 35,000 inhabitants, distant about four miles from Manchester. The first occasion on which the subject of electric lighting was raised was when the Corporation of Salford intimated their intention of promoting a Parliamentary Bill containing clauses empowering them to supply electric light in the Borough of Eccles as well as in their own. This proposal met with protest on behalf of the Eccles authorities, and as a result the latter obtained a Provisional Order for themselves. As has been so often the case when a local authority has obtained a Provisional Order, nothing further was done for several years, except the renewing of the Order when necessary. On a renewal being granted in 1894, it was required that a certain area should be lighted within two years. The late Dr. John Hopkinson's advice was then taken, the usual series of visits were paid to central stations in operation, and the matter appears to have been shelved until the following year. Then Mr. S. V. Clirehugh was asked to prepare a scheme for lighting the whole of the borough. He recommended a high-pressure alternating-current system, proposing to utilise the existing gas lanterns, and placing incandescent lamps in them. The cost of the whole installation for supplying a private lamp connection of about 3,000, and lighting the streets with 700 lamps, was estimated at £20,000. By the casting vote of the Chairman of the Town Council, it was decided to apply to the Local Government Board for borrowing powers, but in view of the great opposition in the Council and among the ratepayers, the Local Government Board refused its sanction. Probably nothing more would have been done towards the electric lighting of Eccles had not private companies sought to obtain Provisional Orders, with the result that application was made to the Board of Trade by the Corporation for another extension of time. This was granted, but limited to one year. Mr. Clirehugh was then asked to modify his scheme to include the lighting of a more limited number of streets only, and finally borrowing powers were obtained, and the work which was estimated to cost about £11,800 was commenced in January last year. It has now been completed, and the small station was formally opened on December 14th by Alderman Kendall, Chairman of the Electricity Committee, in presence of the Mayor and Mayoress, the latter performing the operation of switching on the current.

The works are situated by the Bridgewater Canal, a few hundred yards above the Barton Aqueduct, where it crosses the Manchester Ship Canal. The Bridgewater Canal is separated from the works by a roadway only, and supplies water for condensing, although the town supply is laid on, to be used in case of emergency. Messrs. George Macfarlane and Co., of Manchester, erected the buildings to the plans of Messrs. Woodhouse and Willoughby, of the same city. The frontage occupies 75ft., of which 25ft. represents the width of the engine room, and the remainder is the length of the boiler house. The ground acquired by the Corporation is 198ft. long, so that ample allowance has been made for future extensions. The buildings comprise the engine room, 44ft. by 25ft., the boiler room, 42ft. by 45ft., the accumulator room, 10ft. by 20ft., and offices, &c.

The whole of the steam generating plant has been supplied by Messrs. Tinkers (Limited). Only two boilers have been erected at present, these being of the Lancashire type and embodying the most modern improvements. Provision has, however, been made for extensions. The boilers are 28ft. long by 7ft. 6in. internal diameter, each having two flues 3ft. in diameter. The longitudinal seams of the shell are butt-jointed, with covering strips inside and out, secured with four rows of rivets; the circular seams are lap-jointed and single-riveted. Each ring of the shell is formed of one plate $\frac{5}{8}$in. thick. The flues are formed of solid-welded and machined-flanged rings made of plates $\frac{15}{32}$in. thick, the front and back rings being $\frac{9}{16}$in. thick. The end-plates are $\frac{5}{8}$in. thick, each formed of one plate. Both ends are single-riveted to the shell, the front end being attached by an external angle ring, and the back end being flanged. The boilers rest on special

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seating blocks, manufactured by Messrs. Poulton and Co., and these are placed at all points of contact with the boiler shell. The working pressure of the boilers is 125lb. per square inch, and the test pressure 210lb. per square inch. The main steam pipe is 8in. bore, and provided with water catchers at each end. Valves are fitted in the main steam pipes, so that any section can be shut off without interfering with the working of the other.

The water for condensing purposes is pumped from the canal by a centrifugal pump, driven by a separate vertical engine, through two Ledward ejector condensers, each capable of dealing with 6,000lb. of steam per hour. The condensed water returns to a tank capable of holding 300 gallons, from which it is taken by means of a horizontal duplex feed pump, made by Messrs. Mumford, and capable of delivering 7,000lb. of water per hour against the working boiler pressure. This

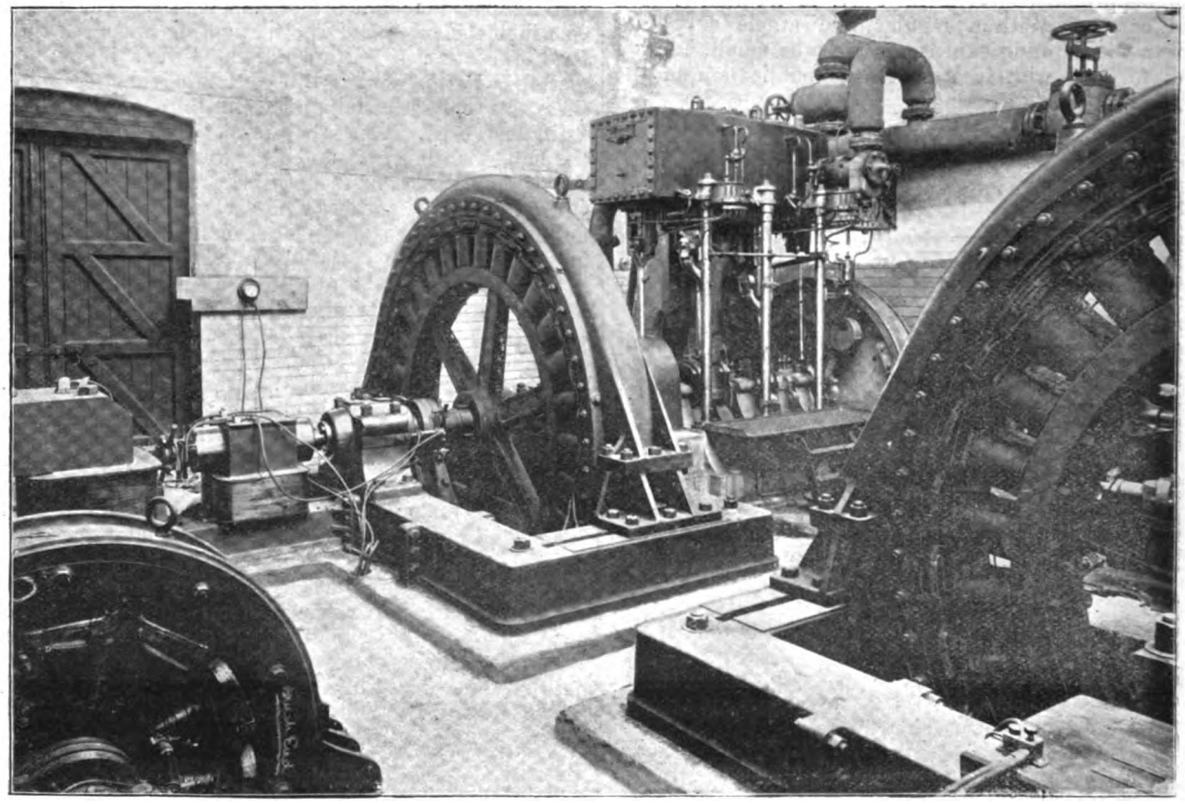

FIG. 1.—View of Engine Room at Eccles Electric Supply Station.

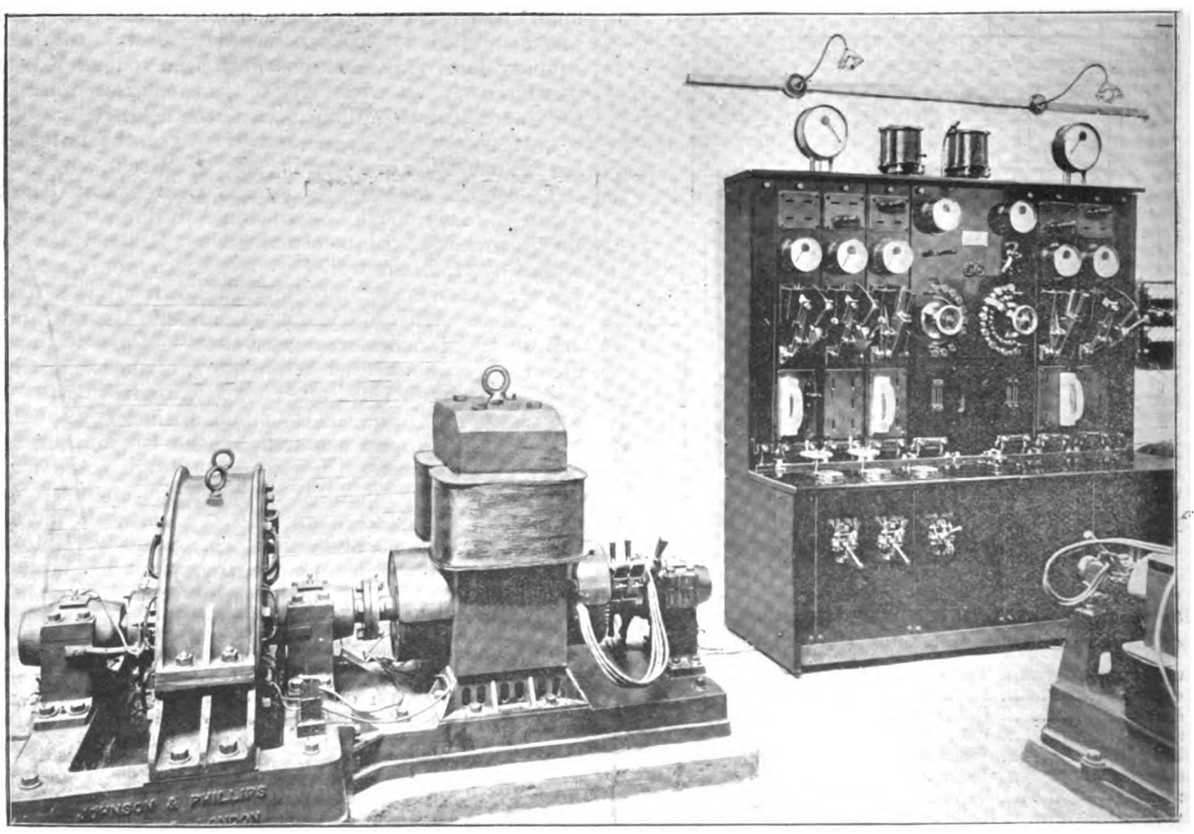

FIG. 2.—Switchboard and Motor-Alternator.

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water is pumped through an oil filter, made by Messrs Haigh Bros., to the feed range for the boilers. There is also an injector of Messrs. Holden and Brooke's "Sirius" pattern as a stand-by, which is capable of delivering 12,000lb. of water per hour against the pressure of 125lb. to the square inch.

There are two sets of compound engines of 200 H.P., each coupled directly to Johnson and Phillips alternators (*see* Fig. 1), and having an output of 120 kilowatts at 200 volts and 50 revolutions per second. The engines are vertical, and were made by Messrs. Browett, Lindley and Co.; high-pressure cylinder 18in., low-pressure cylinder 22in., stroke 16in., and speed 200 revolutions per minute. The high-pressure cylinders have piston valves, and the low-pressure cylinders slide valves. "Begtrup" shaft governors of the latest form are employed, these, it is said, keeping the speed constant to within a maximum variation of 1½ per cent. in any circumstances. The engines are of the open type with cranks set at right angles; they are fitted with self-lubricating devices to all parts, and, in fact, are similar to the Browett-Lindley engines in other electric lighting stations.

A Johnson and Phillips 25-kilowatt motor-alternator, seen in Fig. 2, will, it is expected, suffice to take the whole load of the station after midnight, and to act as a stand-by to dispense with the necessity of employing the second large plant for slight demands above the capacity of one generator. It is run from a 56 cell battery, which it will charge at convenient times, running as a synchronous motor-generator. The machine runs at 600 revolutions per minute, and the alternator side has, of course, the same terminal pressure and frequency as the larger generators. The continuous side is a two-pole machine wound for 100 volts as a motor, and capable of giving 140 volts as a generator, for charging the cells.

The battery has been supplied by Messrs. Pritchetts and Gold. It consists of 56 cells in solid lead boxes, each cell containing 55 plates. The outputs are as follows:—

170 amperes for 9 hours.	273 amperes for 4 hours.
200 amperes for 7 hours.	420 amperes for 2 hours.

An ampere-hour efficiency of 93 per cent. is guaranteed. Each lead box stands in a wooden tray on oil insulators, and the trays are in turn supported on teak rails, which are arranged in two tiers so that there are two rows of cells on each side of the battery room, with a central passage between. The plates are supported by glass bearers, all plates, both positive and negative, being of the Planté type, and any one can be withdrawn and a new one inserted without its being necessary to stop the working of the cell in any way. The plates are kept apart by glass tubes, which are fastened together at the top, each plate having three tubes at equal intervals separating it from the adjacent plates.

The switchboard (*see* Fig. 2) has been manufactured by Messrs. Cowans, of Salford, and is of novel design. There are three machine panels, each of which contains a single-pole switch, fuse, ammeter and voltmeter, the other pole of the alternators being taken direct to another omnibus bar which can be connected to earth or not at will. A spare omnibus bar is provided, so that any machine can be run on either bar, and the feeders run in parallel or separate as desired. At present there are two feeder panels, one for the public lighting and one for private consumers; these have also a single-pole fuse, switch ammeter and voltmeter. All these panels are hinged at the bottom so that they can be swung forward to examine connections and automatically break contact on leaving the vertical position, so that each panel is "dead" and will remain so until restored to its original position. The synchronising transformers are placed on the top of the switchboard and make contact with their feet, two of which form the high-tension and two the low-tension terminals. The transformers can thus be instantly replaced by spare ones, without danger, should either or both fail.

There are two main high-pressure feeders, a 19/16 and a 7/14 cable, both lead-covered. They are laid in wood troughing which is filled in with pitch. An earthenware pipe runs alongside these two feeders to the end of the area proposed in the original scheme. The first scheme has, however, been considerably enlarged on, and cables have been laid into the residential districts, which, it is expected, will readily adopt the electric light. Owing to the fact that the houses are so scattered and the demand not sufficiently centred to allow of the laying down of a low-pressure network, the transformers are at present placed in the houses, except in some cases where the cellar of one of two or three adjacent consumers is made to form a small sub-station. The transformers were supplied by Messrs. Cowans, and have had special side boxes cast on to facilitate making the high-pressure connections. The mains—of which there are about four miles—are all of Messrs. Glover's diatrine type, concentric and lead-covered. The Wright maximum demand system of charging is employed, the prices being 7d. for the first hour's daily consumption and 2d. for remaining units. The street gas-lamps are being converted in every possible instance, and Reason fittings substituted in the lanterns, there being two 100 volt incandescent lamps connected in series for each pillar. This conversion of the gas lamps formed part of Messrs. Glover's contract. Transformer sub-stations are placed at suitable intervals to transform the current down to 200 volts, and a concentric main is taken up the interior of the post. At present there are no arc lamps, but it is expected that some will soon be erected in the principal squares and in the market place.

The whole of the work has been carried out under the direct personal supervision of Mr. Clirehugh, assisted by Mr. F. A. Cortez Leigh, one of the partners in the firm of Lacey, Clirehugh and Sillar, and Mr. Leonard H. Combe, the borough electrical engineer.

Our thanks are due to the above firm and to some of the contractors for assistance in the preparation of this description of the Eccles station.

THE WATER-POWER INSTALLATION AT PADERNO.*

BY G. SEMENZA.

(TRANSLATED BY JOHN R. DICK, B.SC.)

(*Continued from page 258.*)

Having thus shortly described the hydraulic part of the plant, we come now to the electrical part, and will consider, first of all, the general seheme of the installations which are supplied from the central station at Paderno. The current generated by the dynamos is transmited from the omnibus bars at the station directly to the line without the intervention of any transformers. The length of the line is 20 miles (with a branch going to Monza to furnish motive power and light to that industrious town), and it terminates at Porta Volta in Milan. The power house at Porta Volta is divided into two parts: a transformer station for the energy coming from Paderno, and a steam generating station. The transformers, as well as the steam alternators, supply three-phase currents at 3,600 volts and 42 periods. Hence they can be coupled to the same omnibus bars and help each other for the same supply. Porta Volta is thus the centre of distribution in Milan, which comprises three distinct services:

1. The distribution of energy for motors and lighting in the industrial portion of the city by an underground network with three-phase currents at 3,600 volts and a secondary network at 150 volts.

2. The supply for traction purposes with motor-generators placed in the new power house at S. Radegonda.

3. The supply of the old Edison network with continuous current by means of motor-generators placed in the same power house at S. Radegonda.

As regards the system of current, the different manufacturing firms presented proposals for three-phase, two-phase, and continuous current. It must be admitted that, so far as simple transmission without distribution is concerned, the problem within certain limits could be effectively solved by the use of continuous currents. But when one comes to distribution the conditions are changed; it is then necessary to use motor-generators, a solution technically and economically infinitely inferior to that of a system with alternating currents, and destroying all the advantages which are obtained in the transmission.

* Lecture given before the Milan section of the Associazione Elettrotecnica Italiana.

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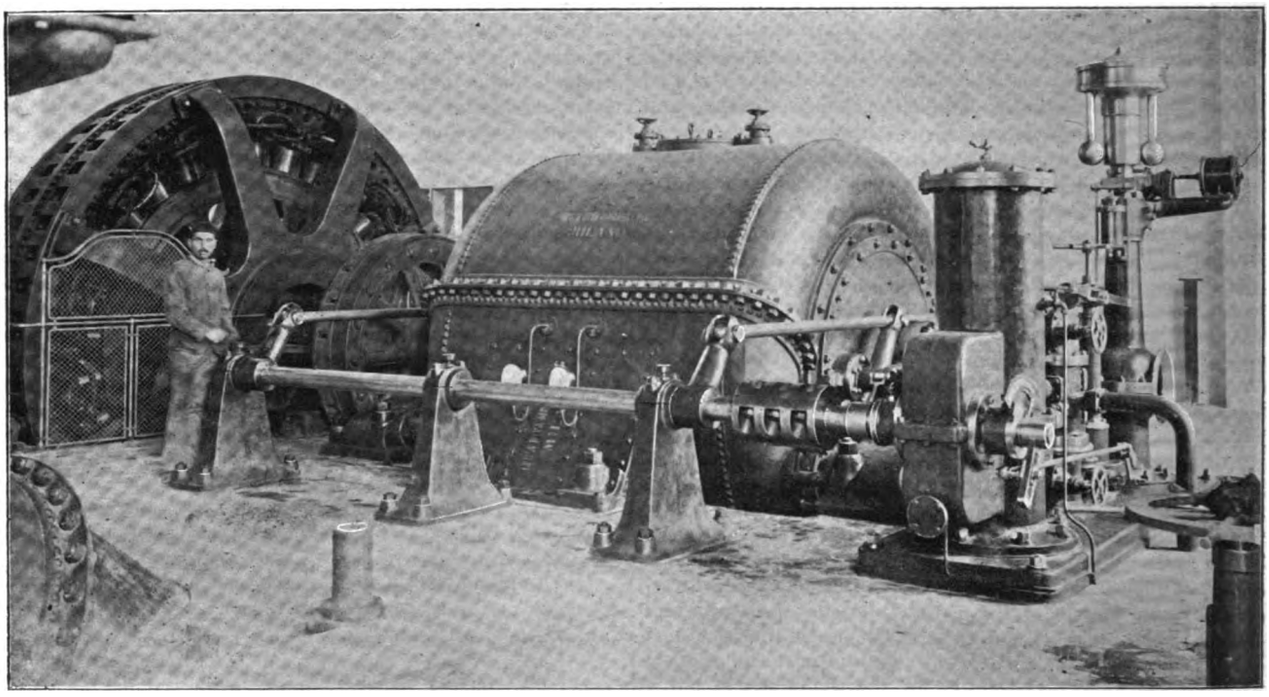
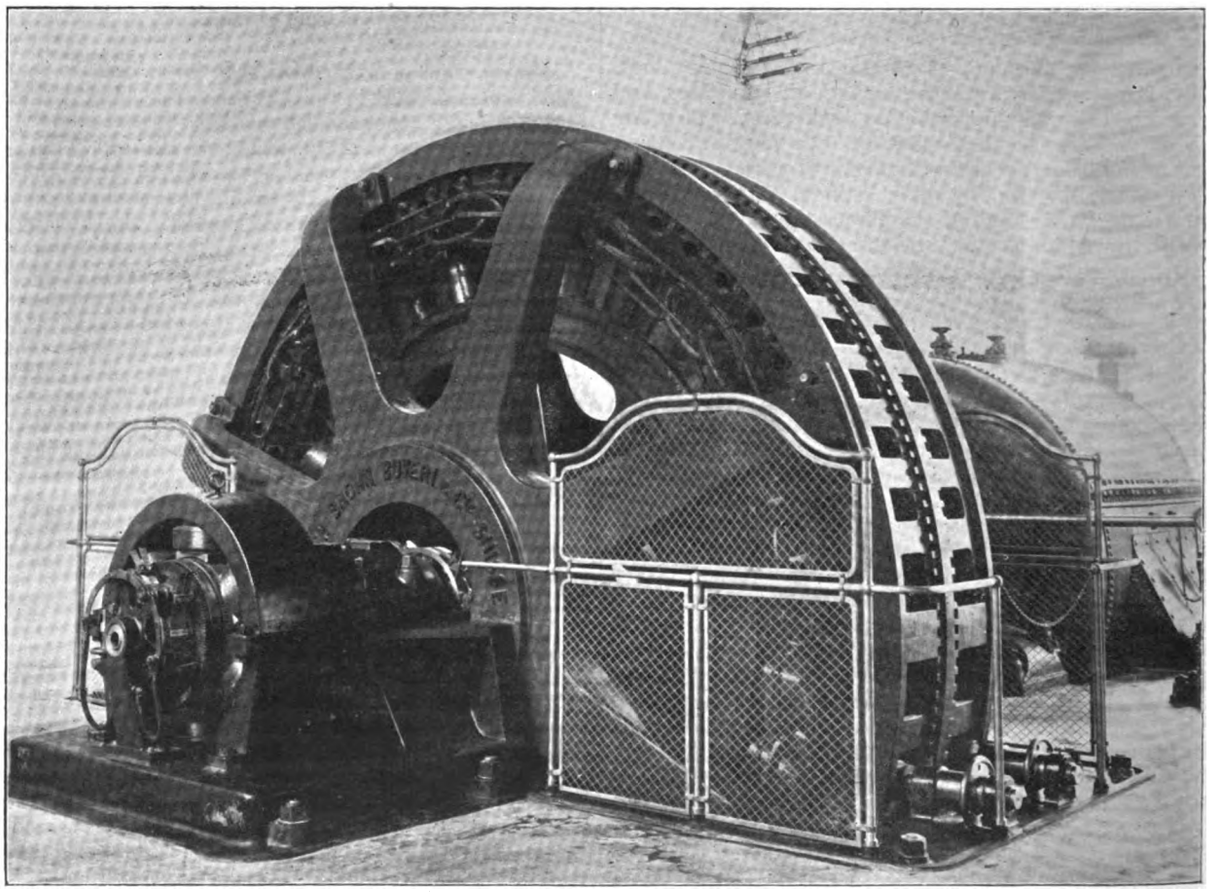
In an installation, which has to supply the varied wants of a large town, a subdivided distribution is now necessary. The choice between two-phase and three-phase was not such an easy matter two years ago as it is to-day. Then the two-phase system, supported by several manufacturers and defended by authoritative opinion, occupied a sufficiently strong position. However, the illusion being destroyed that with the two-phase system the joint supply for motors and lighting was easier, and it having been proved that the transmission was less economical, this system was definitely abandoned for the three-phase, which allows of a mixed supply equally well and perhaps better, and, being perfectly symmetrical in all its



2,160 H.P. Turbine direct connected to the Alternator.



2,160 H.P. Alternator, 13,500-15,000 volts.

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parts, presents a system of distribution more uniform and more elastic.

The choice of the frequency of the current is a matter of the highest importance. After an installation is completed it is easy to change the pressure if it is not too high or too low, and to pass from two-phase to three-phase if the system is not satisfactory, but the frequency, when once the plant has been made, cannot be altered. It is now admitted that the best frequency is from 40 to 60 cycles per second, tending towards the higher limit for installations which are principally for lighting, and towards the lower limit for those in which the motor-load predominates. Our case was of the latter kind, and as the Edison Company already possessed an old monophase Ganz plant, on which were installed several hundreds of kilowatts with transformers constructed for 42 cycles, this frequency was selected. Already it has been proved that incandescent lamps and also arc lamps work in a very satisfactory way at this frequency.

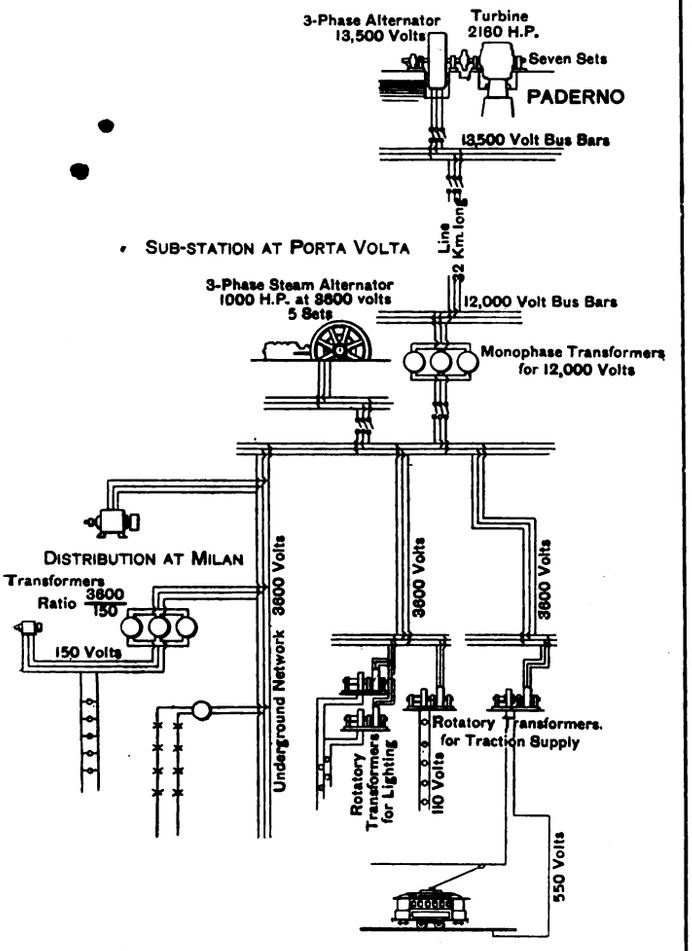

Diagram of System. Length of Line, 32 km.; No. of Wires, 18; Diameter of Wires, 9 mm.; Metallic Posts 60 metres apart.

The pressure may be chosen by superposing two curves, of which the one indicates how the outlay for copper is diminished with the increase of the working pressure, and the other how, with the same output at higher pressures, the cost of the machines, apparatus and insulation are increased. But this is an incomplete calculation, and it would be necessary for its completion to take into consideration the greater expenses of repairs and maintenance in the case of the higher pressure; and above 5,000 volts there is no experience available. For the installation of Paderno the pressure of 13,500 volts, generated directly by the dynamo, was decided upon. The direct production of the line pressure, and hence the elimination of transformers at the generating station, represents a large saving, and as the whole installation becomes very simple, the efficiency is higher, the attention required is small, and the cost of maintenance is trifling. It must be observed, however, that this was the first time that alternators of 13,500 volts had been spoken of. The question might be considered (1) from the point of view of the safety of working and of insulation which a 13,500 volt dynamo presents, and (2) under that of the efficiency of transmission, and finally under that of simplicity of the line.

When the generators of Paderno were first spoken of, there were very few dynamos at work whose pressure reached 3,000 volts. Some manufacturing firms had in their testing room machines for 10,000 volts, which had not been at work, and represented rather a type of laboratory apparatus than a dynamo machine. On the other hand, transformers of 15,000 to 20,000 volts were hardly in existence, and their safety was doubtful. And if it is possible to construct good transformers for 15,000 volts, why is it impossible to construct good alternators for 13,500 volts? As regards the objections which several manufacturing firms raised, most of them depended on their desire to follow, in the construction of machines for high tension, the same methods of construction as employed for low tension, while it should be remembered that a high-tension dynamo is a distinct type, quite different from that for normal tensions. As far as the line was concerned, it was necessary to have a pressure as high as 13,500 volts to obtain a satisfactory solution. In order to avoid a considerable skin effect, the diameters of the wires ought not to exceed $\frac{5}{10}$in. at a pressure of 13,500 volts, and to reduce the loss of energy to 9 per cent. 18 wires were necessary. With 10,000 volts and using 18 wires this loss would amount to 17 per cent., and to reduce it to 9 per cent. 36 wires would be required. Hence the solution with 13,500 volts was simple and economical, and, having the authoritative sanction of Prof. Ferraris, was boldly and deliberately selected. Precautionary measures were taken, however, and the plant was constructed so that, should any unforeseen phenomena arise causing a disturbance, the change to a much lower pressure would be possible without any alteration.

We may summarise the principal data of the three-phase alternator as follows:—The power absorbed is 2,160 H.P. or 1,590 kilowatts, the speed 180 revolutions per minute, the frequency 42 cycles per second. The difference of potential between the wires of the three-phase system is 13,500 volts.

The construction of the machines and of the switchboards was entrusted to the well-known firm of Brown, Boveri and Co., of Baden. The dynamo is of the type with fixed armature circuit, and a revolving field magnet having a number of pole-pieces.

Perhaps, someone may ask why this type was chosen in preference to the inductor type which was common in those days and also to-day, and I am glad of the opportunity to say a little on this point. The advantages of the inductor alternator over others are principally as follows:—The thorough mechanical construction of the revolving part, the abolition of rubbing contacts, the smaller consumption of energy for excitation with a higher efficiency. It is not necessary to stop to prove that these are real advantages; indeed, the fact of not having wires and coils carried round with considerable peripheral speed and exposed to the action of centrifugal force, which tends to damage the insulation, is in itself a very valuable thing. The abolition of rubbing contacts eliminates a source of trouble, which is by no means negligible. The saving in the excitation by the employment of a single coil instead of number of coils may increase the efficiency by 1 or 1½ per cent.

Let us now look at the disadvantages. Not mention the inconvenience of having an exciting coil of 16ft. or 18ft. diameter, we cannot attach too great importance to the fact that, as the iron is badly utilised, these machines are much heavier than others of equal output, and that in many cases this greater size may be very disadvantageous. Let us look next at the enormous leakage of magnetic lines and its effects. On examination of one of these machines it is clear that the external portion of the fixed part and the shaft of the revolving part are free poles of an electro-magnet. At light loads there are but few lines of force which pass through the shaft and supports instead of passing through the air-gap, but when the load increases, and gradually the internal reaction is felt, the lines which escape through the air assume

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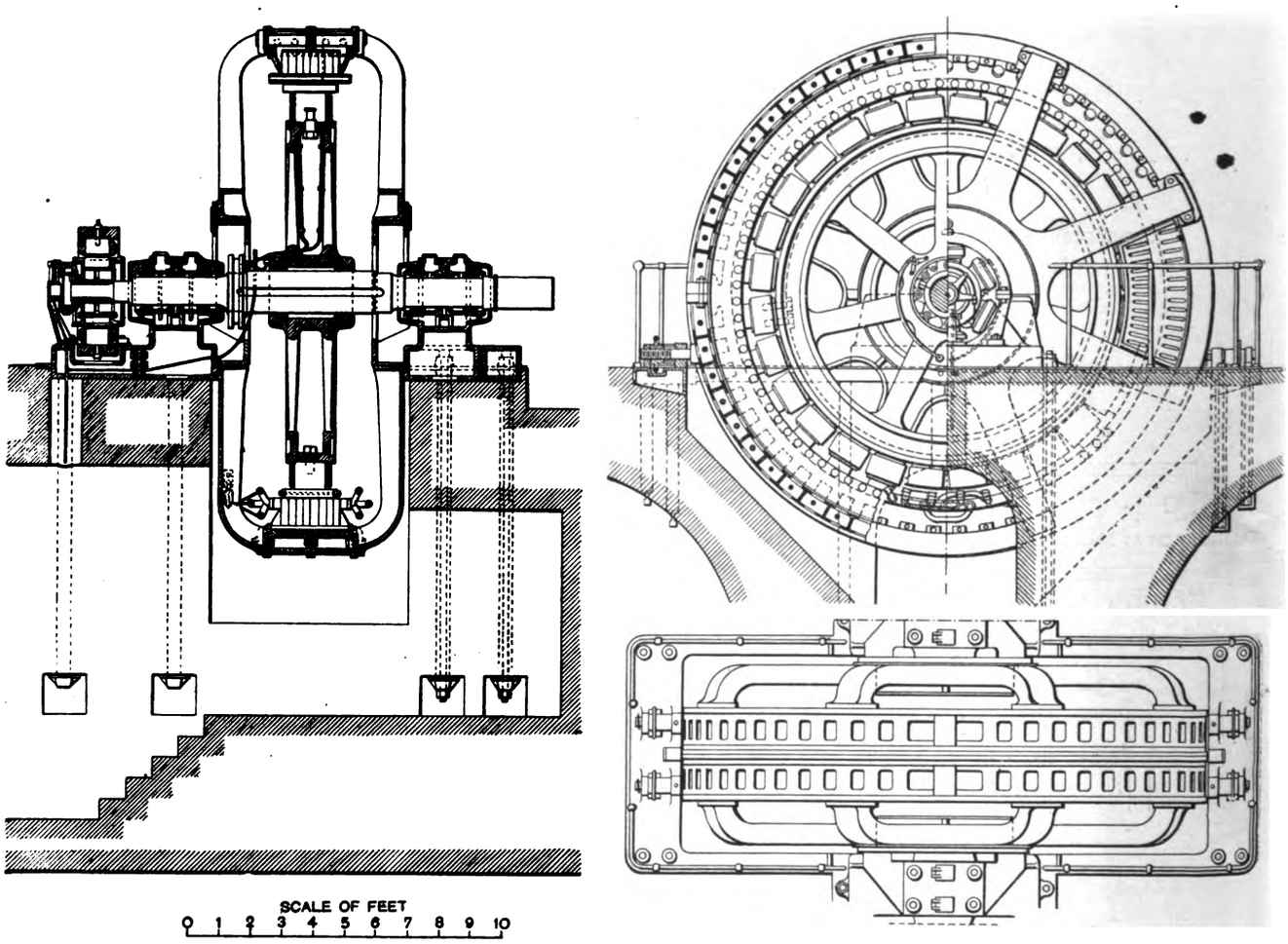
considerable importance, especially if the difference of phase is somewhat large. The proof of this is that all magnetisable objects near the machines are magnetised; for instance, it is necessary to make of bronze the regulators, governors and the parts of the steam engines which are directly coupled to the alternators. The number of leakage lines may become so great that on reaching a certain point it is impossible to increase the pressure, however much the excitation is increased.

To this, if to nothing else, should be attributed the non-success that almost all manufacturing firms have had to record against the machines first made of this type. The whole aspect of this phenomenon called internal reaction is very complicated, and its consequences are accentuated by the fact that in order to lessen the magnetic leakage, it is necessary to have a very small air-gap. In modern alternators it is essential to have a weak internal reaction, otherwise the joint supply of light and of power is impossible, and from this point of view machines with one revolving iron part, which may satisfy well enough the conditions for lighting only, are absolutely inferior to the others.

To turn now to Brown's alternator. It is a machine which at first sight presents a singular appearance. It seems to be composed of two parts which turn round, one inside the other. This form can easily be explained by observing how the internal construction differs essentially from all other machines of this kind. As a rule in the dynamo the fixed parts rest on wide lateral supports to which the bearings are attached. This machine on the other hand rests entirely on the bearings. To the inner side of each bearing is fastened a carrier having a cylindrical surface, and the armature ring is supported by several spokes joining on to a nave which is fitted to this cylindrical surface. This arrangement renders the manufacture simpler and has two special objects in view. The first is to ensure the perfect centering of the fixed part relatively to the revolving part, as everything can be adjusted by subsequently turning the bearing blocks; the second is to facilitate any repairs. In fact, should anything happen to the lower part of the armature it is only necessary to raise the bolts which are seen at the sides of the machine, and to turn the external part round the two cylindrical expansions of the bearings by means of a lever.

The revolving part presents some interesting features as well. 28 poles of cast steel are fastened by two bolts to its periphery. The winding of these poles is not made with wires or strip in the ordinary way, but is constructed as follows:—A flat bar of copper 0·157in. thick and 1in. to 1·18in. wide is wound into a helical form, the turns being insulated from each other by sheets of paper, and the resulting solenoid is compressed hydraulically. A winding is thus obtained which is very solid mechanically, and which does not suffer from the action of centrifugal force. The windings of the armature are passed through tubes of micanite paper. This method of winding is costly, and requires considerable labour, because the coils have to be wound on the machine itself, and have to be passed turn by turn through the tubes; but the use of an internal jointless tube offers great security with high pressures. These tubes project about 4in. from the iron, so as to prevent sparking between the wires and the frame, and the wires themselves are carefully separated by about 6in. distance. For this reason the machine is a great success, but all this care has to be taken in order to obtain an effective insulation.



Three-Phase Alternator.

Each alternator drives its exciter from its own shaft, which is the most economical and simple arrangement. It is true that direct coupling of the exciter has the inconvenience of increasing the variations of pressure due to the variations of speed. For example, as the speed diminishes the pressure will diminish proportionately, and the pressure of the exciter will also be reduced for the same reason, hence the total diminution of pressure of the alternator will be more than proportional to the variations of its speed. Nevertheless, in practice this is not a serious objection, especially if the internal

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reaction is weak, and also because of the magnetic inertia of the machine. On the other hand, the use of separate exciters requires extra turbines, supply pipes and valves, all of which complicate the plant and increase the expense.

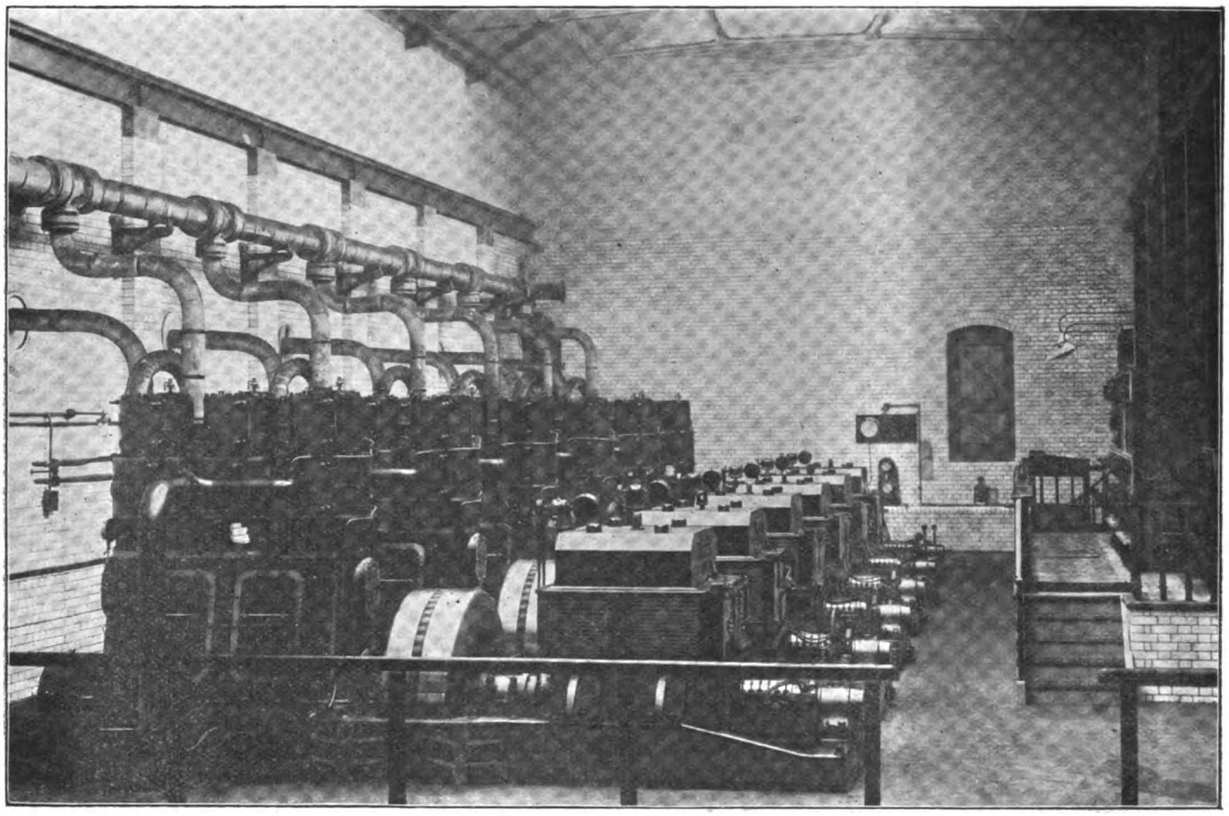
I have said that the internal reaction of this machine is feeble; in fact, it is guaranteed to be within 5 per cent. for a non-inductive load, and 16 per cent. for an inductive load, with a power-factor of 80 per cent. The promised efficiency at full load is 95 per cent. in the first case, and 93 in the second. These alternators are capable of absorbing the full amount of 2,160 H.P. with the above efficiency, when the power-factor is 80 per cent., and they can in this case furnish 80 amperes after running 24 hours at full load. This is what determines the size and power of the machine, and it is the only exact way of stating it. Any statement regarding the power, which does not take into account the power-factor, is absurd.

The method of fixing turbines and alternators in the dynamo room can be seen in the illustrations. The supply pipe passes under the alternator before reaching the turbine. This arrangement was made in order to keep the alternator quite clear of the water discharged, and to interpose a solid wall which would perfectly protect it from dampness, especially in times of flood. Besides, it makes it easier to carry the high-tension conduits from the machine to the switchboards, as these are fixed on that side of the dynamo. The dynamo room in itself does not present any great peculiarities. Great care was taken to secure a good natural ventilation by putting plenty of windows high up. An electrically-driven crane facilitates the operation of dismounting and repairs.

(*To be concluded.*)

WATERLOO AND CITY RAILWAY POWER STATION.

The opening of the Waterloo and City Railway by H.R.H. the Duke of Cambridge on July 12th last was probably the most important event in connection with electric traction in the year just closed. This line, which was described in *The Electrician*, Vol. XLI., p. 383, at the time of its inauguration, is the second completed underground electric railway in the world, that of the City and South London Railway Co. being the first. It possesses no intermediate stations, and was constructed essentially to give an express service between the Waterloo terminus of the L. and S. W. Railway and the centre of the City. We are enabled to give our readers this week a view of the interior of the power station which works this railway, and we are indebted to Messrs. Belliss and Co. for the photograph. The generating plant comprises six direct-coupled high-speed sets. Each set includes a 300 H.P. vertical enclosed Belliss steam engine, coupled to a Siemens 400-ampere compounded two-pole railway generator, working at from 500 to 550 volts. A specially designed switchboard occupies the major part of one end of the room, and is shown at the extreme right of the illustration. Steam is generated in a battery of six dry-back marine-type boilers, built by Messrs. Davey, Paxman and Co., the furnaces being stoked by the Vicars automatic coking stoker. We may add, in conclusion, that this power station is designed for a five-minutes' service of trains running at 25 miles an hour, each train consisting of four coaches, and having accommodation for 204 passengers.



Waterloo and City Railway. Interior of the Machinery Room.

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IMPROVEMENTS IN MAGNETIC SPACE TELEGRAPHY.*

BY DR. OLIVER LODGE, F.R.S.

(Continued from page 309.)

PART III.

DETECTORS.

A large number of devices for improving the dectector of the fluctuating current at the receiving station were made and tried, and a few of them may be here described.

TONE TELEPHONE.

Not only was it considered desirable that the two circuits should be attuned to each other and to the sending dynamo or intermitter, but also it was thought well to make the receiving telephone so that it would only or chiefly respond to one particular note. I had found that the diaphragm of a Bell telephone need not be free everywhere except at the edges, but might nearly as well be fixed all over to a thin deal sound-board, upon which the ear was directly pressed. Consequently, I proposed to use this sound-board idea for a tone telephone. One good form is represented in Figs. 1 and 2, where F is the tuning-fork, screwed into a sound-board, E, with its prongs highly magnetised, and with a short iron electro-magnet, *c*, between its prongs, round which the received alternating currents were to circulate. The whole was mounted, in one form, Fig. 1, in a compact case, in general appearance like a Bell telephone, and the result was very sensitive to the proper note—distinctly more so than an ordinary telephone when both were in circuit. The ear was laid right upon the wooden end E, which holds the stem of the fork; and though, of course, the sound did not rise and decay quite sharply, yet signals could be clearly read, and the damping of the fork might be at any time increased, at the expense of a little sensitiveness, whenever sharper—*i.e.*, quicker—signals were wanted. Such a tone-telephone arranged on a large sound-board, or with a resonant jar, like Fig. 2, may serve as syntonic "call," accurately discriminating one station from another.

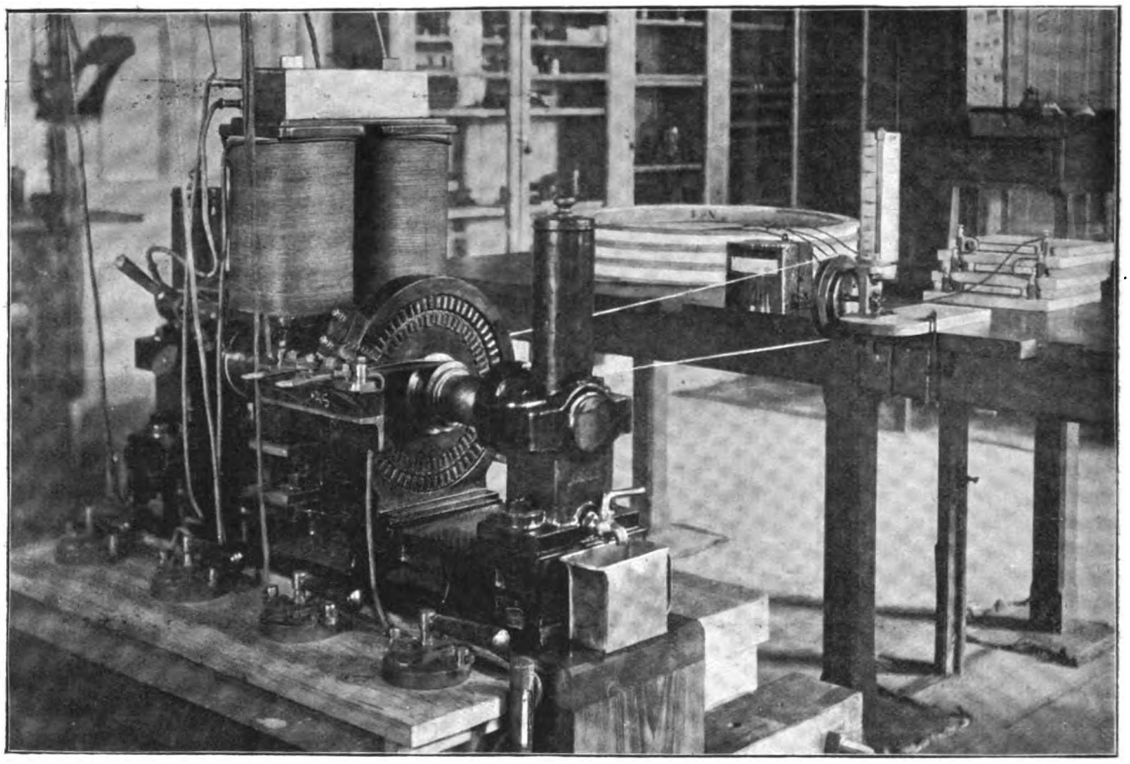
Another use for which a magnetised tuning-fork telephone is convenient is to serve as a weak local sender for the purpose of testing whether the receiving circuit is properly adjusted or not. Thus, for instance, suppose signals are expected from a distant station, and are not being received, it may be because the receiving circuit or its apparatus has gone out of tune a little; so its tone can be tested by twitching with the fingers the tuning-fork of a tone telephone whose local circuit is properly arranged in inductive connection with the main receiving circuit. It gives at each twitch a feeble alternating current, which should make the receiving instruments decidedly respond. If they do not, they must be adjusted till they do. Similarly, a local receiving fork-telephone may be used to test the adjustment of the secondary circuit.

COHERER.

Another totally different form of detector was suggested by my old experiment of the syntonic jars, where the air gap was filled by a pair of knobs in near contact, and with a local battery and bell—in other words, with what is now called a coherer circuit. So now the receiving condenser can be shunted by a coherer, and a relay worked by the signals so obtained. But to the sinuous disturbance of an alternator a coherer turns out practically insensitive; it is to electric jerks that it responds. Accordingly, when the sender is of the make-and-break kind a coherer answers; but when it is of the slowly alternating kind it fails.

COHERER CALL.

By inserting an interruptor I in the receiving current so as to jerk any induced sinuous current that it may find there, the coherer C can be made to work, and one plan of its connections is shown in Fig. 3. It may not at first be apparent why there should be two condensers, S S, in series in this figure, but it must be remembered that the interruptor must not be allowed to affect any portion of the local battery current; else, of course, the coherer will respond when no signals are being sent. A is the receiving coil, R a relay and B a bell.



†FIG. A.—Photograph of the small high-frequency Alternator made for Dr. Lodge by Messrs. Chas. Parsons and Co., Newcastle; driven by motor on same shaft and reaching 3,000 per second.

† The Figures A, B, C, &c., are not referred to actually in the Paper itself, but served, in the form of lantern slides, to illustrate Dr. Lodge's remarks at the Institution on December 8th.

BOLOMETER.

A bolometric call was also tried, and was found to work, but, as it was not specially successful, the details of it will not be given.

VIBRATING COIL TELEPHONE.

For the purpose of disturbing a sound-board, and in general of producing a mechanical effect in solids or liquids, as opposed to gases, it was thought probable that an iron diaphragm was not the best plan, but that the whole receiving coil might be mounted so as to be itself capable of vibration in a strong magnetic field. An early form of the vibrating coil telephone and sound-board is shown in Fig 4, where M is a large horse-shoe magnet with perforated pole-pieces, one of which carries a sound-board E with a stretched wire from its middle passing right through the perforations to a screw tightener H, and carrying, rigidly

* Paper read at the Institution of Electrical Engineers, Dec. 8, 1898.

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attached to its middle, a light fine-wire coil, C, matted together with shellac, and placed between the pole-pieces. The magnet was magnetised, not in the customary way, but with its adjacent poles of the same sign, so that the lines of force

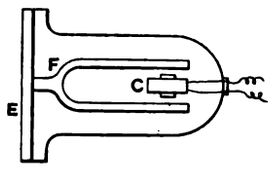

FIG. 1.

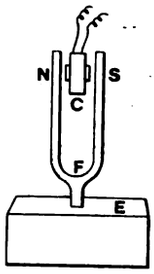

FIG. 2.

spread out through the coil, and gave it the chance of cutting them rapidly if it moves at all axially. On passing feeble alternating currents through the coil the sound-board was strongly affected by

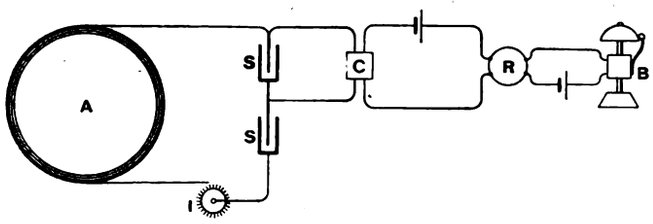

FIG. 3.

its taut wire. A subdivided iron core was subsequently placed in the coil, but, whether by reason of the increased mass, or for some other reason, it did not now work so well.

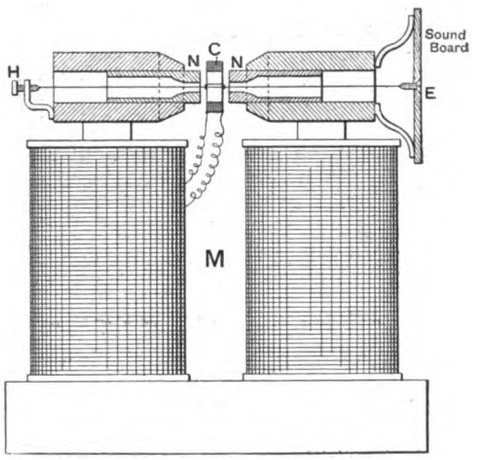

FIG. 4.

Another form was then made with a magnet specially designed as shown in Fig. 5. All the iron was well annealed, plenty of field winding put on, and the air gap was an annulus $\frac{3}{8}$in. square in

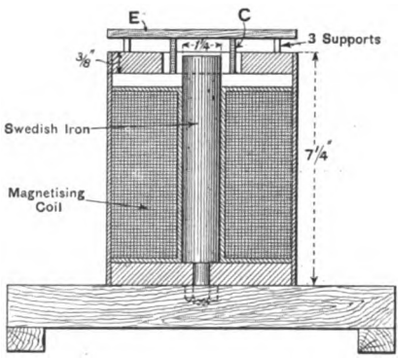

FIG. 5.

section and $1\frac{1}{2}$in. in diameter; no attempt was made to subdivide the iron, because in this arrangement it is plain that eddy-currents are all to the good. They do not occur in any moving part, so their chief effect is to diminish the impedance of the receiving coil. The coil is powerfully damped by the strong field, and a certain strength of field is, therefore, best. The coil was cemented direct to a wooden disc, and the thicker this disc the higher the note to which the arrangement most powerfully responded. By placing the ear on the wood, the first-made instrument on this plan was exactly as sensitive as the best of the usual patterns of telephone—for instance, the Collier or the Ader pattern.

Tambourine membranes and many other plans were tried for holding the coil, but the simple wooden sound-board answered best.

The wooden disc need not be clamped at its edge. It has a circular nodal line, and in three points on this circle it was usually clamped so that it could vibrate freely like a circular sort of harmonicon reed. Thus mounted it was very sonorous, at least before the coil was put on. The load of the coil had to be taken into account in finding the nodes, and they were accordingly found experimentally. When the plate was unloaded its nodal line was at 0·68 of its radius, which agrees with theory. The loading, however, spoiled all this and greatly increased the damping, so that considered as a syntonic receiver it was not successful. The coils at and time were of copper, and heavy. Now they are of aluminium, this much lighter.

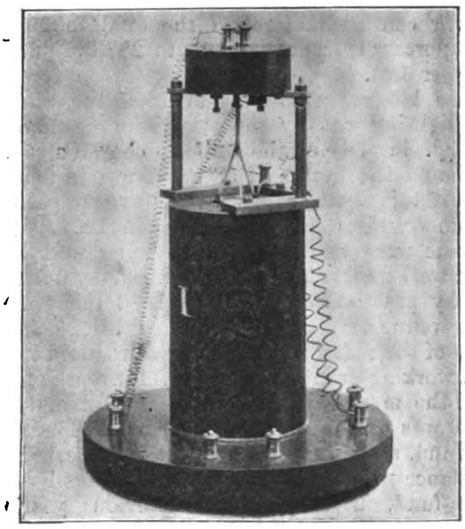

FIG. B.—Photograph of Single-pole Electromagnetic Magnifying Telephone, with suspended coil and extra large microphonic transmitter for strong currents. Compare Fig. 5.

The present plan of a large soundboard, and a light coil rigidly attached to its middle by either a light wooden tripod or a light cone, was then designed, and has not been improved upon.

(*To be concluded.*)

An American Lighthouse.—It is announced, says the *Western Electrician*, at Marquette, Mich., that experiments will be conducted by the government at that point in the use of electricity in lighthouses. A submarine cable has been shipped to the local electric light and power company, and it will be laid to the lighthouse on the extreme end of the breakwater in the lower harbour. The lantern in the lighthouse will be fitted with a concentrated-filament stereopticon incandescent light of 50 c.p., five times the candle power of the kerosene light which is now in use. But the increase in brilliancy is a secondary object. In the spring and autumn gales waves frequently sweep the breakwater from end to end; and it is a matter of much peril for a man to traverse 3,000ft. of breakwater in order to light the lamp. The first 1,000ft of the breakwater is capped with a concrete superstructure which has a tunnel running through it. That far the cable will pass thorough the tunnel and be throughly embedded in cement. For the remaining 2,000ft., which is not capped by a superstructure, the cable will pass over the top of the breakwater, being held in its place by cleats. It is this part of the course which necessitates the use of a submarine cable, because heavy seas constantly break over it in storms. Here would have been a good opportunity for a short-distance trial of Mr. Tesla's wireless power transmission system.

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ELECTRICITY WORKS ACCOUNTS.

Aberdeen Municipal Electric Supply Works.

The first of our two analyses this week deals with the accounts of the second and third years of working of the Aberdeen Municipal undertaking. As well be gathered from a comparison of the two years' figures given in our table, the progress of the concern both in the matter of output and increased economy of working was well maintained in 1897.

Of the total authorised capital of £52,000 at December 31, 1897, £45,086 had been received, while of this latter sum £2,155 had been repaid out of the sinking fund. The total capital expenditure amounted to £48,423, representing £79·3 per kilowatt capacity of generating plant in the station; the amount expended during 1897 being £11,802. The capacity of the plant in the station had, during the year, been augmented by 180 kilowatts, thus raising the total generating capacity to 610·8 kilowatts. As regards the custom—corresponding to an increase in the equivalent 8 c.p. lamp connection of 17 per cent., which raised the total to 29,635, the output has increased from 210,185 to 287,072 units sold, or about 32 per cent.

During the latter six months of 1897 the charges for current for lighting was by the maximum demand system from 6d. to 3d., in place of the uniform charge of 5d. which, during 1896 and the first half of 1897, was in force. As a consequence of this change, the average revenue per unit sold dropped from 5·18d. in 1896 to 4·77d. in 1897. Although the 1896 costs were very satisfactory, being well below the average, the works costs have been reduced by 0·3d. and the total costs by practically 0·5d. In 1896 the works costs bore to the revenue a ratio of 51·1 per cent., in 1897 this ratio was, in spite of the reduction in the tariff, reduced to 45·5 per cent., and a working profit made of £3,111, representing 7·32 per cent. of the mean capital expended. Out of this gross profit £1,150 was paid in interest on loans, £768 allocated to the reserve fund, and £1,024 paid into the depreciation fund, leaving a balance to the good of £169, which has been carried to a reserve fund, out of which the previous year's deficit was paid.

It may be interesting to note that the sum of £1,024 paid on account of depreciation was arrived at under the following scale of depreciation charges on the respective items of capital expenditure:—Buildings 1 per cent., machinery 5 per cent., accumulators 5 per cent., mains and services 1½ per cent., electrical instruments 2½ per cent., and meters 5 per cent.

The progress of electricity supply at Aberdeen since the commencement is shown by the following table:—

Year.	Quantity generated B. T. U.	Sold public lamps.	Sold private consumers.	Total sold.	No. of public lamps.	Price per unit.
1894 ...	71,921	6,169	58,843	65,012	10	7d.
1895 ...	159,777	8,257	130,115	138,372	10	6d.
1896 ...	236,649	11,057	199,128	210,185	14	5d.
1897 ...	317,552	15,310	271,762	287,072	22	5d., 6d., 3d.

Cardiff Municipal Electric Supply Works.

Started in December, 1894, the Cardiff supply undertaking has completed its third year of working, the accounts of which form the subject of our second analysis this week. It should be noticed that the first year in our table ends at December, 1896, while the second year dates from March 31, 1897, and ends at March 31, 1898. The authorised capital at this latter date was £59,835, and the total amount borrowed and received was £32,500. The sinking fund stands with a balance of £2,621 for repayment of loans, of which £31,146 was at 3 per cent. and £1,354 at 3½ per cent. interest. The total capital expended at March 31st last amounted to £62,430, representing £142 per kilowatt of plant capacity.

Owing to the non-delivery by the contractors of a 300 kilowatt generating set, which should have been in place more than a year ago, the progress of the business has been severely handicapped, with the result that the lamp connections during 1897-8 were only the equivalent of 2,976 8 c.p. lamps, representing an increase of 21 per cent.

The output for 1897-8 was 357,193 units sold, as compared with 308,430 in 1896, being an increase of about 16 per cent. It is rather interesting to note the somewhat high ratio of the output to the plant capacity which obtains at Cardiff, in spite of its having an alternating-current system of supply with, therefore, no batteries nor motor load. In this respect it may be likened to the Portsmouth and Tunbridge Wells loads where this ratio was, in 1897, of the values 37 and 23·7 respectively, as compared with the mean of most of the alternating current supply systems in operation, viz., about 18 units per 8 c.p. lamp capacity of plant. Take, again, Bristol with its good proportion of arc lighting, but with an output for 1897 of not more than 19 units per 8 c.p. lamp capacity of plant as compared with Cardiff's 26 and Portsmouth's 37, and we are constrained to the conclusion that arc lighting supplied from the usual incandescent lighting plant in the station must prove of great advantage to an undertaking.

Costs at Cardiff have been sensibly reduced during the last year chiefly through economies in generation items which, collectively, have dropped nearly 0·5d. Management and property charges have risen, however, with the result that the total costs show a drop of not more than about one-third of a penny, the figure for 1897 being 2·97d. per unit sold—a not abnormal value considering the embarrassment occasioned by the delay in the plant extensions and the cost in wages of running the rectifiers in a sub-station a mile away from the central station.

We are very pleased to see that the undertaking has attained a self-supporting stage, in that instead of a deficit, as was the case in 1896 to the extent of £548, a profit of £61 was made, after paying £1,667 as interest on loans, and £848 to the sinking fund.

We shall look forward with pleasure to further decreases in the costs at Cardiff when the arc lighting rectifiers, hitherto installed below the Town Hall, shall have been removed to the central station in Canton, and when the present plant extensions permit of the normal expansion of business.

In 1895 the output was 175,078, and the maximum load 275 kilowatts, while at the end of that year the equivalent lamp connection was 9,330 8 c.p. lamps, and the number of consumers 108.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Ayr (Municipal)	Nov. 11	Kens'gton & Knightsbr'ge (Co.)	Sept. 30
Bedford (Municipal)	Mar. 4	Kingston-upon-Hull (Municipal)	Aug. 19
Belfast (Municipal)	Sept. 23	Kingston-upon-Thames (Mun.)	Mar. 25
Birmingham (Company)	Dec. 16	Lancaster (Municipal)	Oct. 21
Blackpool (Municipal)	Oct. 7	Leeds (Company)	April 8
Bournemouth (Company)	June 8	Leyton (Municipal)	Sept. 23
Bolton (Municipal)	Dec. 9	Liverpool (Municipal)	Aug. 12
Bradford (Municipal)	May 20	Manchester (Municipal)	July 29
Brighton (Municipal)	May 6	Newcastle and District (Co.)	Dec. 2
Bristol (Municipal)	July 29	Newcastle-upon-Tyne (Co.)	April 29
Burnley (Municipal)	Sept. 16	Northampton (Company)	April 15
Burton-upon-Trent (Municipal)	April 15	Norwich (Company)	Dec. 2
Bury (Municipal)	Nov. 25	Notting Hill (Company)	Mar. 11
Cambridge (Company)	June 17	Nottingham (Municipal)	Oct. 28
Charing Cross (Company)	April 22	Oldham (Municipal)	Nov. 18
Chelsea (Company)	May 20	Oxford (Company)	April 1
Cheltenham (Municipal)	Oct. 7	Portsmouth (Municipal)	Nov. 4
Chester (Municipal)	Oct. 14	Preston (Company)	Oct. 28
Clerkenwell (Company)	Mar. 18	Reading (Company)	Sept. 16
Derby (Municipal)	Dec. 9	Richmond (Company)	Mar. 4
Dewsbury (Municipal)	Nov. 25	Scarborough (Company)	April 1
Dover (Company)	Mar. 11	St. James' & Pall Mall (Company)	July 1
Dundee (Municipal)	Nov. 4	St. Pancras (Vestry)	May 13
Eastbourne (Company)	July 22	Sheffield (Company)	Dec. 16
Edinburgh (Municipal)	Oct. 14	Shoreditch (Vestry)	May 27
Exeter (Municipal)	Aug. 5	Southampton (Municipal)	June 3
Glasgow (Municipal)	Aug. 12	Southport (Municipal)	Dec. 23
Guildford (Company)	May 13	Stafford (Municipal)	Oct. 21
Halifax (Municipal)	Nov. 18	Sunderland (Municipal)	Aug. 19
Hammersmith (Vestry)	June 10	Taunton (Municipal)	Aug. 5
Hampstead (Municipal)	Sept. 9	Tunbridge Wells (Municipal)	July 23
Hanley (Municipal)	April 8	Walsall (Municipal)	Nov. 12
Harrogate (Municipal)	Dec. 30	Wandsworth (Company)	Mar. 11
Harrow (Company)	Sept. 9	Westminster (Company)	April 20
Hastings & St. Leonard's (Co.)	April 29	Whitehaven (Municipal)	Dec. 25
House-to-House Co. (Kensington)	Sept. 30	Windsor (Company)	Dec. 30
Hove (Company)	May 6	Wolverhampton (Municipal)	July 17
Huddersfield (Municipal)	Mar. 25	Worcester (Municipal)	May 12
Islington (Vestry)	June 24	Yarmouth (Municipal	June 18

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	ABERDEEN.				CARDIFF.			
Undertaking Worked by	Aberdeen Corporation.				Cardiff Corporation.			
Date of Commencement of Supply	March, 1894.				December, 1894.			
System of Supply	3-wire continuous-current.				Alternate-current transformer sub-stations.			
Chief Engineer	A. Blackman.				N. Appelbee.			
YEAR ENDED	DEC. 31 **1896.**		DEC. 31, **1897.**		DEC. 31, **1896.**		MAR. 31, **1898.**	
QUANTITIES—								
Units generated	236,649		317,552		397,204		480,538	
„ SOLD (TOTAL)	210,185		287,072		308,430		357,193	
„ sold to consumers	199,128		271,762		209,114		259,828	
„ sold for public lighting, &c.	11,057		15,310		99,316		97,365	
„ used on works	3,869		6,524		11,881		5,004	
UNITS SOLD PER 8 C.P. LAMP CAPACITY	15·60		15·04		22·4		26·0	
Maximum supply demanded	—		368·5 kilowatts		355		375	
Number of public lamps	14 arc		22 arc, 2 (32 c.p.) glow		52		52	
Number of consumers	—		279		164		184	
Connections to mains in 8-c.p. lamps	25,329		29,635		14,136		17,112	
CAPACITY OF PLANT IN 8-C.P. LAMPS	13,460		19,080		13,750		13,750	
CAPACITY OF PLANT IN KILOWATTS	430·8		610·8		440		440	
CAPITAL—	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.
AUTHORISED (TOTAL)	£32,000	£74·3	£52,000	£85·1	£57,385	£130	£59,835	£136
Share	—	—	—	—	—	—	—	—
Loan (including Debenture charges)	32,000	74·3	52,000	85·1	57,385	130	59,835	136
RECEIVED (TOTAL)	34,555	80·2	45,086	73·8	32,500	73·9	32,500	73·9
Share	—	—	—	—	—	—	—	—
Loan (including Debenture charges)	34,555	80·2	45,086	73·8	32,500	73·9	32,500	73·9
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	—	—	6,914	11·31	24,885	56·6	27,335	62·1
Share (unissued)	—	—	—	—	—	—	—	—
Share (uncalled)	—	—	—	—	—	—	—	—
Loan (including Debentures)	—	—	6,914	11·31	24,885	56·6	27,335	62·1
REPAID (TOTAL)	1,405	3·26	2,155	3·53	—	—	—	—
RESERVE OR SINKING FUND	—*	—	—*	—	1,716	3·9	2,621	5·96
DEPRECIATION FUND	1,841	4·27	2,865	4·69	—	—	—	—
EXPENDED (TOTAL)	36,621	85·0	48,423	79·3	49,517	113	62,430	142
Lands and buildings	7,076	16·4	8,677	14·2	11,661	26·5	14,358	32·6
Plant	15,742[a]	36·5	23,505[d]	38·5	14,937	34·0	22,770	51·8
Mains	13,803	32·0	16,242	26·6	17,916	40·7	19,990	45·4
Miscellaneous	—	—	—	—	5,002	11·4	5,309	12·1
BALANCE OF CAPITAL ACCOUNT	−2,066[b]	−4·79	−3,337[b]	5·46	−17,017[a]	−38·7	−29,930[a]	−68·0
REVENUE—	Total.	Per unit sold.	Total.	Per unit sold.	Total.	Per unit sold.	Total.	Per unit sold.
TOTAL	£4,534	5·176d.	£5,708	4·772d.	£5,858	4·558d.	£7,026	4·720d.
Revenue from supply	4,126	4·712d.	5,373	4·490d.	4,749	3·695d.	5,984	4·020d.
„ meters, &c.	119	0·136d.	78	0·065d.	182	0·142d.	117	0·079d.
„ public lighting	209	0·239d.	257	0·215d.	922	0·718d.	925	0·622d.
„ sale of lamps, &c.	—	—	—	—	—	—	—	—
„ miscellaneous sources	80	0·091d.	—	—	5	0·004d.	—	—
EXPENDITURE OUT OF REVENUE—								
TOTAL COSTS	£2,315	2·643d.	£2,596	2·168d.	£4,245	3·301d.	£4,427	2·974d.
WORKS COSTS	1,476	1·685d.	1,659	1·387d.	3,704	2·882d.	3,578	2·405d.
Generation of electricity	*1,364*	*1·557d.*	*1,502*	*1·255d.*	*3,242*	*2·522d.*	*3,069*	*2·062d.*
Fuel (including cartage, &c.)	219	0·250d.	451	0·377d.	806	0·627d.	872	0·586d.
Oil, waste, water, stores	76	0·087d.	146	0·122d.	511	0·398d.	499	0·335d.
Wages at station	515	0·588d.	554	0·463d.	1,562	1·215d.	1,460	0·981d.
Repairs and maintenance at station	554	0·633d.	351	0·293d.	364	0·283d.	238	0·160d.
Distribution of electricity	*112*	*0·128d.*	*157*	*0·131d.*	*155*	*0·120d.*	*243*	*0·163d.*
Wages, &c.	—	—	—	—	93	0·072d.	89	0·060d.
Repairs, renewals of mains, &c.	112	0·128d.	157	0·131d.	62	0·048d.	154	0·104d.
Public lighting	—	—	—	—	*307*	*0·239d.*	*266*	*0·179d.*
Attendance	—	—	—	—	158	0·123d.	147	0·099d.
Renewals	—	—	—	—	149	0·116d.	119	0·080d.
MANAGEMENT AND PROPERTY CHARGES	839	0·958d.	937	0·784d.	541	0·421d.	849	0·571d.
Royalties	—	—	—	—	—	—	—	—
Rent, rates, taxes	*352*	*0·402d.*	*402*	*0·336d.*	*77*	*0·060d.*	*80*	*0·054d.*
Management	*487*	*0·556d.*	*535*	*0·447d.*	*464*	*0·361d.*	*769*	*0·517d.*
Salaries	298	0·340d.	313	0·262d.	313	0·244d.	570	0·383d.
Stationery, &c.	105	0·120d.	100	0·084d.	85	0·066d.	59	0·040d.
Establishment charges	52	0·059d.	97	0·081d.	25	0·019d.	54	0·036d.
Law charges, &c.	32[c]	0·037d.	25[e]	0·021d.	41[b]	0·032d.	86[d]	0·058d.
FINANCIAL RESULTS—	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£2,220	6·61%	£3,111	7·32%	£1,613	3·65%	£2,600	4·64%
Sum carried to Depreciation Fund	845	2·52%	1,024	2·41%	—	—	—	—
Sum carried to Reserve or Sinking Fund	641	1·91%	768	1·81%	—	—	848	1·51%
Net interest on loans (incl. Debenture charges)	926	2·76%	1,150	2·71%	2,145	4·85%	1,667	2·98%
BALANCE FROM LAST ACCOUNT	—	—	—	—	—	—	—	—
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	—	—	169[g]	0·398%	—	—	61[e]	0·109%
Deficit	*193[f]*	*0·575%*	—	—	*548[c]*	*1·24%*	—	—
ORDINARY DIVIDEND PAID	—	—	—	—	—	—	—	—
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	51·1%		45·5%		72·5%		63·0%	
Expenditure per kilowatt capacity	£5. 7s. 6d.		£4. 5s. 0d.		£9. 13s. 0d.		£10. 1s. 2d.	
REVENUE PER KILOWATT CAPACITY	£10. 10s. 5d.		£9. 7s. 0d.		£13. 6s. 0d.		£15. 19s. 2d.	
Expenditure per 8-c. lamp capacity	3s. 5¼d.		2s. 8½d.		6s. 2d.		6s. 5½d.	
REVENUE PER 8-C.P. LAMP CAPACITY	6s. 8¾d.		5s. 11½d.		8s. 6½d.		10s. 2½d.	
REVENUE PER 8-C.P. LAMP CONNECTED	3s. 7d.		3s. 10¼d.		8s. 3¼d.		8s. 2½d.	
Price charged for lighting, per unit	5d.		6d. to 3d.[h]		6d. to 3½d.		6d. to 3½d.[f]	
Price charged for power, per unit	5d.				3d.		3d.	
Price charged for public lighting	5d.				£18 per lamp per ann.		£18 per lamp per ann.	

ABERDEEN.—REMARKS—* The sinking fund has been absorbed in repayment of loans, but there is a reserve fund distinct from the sinking and depreciation funds which amounted to £253 in 1896 and £429 in 1897. *a* Inclusive of £901 on accumulators, £1,631 on electrical instruments and £2,057 on meters. *b* Over-expended. *c* Includes insurance, £13, and bad debts, £19. *d* Inclusive of £1,655 on accumulators, £1,702 on electrical instruments and £3,055 on meters. *e* Includes insurance, £20, and bad debts, £6. *f* Met by the reserve fund. *g* Paid into the reserve fund. *h* By the maximum demand system. This scale superseded the even charge of 5d. per unit, as in 1896, at the middle of 1897.

CARDIFF.—REMARKS—*a* Over-expended. *b* Being to insurance. *c* Includes £16 paid for management of stock and composition duty; this deficit is met by the district rate. *d* Includes auditing £25, and insurance £61. *e* After deducting £24 to management of stock and composition duty. *f* By maximum demand system.

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SPECIAL NOTICE.

With this issue of "THE ELECTRICIAN" is published the large Sheet Table of Electrical Supply Undertakings of the United Kingdom, which all purchasers of the Paper should receive gratis. Complaints of non-receipt should be promptly made to THE PUBLISHER.

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1898.

The commencement of a New Year once more gives occasion for a brief review of the progress in electrical industry and science during the past twelve months. It is pleasing to note on every hand a steady advance, and abundant indications that both in theoretical science and in industrial applications electricity is still making rapid strides. As the new century looms nearer and nearer it becomes more apparent that electricity is, as it were, the key note, whether for researches into the true-inwardness of physical and physico-chemical phenomena, or for improving the material conditions of modern civilisation. Even in biological science electrical action is held to explain much of the physical aspect of that inscrutable mystery—Life; and in the practical side of biology, in medical and surgical treatment, the value of electricity is being increasingly recognised. Thus, throughout a wide range of the scientific and practical life of to-day, electricity, in one aspect or another, is playing a part that constantly assumes greater importance; and the promise that the new century will inaugurate an "Age of Electricity" was never so sure as it is at the present time.

Casting a glance backwards over the events of the year just closed, we may first notice those which relate to the more practical side of electrical affairs. The leading character of all these, we think, is reflected in three conspicuous events—the engineering strike, the Parliamentary inquiry into the law of electric generating stations, and the Parliamentary inquiry into the telephone question. The triad may appear ill-assorted, yet it is not so incongruous as at first sight appears. Although the engineering strike belongs more especially to the previous year, it was not actually terminated until well on into 1898, while its evil influence and disastrous consequences have been stamped on British industry ever since, and are not soon to be eradicated. Since the termination of the strike there has been an enormous accession of work in the engineering manufactories of the country; large and small contractors

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alike have had their hands full, have been working continuously on double shifts and overtime, and yet have dismayed their customers on all sides by protracted delays in fulfilling contracts. This activity may or may not be encouraging, according to whether it is to be permanent or only transient; but it is beyond dispute that British manufacturing industry is suffering appreciable loss of prestige through the disappointment and want of confidence engendered by the delays. We hope manufacturers will speedily awake to this stern fact and, by endeavouring to restore the confidence of home and foreign customers in the promptness and reliability of British work, stem the tide of orders that has set in in the direction of foreign manufactures. Fortunately, it is not too late, for the present activity in home engineering manufactures reveals that a large bulk of customers are still determined to have British goods. Another deplorable effect of this delay in executing orders is noticeable in some of the electric supply stations that are waiting for the delivery of plant. Where the delay involves postponement of the opening of a new system of supply, as at West Ham, the case is bad enough; but in many other instances it is far worse, the over-loaded station being unable to keep the requisite pressure on its mains, and hourly running the risk of breakdown of its insufficient plant. The unusual number of temporary interruptions to electric supply that we have regretfully recorded this winter must, we fear, be laid primarily at the door of those fatuous individuals who promoted the engineering strike. Precisely the same mischievous influence on British electrical industry threatens to result from the opposition of *doctrinaire* and purblind socialists to the adoption of the recommendations of the Parliamentary Committee in regard to the law of electric generating stations. The history of this matter may be written in a very few words: the Electric Lighting Acts, as they stood, discouraged and even debarred companies from obtaining powers to supply power in perpetuity over extensive areas, the recognised practice being to acquire powers for 42 years for a limited area controlled by some one local authority, which might acquire the undertaking at the end of that time. Parliament appointed a Select Committee to enquire whether the disability might be removed, and the Committee advised that it should be. But the mania for owning and working public undertakings, instead of wisely governing them by judicious bye-laws, had so taken possession of local authorities that these bodies fancied they saw in the Parliamentary recommendation a distinct injury to their own local interests. Hence a deal of ignorant opposition has been raised, and threatens to be still more vigorously pursued this year, against a method of generating and supplying wholesale electric power that could not fail to be fraught with many benefits to the industries of this country. Another evil effect of this mischievous socialism—which unhappily is making a playground of electrical undertakings—is to be seen in the recommendations of the Telephone Committee, a body of men as biassed and unfair in its methods and judgment as the Select Committee just referred to was the reverse. We hold no brief for any telephone company, nor do we especially advocate that the telephone system of this country should be carried on in the manner it is at present; but we strongly protest against the doctrine which is so readily taken for granted in certain journals and official quarters, and by a large section of the general public, that a national telephone system can be efficiently worked on the basis of local government ownership and control. The control should be coextensive with the system itself; and, in our opinion, none better than that which might be administered by the Post Office is to be had from any existing organisation.

During the past year a considerable number of new electricity works, whether for supply or for traction, have been put in operation, and several important extensions to already existing works have been made. The new electric supply works started comprise those at Wakefield, Morley, Stockport, Colchester, Eccles, Salisbury, Cork, Lincoln, Folkestone and the village of Mardy; and new stations have been started in connection with the already existing systems at Belfast, Hull and Glasgow. New electric traction undertakings which have been completed and put in operation during the year comprise the underground Waterloo and City Railway, and surface tramways at Glasgow, Liverpool, Bradford, Halifax, Kidderminster-Stourport, Middlesbrough-Stockton, Laxey-Ramsey and Cork. Besides these undertakings there are several works on the eve of completion; and it will be seen from the large supplement sheet Table of Electric Supply Works for 1897-8, which we publish this week, that a further very large number of undertakings in this class will be completed during the early months of this year. In a corresponding supplement Table of Electric Railways and Tramways, which we hope shortly to publish, it will be shown that electric traction progress and prospects are not less bright. Indeed, there are indications of an extensive field for the labours of British electrical engineers, that will keep them occupied for a long while to come, if they and the vast body of workmen employed by them use aright the opportunities presented to them.

Theoretical science must always be regarded by the practical and commercial mind as the handmaid of applied science. It is, therefore, fitting that, having briefly surveyed the present position of applied electricity, we should turn to see what advances have been made in scientific discovery and research, and what promise these hold out of immediate improvement in practice. We are aware that the theoretically-minded professor is apt sometimes to disclaim any practical intention in his researches. By way of retort, we would point to the alacrity with which he hastens to the Patent Office whenever, by any chance, his researches prove to be of practical value. "Science for its own sake" is a very laudable thing to pursue; but we could wish that a greater proportion of scientists would allow their researches to be influenced by the practical problems and difficulties of applied science. There are numerous obstacles that the man of leisure and means, and with a mind capable of scientific research, might greatly help engineers to surmount. We need enumerate only a few of them: We want a more durable, efficient and less heavy secondary battery; we want a glow-lamp filament combining higher efficiency with a life at least as long as it now has; we want to know more about the iron to use for our transformers and dynamos; about the possibility of obtaining energy direct from carbon without heat; about the chemistry of the application of electricity to new industrial processes and manufactures, and so on. Wireless telegraphy is a happy exception to the all-too-prevalent custom of scientists to ignore the practical value of research; it has enlisted the services of numerous leaders of physical science, and now that so many able minds are engaged upon its problems, a really practical, commercial solution should not be far off. The empyricism that apparently has characterised the practical experiments in this direction needs to be replaced by systematic and scientific investigation as to the best means of propagating the waves and collecting their energy, and as to the most satisfactory way of doing what is now so unsatisfactorily done by the coherer. Doubtless Prof. Oliver Lodge's Paper, recently read at the Institution of Electrical Engineers, and the discussion which is yet to

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take place upon it, will go far to instil a scientific spirit into the practical work that is being done, as well as to acquaint the professors with the practical difficulties presented in actual operations. It cannot be said that in any other branch of scientific work, besides research in wireless telegraphy, has pure research contributed conspicuously to practical advance in electricity during the past year. An important scientific movement, however, should not pass unnoticed, viz., the proposal to establish a national physical laboratory. In August, 1897, the Treasury appointed a Committee to consider this scheme; the members of the Committee were Lord RAYLEIGH (Chairman), Sir COURTENAY BOYLE, Sir ANDREW NOBLE, Sir J. WOLFE BARRY, Prof. W. C. ROBERTS-AUSTEN, Mr. ROBERT CHALMERS, Prof. A. W. RÜCKER, Mr. ALEX. SIEMENS and Prof. T. E. THORPE. A report was presented in October last (*The Electrician*, Vol. XLI., p. 780), and it was proposed to establish a national laboratory as an extension of Kew observatory, under the control of the Royal Society. No further developments have yet been disclosed.

It is our sad duty, in conclusion, to record that the hand of death has been laid with unusual severity on the ranks of the electrical profession, and its immediate friends, during the past year. Among the distinguished personages associated with electrical enterprise who have passed away are included Lord SACKVILLE ARTHUR CECIL, the Earl of SUFFOLK AND BERKSHIRE, Sir A. B. FORWOOD, Sir JOHN FOWLER and Sir J. N. DOUGLASS. The tragic death of Dr. JOHN HOPKINSON, through a disaster in the Alps, will be fresh in the memory of every member of the electrical profession, which has also been deprived of LATIMER CLARK, CAMILLE A. FAURE, Dr. C. E. EMERY, and NELSON PERRY. A historic personage disappeared with the death of DE MERITENS, in Paris; and the names of Dr. E F. A. OBACH and O. B. SCHALLENBERGER will also be remembered as being among those who contributed to the early development of electrical industry. Telegraphists will miss many from their ranks, including Major ALEX. WOOD, Capt. W. H. DAVIES, JAMES BROWN, J. W. JAQUES, W. T. NEWITT, R. S. HAMPSON, G. K. WINTER and W. F. O'BRIEN.

ELECTRICITY SUPPLY WORKS COSTS IN 1896 AND 1897.

Since March last year, when the more detailed analyses of electricity works accounts—as they now appear in these pages—were commenced, we have dealt with most of the important electric lighting undertakings of which we have been supplied with data, and in this, the first number of a new year, it may not be either inappropriate or uninstructive if some attempt be made to glean from the accrued data and records some general conclusions regarding the progress made in the economy of generation and supply of electricity during the two years generally dealt with in such analyses of accounts as have appeared.

Having in view the differences in the management, the administration and the rendering of accounts of undertakings worked by local authorities and those worked by companies, we have considered it more useful and satisfactory to separately consider and compare the results of working under the two *régimes*. In the following tables and curves reference to undertakings which have not been in normal operation for fully two years has been avoided, so as to maintain a legitimate basis of comparison, and, for a like reason, has been omitted such stations the analyses of which have referred to periods other than one year.

Municipal Electric Supply Works.—In Table I. are set out the more interesting particulars and results of working of 33 municipal stations during 1896 and 1897. Although in the majority of cases the financial year ends with March, we have, for convenience, adhered to the practice of terming the years ending at March 31, 1897 and 1898, respectively 1896 and 1897. There are two columns in this table, adduced from the figures given in our analyses, which we have considered of sufficient interest to include with the usual costs data—viz., the columns headed "Load Factor" and "Total Costs plus 6 per cent. of Capital." The former gives for each undertaking and year of operation the percentage ratio of the output (in units sold) to an output equal to the maximum demand on the station continued without intermission during the whole of the year referred to; in other words, it gives the percentage ratio of the actual output (in units sold) to the maximum demand (in kilowatts) multiplied by the constant 8,760—the number of hours in the normal year. The other column referred to has been introduced in an attempt to facilitate a fairer comparison of the financial results of working of the several undertakings by taking account of the capital charges upon the revenue as well as the costs of working and management. To do this we have assumed 3 per cent. as a fair average rate of interest on loans to municipalities, and 3 per cent. of the expended capital to cover depreciation and the repayment of loans. At the bottom of the table the averages for the years 1896 and 1897 of the 33 undertakings referred to is given, with the per cent. increase or decrease (as the case may be) of the average values during 1897, as compared with the previous year. The record costs, &c., of the list are shown in heavy type.

Manchester, of course, heads the list as regards output, both in 1896 and 1897, but it is singular to find Portsmouth—an alternating station, with, therefore, a very moderate, almost negligible motor load and no batteries—having a higher output compared with the plant capacity, that is "plant load factor," than Edinburgh in both years. This is, no doubt, due to the large rectified current arc lighting load on the ordinary plant. Portsmouth also possessed the highest load factor in 1896, but Edinburgh, with its increasing motor load and arc lighting, crept into the enviable position in 1897 with a load factor of 13·8 per cent.

It is, no doubt, largely in consequence of its position in this respect, as well as its large output, that Edinburgh carries record lowest wages at the station in 1897, and in both years the lowest generating costs, works costs, management, property charges, total costs, and, what is more important, stands in the place of priority in the column representing the total costs plus the estimated capital charges. It is to be also noticed that, bearing the lowest figure in the table for average revenue per unit and by no means the highest percentage of working profit, Edinburgh has justly given the benefit of the economical working of the electricity supply undertaking to the patrons of the department.

As regards fuel costs, Stafford shows the lowest figures in the list for the two years, though in 1897 this item had risen to 0·32d., as compared with 0·242d. in 1896. In 1897 Worcester shares with Edinburgh the satisfaction of the lowest management and property charges in the list, though, needless to say, the signification of such a record is far greater as regards the latter undertaking, since it has so many other low records to boast of in the matter of costs. It may be observed that the average costs, revenue per unit sold, and ratio of costs to revenue have substantially decreased during 1897 as compared with 1896. The items of cost showing the largest decrease are those of oil, waste, water, &c., the average of the 33 stations on the list being for 1897 0·143d., as compared with 0·18d. for 1896, a drop of nearly 26 per cent. Management and property charges is a collective item which also bears evidence of increased economy. On the other hand, it is interesting to note that the *records* of the list respecting fuel, generating costs, works costs, total costs, and the ratio of costs to revenue, all show an increase for 1897 over the 1896 records of the list.

As indicating the influence of capital expenditure on the true financial position of a concern, the following little table (II.) is instructive. The six undertakings in each year having the lowest figures in the last column of Table I. are arranged in order of priority in this respect, together with the total costs per unit, the expended capital per kilowatt of capacity, the

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Table I.

Place.	Output 1,000 units sold in		Units sold per 8 c.p. lamp capacity.		Load factor viz., units sold×100 / max dem.×8760		Revenue per unit sold.		Fuel costs per unit sold.		Oil, waste, water and engine room stores per unit sold.		Wages at the generating station per unit.		Repairs and maintenance at station per unit.		Generating costs per unit.		Distribution costs per unit sold.		Works costs per unit sold.		Manag'm'nt and property charge per unit.		Total costs per unit sold.		Working profit % of mean capital expended.		Ratio of total costs to revenue (per cent.).		Total costs plus 6% of the ex. capital (pence).	
	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897
Ayr	125	161	17·8	8·26	11·1	12·6	3·62	3·64	0·922	0·679	0·200	0·091	0·997	1·030	0·192	0·106	2·31	1·91	0·298	0·194	2·81	2·21	1·000	0·723	3·81	2·93	0·405	1·450	10·5	80·4	7·15	6·24
Bedford	158	256	11·3	18·3	9·03	10·8	4·56	4·42	1·350	1·24	0·158	0·127	0·853	0·602	0·118	0·169	2·48	2·14	0·073	0·110	2·70	2·39	0·495	0·455	3·28	2·93	3·010	3·750	72·0	66·3	6·81	5·54
Belfast	150	202	9·6	12·9	7·13	6·40	6·50	6·26	1·33	1·30	0·195	0·150	0·870	0·781	0·351	0·185	2·75	2·42	0·178	0·216	2·93	2·63	1·090	0·902	4·01	3·54	4·810	5·250	61·8	56·5	7·39	7·25
Blackpool	430	708	27·5	21·6	...	...	5·94	4·83	1·21	0·876	0·401	0·267	0·680	0·507	0·327	0·221	2·62	1·87	0·158	0·159	3·06	2·35	0·640	0·394	3·70	2·74	6·720	8·070	62·2	56·8	5·98	4·45
Bolton	187	342	10·9	14·6	8·02	10·3	5·76	4·70	0·40	0·485	0·259	0·232	1·210	0·698	0·077	**0·050**	1·95	1·47	0·033	0·016	1·98	1·48	0·830	0·571	2·81	2·05	5·520	7·260	48·8	43·7	6·42	4·45
Bradford	814	994	7·98	11·0	8·92	10·1	4·77	4·69	0·403	0·375	0·114	0·123	0·364	0·302	0·091	0·158	0·97	0·94	0·110	0·398	1·08	1·38	0·700	0·603	1·79	1·98	11·30	8·980	37·3	42·7	3·65	4·04
Brighton	1389	1993	26·9	30·5	12·3	12·9	4·58	3·47	0·688	0·619	0·106	0·079	0·345	0·355	0·091	0·159	1·23	1·21	0·211	0·124	1·44	1·34	0·611	0·439	2·05	1·77	8·89	7·22	44·7	51·1	3·91	3·30
Bristol	651	911	17·0	19·0	9·7	10·3	5·55	5·42	0·765	0·878	0·079	0·073	0·472	0·430	0·138	0·135	1·45	1·52	0·214	**0·118**	1·87	1·77	0·895	0·733	2·75	2·50	7·30	8·52	49·5	46·1	5·18	4·81
Burnley	173	198	18·2	20·8	11·0	10·5	5·20	4·60	0·394	0·363	0·351	0·098	0·524	0·495	0·262	0·664	1·53	1·62	0·029	0·058	1·58	1·69	0·728	0·740	2·31	2·43	8·29	8·30	44·4	52·9	4·51	4·52
Burton	58·2	79·5	8·80	9·70	6·64	6·77	6·32	6·27	0·580	0·530	0·230	0·170	3·390	2·690	0·140	0·160	4·33	3·55	0·060	0·050	1·39	3·60	0·670	0·540	5·06	4·14	1·00	2·40	80·0	66·0	12·3	9·67
Derby	295	341	15·7	17·4	5·49	6·78	5·59	5·54	1·160	0·982	0·265	0·160	0·720	0·569	0·578	0·377	2·73	2·09	0·233	0·077	3·67	2·49	0·836	0·786	4·20	3·28	3·01	5·17	75·3	59·1	7·07	6·06
Dundee	254	323	14·5	18·5	8·38	8·23	5·04	4·47	0·594	0·624	0·169	0·153	0·402	0·395	0·390	0·254	1·55	1·43	0·311	0·019	1·89	1·53	0·855	0·864	2·74	2·40	6·74	7·24	54·0	53·7	4·84	4·17
Edinburgh	1722	2894	20·4	28·1	12·1	**13·8**	3·74	**3·16**	0·312	0·347	0 058	0·056	0·240	**0·172**	**0·053**	0·135	**0·66**	**0·71**	0·064	0·128	**0·99**	**1·08**	0·408	**0·364**	**1·40**	**1·44**	8·97	7·97	37·3	45·8	**3·33**	**2·87**
Glasgow	1498	2114	22·9	32·3	5·08	5·04	4·88	4·13	0·455	0·448	0·070	0·058	0·356	0·288	0·219	**0·267**	1·10	1·06	0·260	0·270	1·43	1·56	0·566	0·588	2·00	2·15	**13·2**	10·6	40·9	52·0	3·37	3·43
Halifax	178	240	9·50	9·04	8·06	9·28	5·86	4·85	0·886	0·795	0·398	0·306	1·080	0·772	0·100	0·102	2·47	1·90	0·083	0·071	2·55	2·05	1·023	1·827	3·57	2·84	3·78	3·77	61·0	59·3	7·38	6·31
Hanley	248	352	12·4	17·6	8·60	10·7	4·43	4·45	0·730	0·685	0·192	0·154	0·555	0·476	0·310	0·414	1·79	1·73	0·202	0·189	2·16	2·12	0·528	0·610	2·69	2·73	4·69	5·26	60·7	61·4	5·25	4·84
Huddersfield	304	439	11·4	11·6	8·06	7·88	5·41	4·96	0·484	0·493	0·048	0·057	0·543	0·478	0·124	0·277	1·20	1·30	0·174	0·181	1·41	1·52	1·070	0·718	2·47	2·24	6·95	7·78	45·6	45·2	5·22	4·52
Kingston	156	194	17·3	21·6	11·9	11·1	4·64	4·85	1·790	1·620	0·219	0·192	0·933	0·772	0·191	0·137	3·14	2·72	...	...	3·55	3·04	0·630	0·745	4·18	3·78	1·28	2·87	90·0	77·8	6·38	6·51
Lancaster	106	147	14·15	19·6	9·84	8·83	5·05	4·76	0·749	0·700	0·236	0·163	0·754	0·605	0·088	0·085	1·82	1·55	0·104	0·072	2·08	1·74	0·670	0·474	2·75	2·21	4·52	6·62	54·5	46·4	5·88	4·59
Manchester	**2509**	**3435**	21·6	32·7	10·5	10·4	4·93	4·01	0·397	0·451	0·113	0·162	**0·211**	0·191	0·276	0·261	1·00	1·06	0·117	0·134	1·11	1·20	0·519	0·506	1·63	1·71	12·3	9·90	**33·1**	42·6	3·40	3·21
Nottingham	297	480	10·0	16·0	8·48	7·44	5·94	5·37	0·568	0·535	0·124	0·109	0·385	0·349	0·191	0·147	1·27	1·14	0·025	0·055	1·32	1·21	0·881	0·621	2·20	1·83	7·62	9·83	37·1	**34·2**	5·49	4·11
Oldham	228	322	16·9	15·7	8·67	8·90	5·86	4·40	0·472	0·461	**0·047**	0·048	0·452	0·387	0·563	0·211	1·53	1·11	0·436	0·148	1·97	1·26	0·789	0·537	2·76	1·79	8·28	7·88	47·0	40·8	4·50	3·99
Portsmouth	839	981	**31·6**	**37·0**	**14·5**	13·1	4·05	3·92	0·563	0·642	0·149	0·245	0·226	0·237	0·231	0·176	1·17	1·30	0·157	0·199	1·65	1·85	**0·389**	0·388	2·04	2·24	7·52	6·48	50·4	57·2	3·75	3·89
St. Pancras (London)	1189	1520	26·7	26·0	6·79	7·89	5·47	5·29	1·000	0·840	0·140	0·094	0·603	0·496	0·426	0·276	2·17	1·70	0·709	0·690	2·99	2·48	0·927	0·427	3·91	2·91	5·12	7·52	71·6	55·2	6·18	4·91
Southampton	132	192	14·2	20·6	8·06	8·36	6·36	5·49	1·160	1·200	0·136	0·138	0·479	0·514	0·286	0·101	2·06	1·95	0·213	0·178	2·28	2·13	1·400	0·974	3·68	3·10	5·18	6·45	57·8	56·5	6·78	5·42
Stafford	43·6	55·5	7·04	8·96	9·40	7·92	6·68	5·59	**0·242**	**0·320**	0·115	**0·039**	0·743	1·357	0·660	0·220	1·75	1·94	0·413	0·406	2·27	2·39	1·110	0·804	3·38	3·19	3·47	2·92	50·5	57·1	9·56	8·17
Sunderland	146	270	10·5	13·0	7·44	8·54	4·45	3·77	0·500	0·411	0·210	0·114	0·931	0·591	0·307	0·270	1·95	1·39	0·057	0·034	2·01	1·45	1·260	0·853	3·27	2·31	2·12	3·94	73·5	61·2	7·11	4·70
Taunton	127	140	13·4	14·8	9·86	9·69	5·62	5·75	1·330	1·380	0·214	0·223	0·672	0·638	0·214	0·190	2·43	2·43	0·078	0·135	2·96	2·93	1·020	1·000	3·99	3·93	4.19	4·41	70·9	68·3	6·62	6·51
Tunbridge Wells	174	259	15·9	23·7	9·98	12·0	5·92	5·40	1·410	1·290	0·081	0·106	0·579	0·415	0·103	0·072	2·17	1·88	0·055	**0·005**	2·34	2·00	0·603	0·578	2·94	2·57	11·0	**11·1**	49·7	47·6	4·92	4·31
Walsall	67	96	9·33	12·9	8·14	7·08	5·61	5·10	0·636	0·695	0·204	0·217	0·701	0·551	0·454	0·543	2·00	2·00	0·229	0·167	2·37	2·37	1·670	1·360	4·04	3·74	2·26	2·71	72·0	73·0	6·88	5·89
Wolverhampton	225	291	14·9	15·0	7·12	7·35	5·46	5·16	0·538	0·507	0·214	0·183	0·695	0·684	0·423	0·449	1·87	1·82	**0·015**	0·012	2·10	2·01	0·836	0·781	2·94	2·82	6·41	7·05	53·9	54·8	5·41	4·89
Worcester	334	429	20·1	25·9	5·79	6·62	**3·42**	3·52	0·637	0·742	0·087	0·082	0·686	0·535	0·078	0·353	1·49	1·70	0·053	0·035	1·70	1·93	0·572	**0·364**	2·27	2·29	3·84	3·43	66·4	65·0	4·89	4·55
Yarmouth	157	190	13·1	15·8	9·70	9·86	4·80	5·07	1·430	1·360	0·348	0·251	0·542	0·455	0·119	0·104	2·44	2·17	0·070	0·075	2·82	2·57	0·886	0·781	3·71	3·35	2·84	4·32	77·2	66·0	6·43	5·90
Average	466	656	15·7	18·8	8·78	9·30	5·21	4·77	0·791	0·754	0·180	0·143	0·703	0·601	0·248	0·225	1·92	1·72	0·169	0·148	2·23	1·99	0·831	0·669	3·04	2·66	5·80	6·26	58·7	55·8	5·88	5·09
Per cent. increase	40·8		19·8		5·92		...		...		...		...		...		...		...		...		...		...		7·93		...		...	
Per cent. decrease	...		...		...		9·23		6·24		25·9		17·0		10·2		11·6		14·2		12·1		22·7		14·3		...		5·20		15·5	

Table II.

1896.						1897.					
Place.	Output 1,000 units.	Units sold per 8 c.p. lamp capacity.	Total costs.	Capital expended per kilowatt.	Total costs + 6 % (capital expended.	Place.	Output 1,000 units.	Units sold per 8 c.p. lamp capacity.	Total costs.	Capital expended per kilowatt.	Total costs + 6 % of capital expended
Edinburgh	1,722	20·4	1·40d.	£85·6	3·33d.	Edinburgh	2,894	28·1	1·44d.	£87·1	2·87d.
Glasgow	1,498	22·9	2·00d.	67·8	3·37d.	Manchester	3,435	32·7	1·71d.	106	3·21d.
Manchester	2,509	21·6	1·63d.	83·1	3·40d.	Brighton	1,993	30·5	1·77d.	102	3·30d.
Bradford	814	7·98	1·79d.	34·4	3·65d.	Glasgow	2,114	32·3	2·15d.	90·3	3·43d.
Portsmouth	839	31·6	2·04d.	117	3·75d.	Portsmouth	981	37·0	2·24d.	132	3·89d.
Brighton	1,389	26·9	2·05d.	108	3·91d.	Oldham	322	15·7	1·79d.	74·7	3·99d.

Table IV.

1896.						1897.					
Place.	Output in 1,000 units sold.	Units sold per 8 c.p. lamp capacity.	Total costs per unit.	Capital Expenditure per kilowatt.	Total costs + 7% of the capital.	Place.	Output in 1,000 units sold.	Units sold per 8 c.p. lamp capacity.	Total costs per unit.	Capital expenditure per kilowatt.	Total costs + 7% of the capital.
St. James's	2,401	27·9	2·29d.	987·8	3·98d.	St. James's	3,028	25·2	2·23d.	£65·5	3·64d.
Leeds	701	18·3	1·74d.	70·3	4·26d.	Newcastle-on-T.	661	24·5	2·11d.	91·9	4·18d.
Newcastle Dist.	541	13·6	2·29d.	50·8	4·29d.	Norwich	572	20·6	2·00d.	89·3	4·33d.
Westminster	3,503	30·2	2·26d.	127	4·56d.	Sheffield	747	25·8	1·55d.	133	4·34d.
Norwich	436	19·8	2·13d.	93·4	4·66d.	Newcastle Dist.	601	15·1	2·26d.	60·4	4·41d.
Charing Cross	1,944	27·6	2·34d.	138	5·03d.	Westminster	4,356	31	2·34d.	124	4·50d.

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output, and the figure representing the units sold per 8 c.p. lamp capacity.

It will be noticed that in both years Edinburgh had, to a high degree and in combination, the conditions for low total charges on revenue. It combines the lowest total costs with a low capital expenditure and a high "plant load factor," as measured by the ratio of units sold per 8 c.p. lamp capacity. The result is that the low figure of 8·38d., representing the estimated total charges in 1896, have been improved upon in 1897 by 2·87d. per unit. Thanks chiefly to its low capital expenditure and high plant load factor Glasgow camesecond in 1896, but Manchester and Brighton, with lower total costs and increasing plant load factor, ousted it from this position, and compelled Glasgow to take fourth place in 1897. Portsmouth's working costs and high capital charges prevent its taking a higher position than fifth in spite of a high-plant load factor.

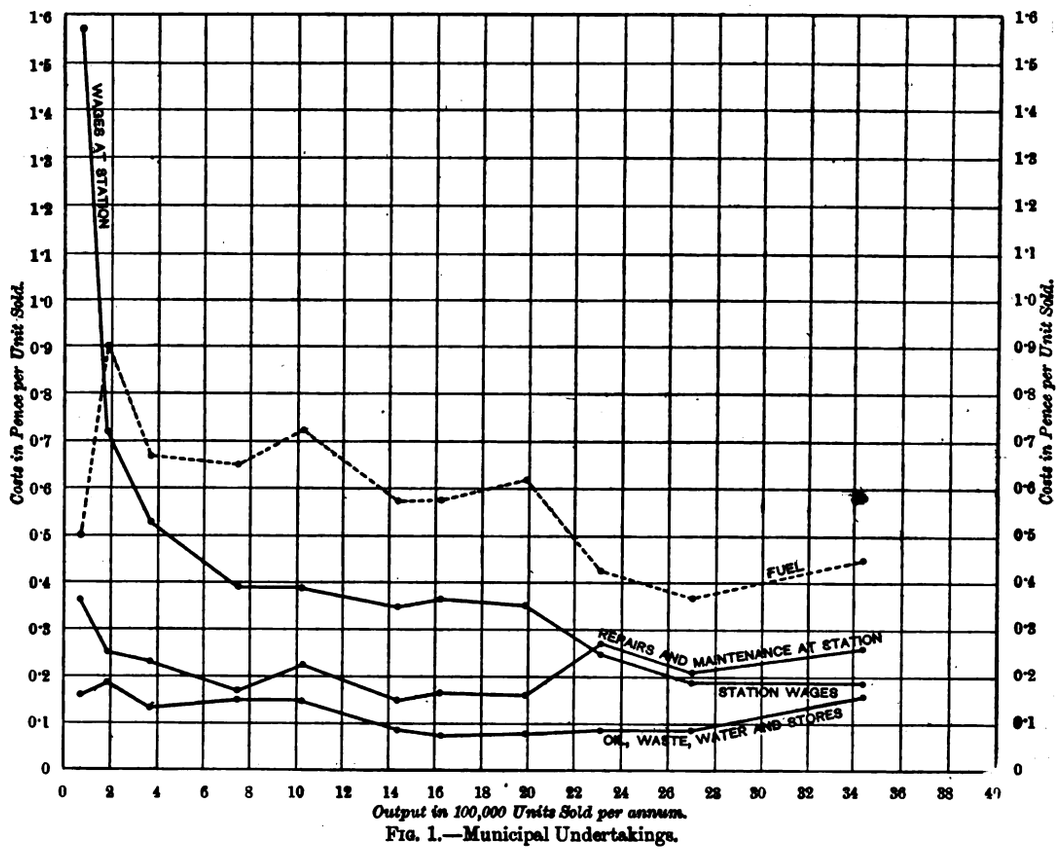

FIG. 1.—Municipal Undertakings.

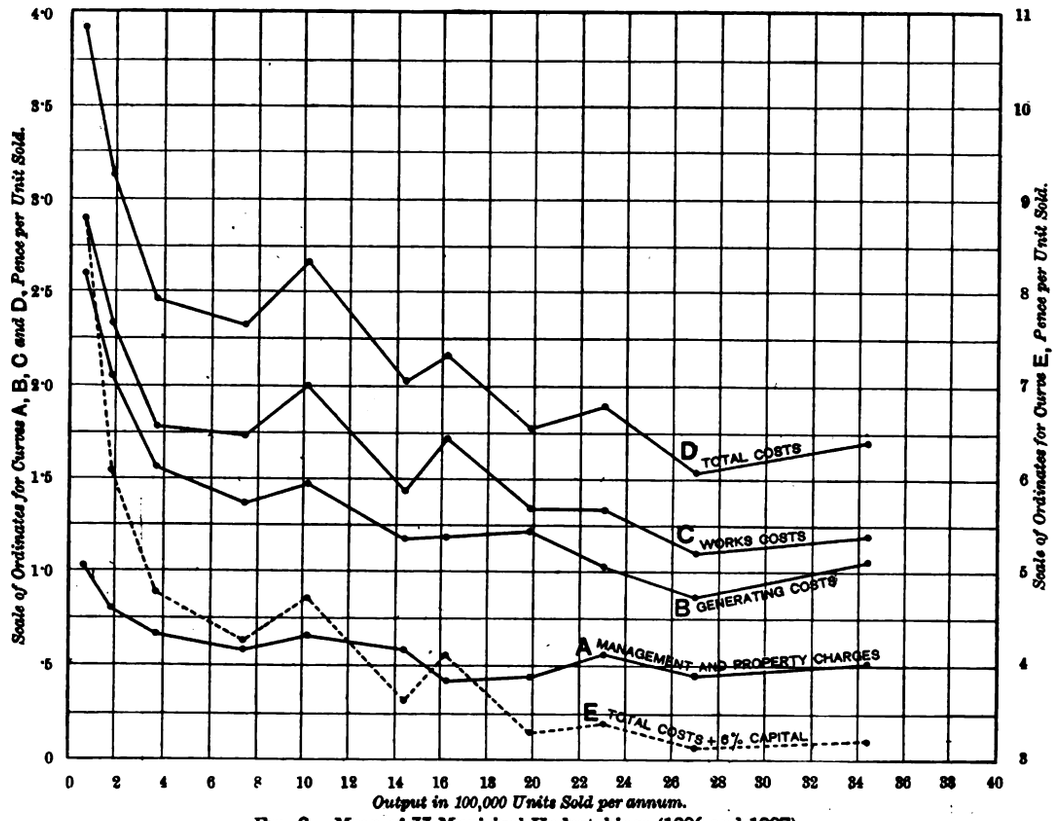

FIG. 2.—Mean of 33 Municipal Undertakings (1896 and 1897).

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In Figs. 1 and 2 are given nine curves, showing the relation between the various items of cost and output per annum. These have been plotted from the mean of the data, irrespective of the year, of the 33 municipal undertakings included in Table I. Naturally, for outputs higher than about 1,200,000 units sold, the points on the curves are dependent on

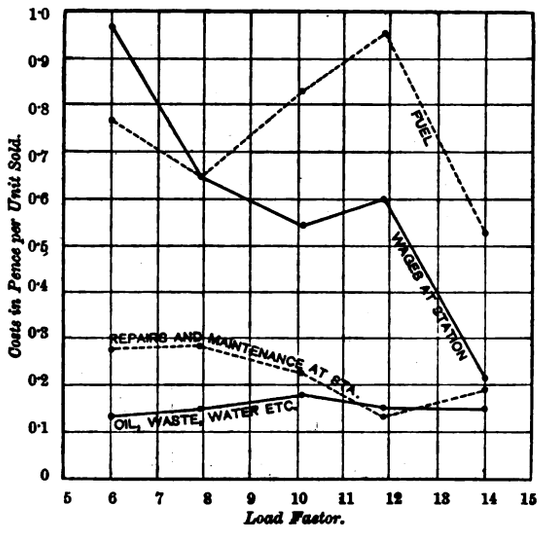

Fig. 3.—Municipal Undertakings.

the mean of two concerns at most, and two points, viz., those representing the data for the outputs, 1,993,000 units and 3,435,000 units are dependent alone on the 1897 results at Brighton and Manchester respectively. In spite, however, of this paucity of data for the high outputs the trend of the curves is sufficiently decided and consistent to justify their careful study. As might be expected, the curve of wages at the station is the most decided in its fall with increased output, while repairs and maintenance at the station, and oil, waste, water, &c., are practically constant.

Fuel costs per unit also has a decided but slight fall, and we should have expected the management and property charges curve to have come out somewhat steeper.

As to the curves of generating, works and total costs, they tell their own tale in no uncertain language, and it is interesting to mark their sensitiveness at outputs below about 600,000 units. It may be interesting to know that the values

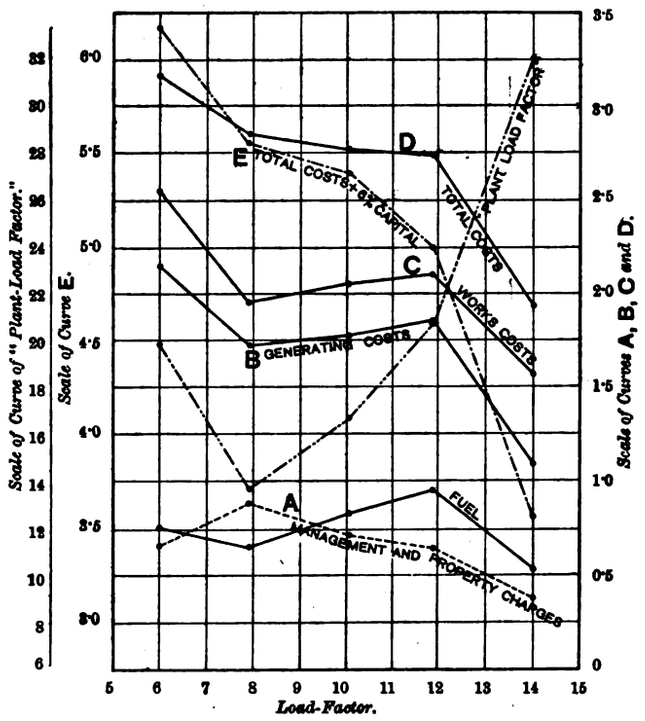

Fig. 4.—Municipal Undertakings.

for the various points for the output, 2,702,000 units sold, are the means of the Edinburgh 1897 and the Manchester 1896 working.

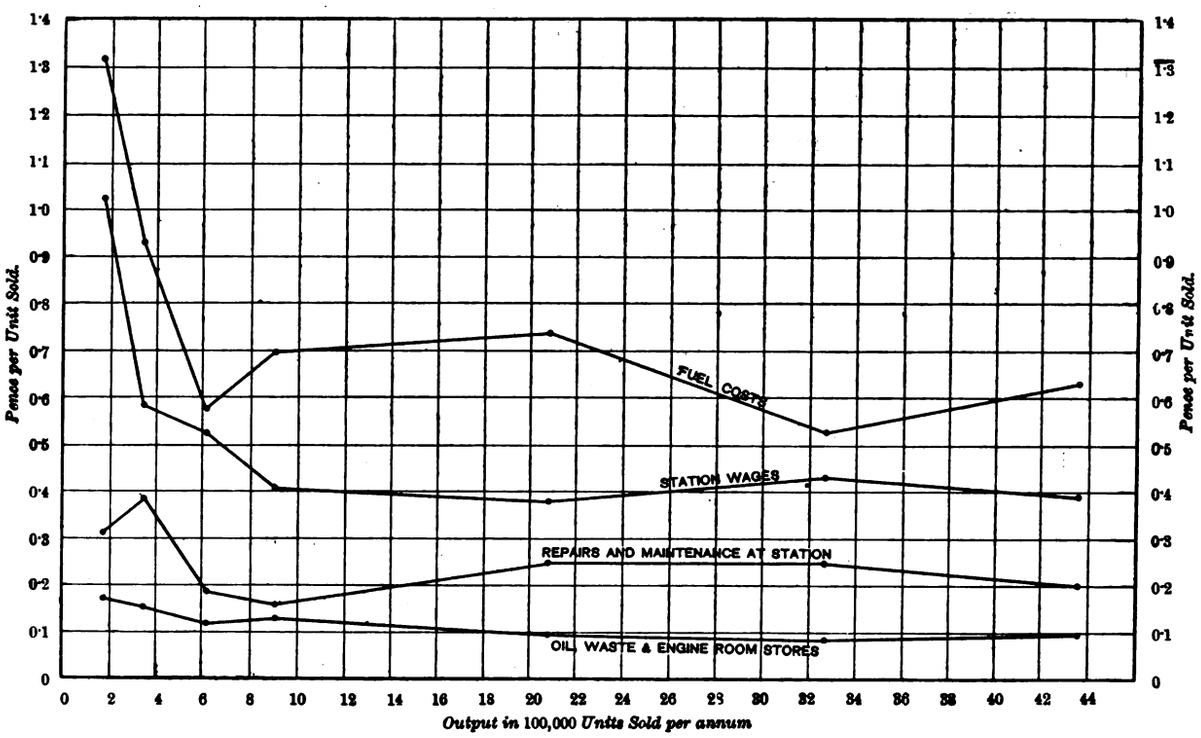

Fig. 5.—Company Undertakings.

Figs. 3 and 4 give the curves connecting the various costs with the load factor. Here, again, in Fig. 3, the station wages item shows the most decided fall as the load factor increases; repairs and maintenance, however, appear to show a more sensitive relation to load factor than to output, while fuel seems more indifferent. Turning to the curves in Fig. 4,

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Table III.

Place.	Output 1,000 units sold in		Units sold per 8 c.p. lamp capacity.		Load factor, viz., units sold × 100 max. dem. × 8760		Revenue per unit sold.		Fuel costs per unit sold.		Oil, waste, water and engine room stores per unit sold.		Wages at the generating station.		Repairs and maintenance at station per unit.		Generating costs per unit.		Distribution costs per unit sold.		Works costs per unit sold.		Manag'm'nt and property charges per unit.		Total costs per unit sold.		Working profit % of mean capital expended.		Ratio of total costs to revenue (per cent.).		Total costs plus 7 % of the ex. capital. (pence).	
	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897	1896	1897
Birmingham	756	1184	16·1	25·3	...	...	5·67	5·14	0·710	0·722	0·182	0·145	...	...	0·170	0·166	...	...	...	...	1·68	1·72	1·11	0·837	2·78	2·56	5·68	6·32	49·1	49·8	6·87	5·67
Bournemouth	281	339	13·9	16·7	8·00	7·97	7·04	6·99	1·43	0·928	0·410	0·321	0·941	0·826	0·672	0·224	3·46	2·30	0·675	0·223	4·13	2·52	0·956	1·10	5·08	3·62	3·03	5·74	72·4	51·8	9·81	7·90
Cambridge	198	222	12·1	13·5	3·80	8·93	6·83	7·18	1·41	1·19	0·147	0·145	0·940	0·834	0·266	0·452	2·76	2·62	0·043	0·036	2·81	2·66	0·993	1·09	5·08	3·75	6·78	7·72	55·7	52·3	7·04	7·07
Charing Cross	1944	2616	27·6	32·7	19·1	21·7	4·83	4·49	0·875	0·950	0·078	0·092	0·319	0·368	0·178	0·157	1·45	1·57	0·241	0·208	1·69	1·78	0·650	0·498	3·80	2·27	7·24	7·63	48·5	50·6	5·03	4·57
Chelsea	814	1062	19·4	17·7	9·50	8·96	6·30	6·19	0·885	0·875	0·178	0·143	0·302	0·293	0·205	0·182	1·57	1·50	0·277	0·338	1·85	1·84	1·40	1·06	3·24	2·90	5·13	5·52	51·5	46·8	7·66	7·24
Dover	154	234	14·0	13·4	11·4	9·24	4·42	5·38	1·62	1·67	0·135	0·095	1·23	0·834	0·246	0·266	3·28	2·95	0·235	0·264	3·71	3·38	1·42	0·787	5·13	4·17	1·16	0·92	116	77·6	10·70	8·70
Eastbourne	208	241	21·5	16·8	10·7	10·7	8·52	7·98	1·63	1·33	0·358	0·278	1·04	0·969	0·272	0·297	3·29	2·87	0·415	0·445	3·80	3·41	1·10	0·971	4·90	4·37	6·54	7·00	57·6	54·8	8·94	8·10
Hastings and St. Leonards	294	339	28·0	28·9	12·6	17	5·92	6·30	1·99	1·57	0·169	0·142	0·599	0·560	0·447	0·498	3·20	2·77	0·104	0·162	3·54	3·18	0·836	0·687	4·37	3·85	3·75	6·62	73·8	61·4	7·35	6·44
House-to-House (Kens., Lond.)	644	811	15·5	18·4	11·2	11·5	6·50	6·16	0·994	0·735	0·125	0·084	0·714	0·612	0·220	0 069	2·05	1·51	0·087	0·084	2·14	1·59	0·997	1·01	3·14	2·60	7·65	8·24	48·2	42·2	6·62	5·88
Hove	196	268	15·1	20·6	8·86	9·88	7·99	6·51	...	0·692	0·107	0·115	0·382	0·347	0·347	0·360	1·51	1·51	0·215	0·166	2·28	1·72	1·59	1·21	3·85	2·93	5·65	6·20	48·2	45·1	9·16	7·11
Kensington & Knightsbridge	1515	1898	24·3	27·1	12·3	14·2	5·76	5·56	0·673	0·692	0·107	0·115	0·382	0·347	0·347	0·360	1·51	1·51	0·215	0·166	1·72	1·68	1·30	0·966	3·03	2·65	7·89	9·53	52·6	47·6	5·58	4·88
Leeds	701	833	18·3	13·9	10·2	9·5	5·32	5·30	0·290	0·252	0·072	0·053	...	...	..	...	...	...	...	...	1·25	1·02	0·492	0·520	1·74	1·54	11·5	9·80	32·6	29·1	4·26	4·79
Newcastle	536	661	19·8	24·5	10·1	10·3	4 63	4·60	0·468	...	0·118	...	0·572	...	0·254	...	1·41	1·28	0·243	...	1·73	1·53	0·958	0·574	2·69	2·11	6·52	8·10	58·0	45·8	5·08	4·18
Newcastle District	541	601	13·6	15·1	13·4	12·3	4·41	4·53	0·616	0·651	0·185	0·198	0·466	0·436	0·127	0·163	1·39	1·45	0·219	0·211	1·61	1·66	0·678	0·600	2·29	2·26	7·86	8·04	51·9	49·9	4·29	4·41
Northampton	89·4	115	11·2	12·8	5·76	7·20	7·34	6·91	1·05	1·06	0·210	0·190	1·29	1·44	0·300	0 260	2·84	2·96	0·170	0·070	3·00	3·03	0·690	0·920	3·69	3·94	6·30	5·30	50·0	57·0	7·92	8·45
Norwich	436	572	19·8	20·6	9·30	9·90	5·29	4·86	0·736	0·700	0·075	0·064	0·412	...	0·291	...	1·52	...	0·179	...	1·69	1·49	0·433	0·514	2·13	2·00	9·82	9·35	40·2	41·2	4·66	4·33
Notting Hill	231	355	11·5	17·7	11·2	13·1	8·89	7·86	0·710	0·664	0·181	0·093	0·430	0·323	0·425	0·418	1·75	1·60	0·040	0·020	1·79	1·52	2·18	1·70	3·97	3·22	5·17	6·46	44·6	41·0	11·20	8·68
Oxford	292	344	14·6	11·5	12·3	12·6	6·30	5·99	0·638	0·650	0·065	0·071	0·626	0·602	0·754	0·571	2 08	1·90	0·148	0·175	2·23	2·08	1·24	1·12	3·45	3·2	4·69	4·98	55·6	53·4	7·83	7·33
Preston	321	371	17·0	19·7	...	9·90	5·04	5·06	0·381	0·345	0·100	0·081	0·530	0·425	0·118	0·212	1·13	1·05	0·085	0·101	1·29	1·28	0·736	1·12	2·03	2·40	5·83	5·84	40·3	47·5	5·73	5·58
Reading	82·2	124	7·02	10·6	5·33	6·78	6·24	6·20	1·79	1·59	0·216	0·179	1·40	1·59	0·184	0·192	3·59	3·56	0·275	0·340	3·86	3·90	1·35	1·51	5·22	5·41	10·3	1·06	83·6	87·2	12·50	7·09
Richmond	97	139	10·2	14·6	8·23	8·55	7·89	7·72	1·12	1·08	0·114	0·173	0·962	0·653	0·455	0·413	2·65	2·32	0·388	0·258	3·04	2·58	1·99	1·28	5·02	3·85	2·91	5·20	63·7	50	12·13	9·30
St. James's and Pall Mall	2401	3028	27·9	25·2	12·7	15	5·59	5·41	0·502	0·516	0·082	0·073	0·471	0·407	0·191	0·299	1·25	1·30	...	...	1·35	1·42	0·942	0·800	2·29	2·23	13·9	16·2	40·3	41·2	3·98	3·64
Scarborough	175	211	8·31	10·1	8·13	8·42	6·03	5·88	1·24	1·29	0·096	0·076	0·915	0·876	0·416	0·251	2·67	2·49	0·212	0·256	2·88	2·74	0·916	0·786	3·80	3·53	4·93	5·83	63·0	60·0	7·04	6·36
Sheffield	483	747	19·3	25·8	8·32	9·61	6·20	5·24	0·578	0·322	0·089	0·061	0·584	0·440	0·201	0·162	1·45	0·985	0·179	0·115	1·63	1·10	0·604	0·453	2·24	1·55	10·3	10·9	36·1	29·6	5·27	4·34
Westminster	3503	4356	30·2	31·0	13·3	13·6	5·94	5·92	0·537	0·632	0·095	0·096	0·449	0·392	0·191	0·200	1·27	1·32	0·102	0·097	1·37	1·42	0·891	0·923	2·26	2·31	11·6	12·5	38·1	39·6	4·56	4·50
Average	676	867	17·4	19·4	10·3	11·0	6·20	5·98	0·953	0·888	0·150	0·129	0·708	0·662	0·301	0·277	2·16	1·99	0·216	0·188	2·32	2·09	1·06	0·922	3·38	3·01	6 47	7·33	54·9	50·1	7·25	6·26
Per cent. increase	28		12		6·8		3·7		7·3		16		7·0		8·7		8·6		15		11		15		12		13		9·6		16	
Per cent. decrease	...		...		...		...		...		...		...		...		...		...		...		...		...		...		...		...	

there is no mistaking the influence of load factor on total costs, and especially on total costs plus capital charges.

Electric Supply Undertakings worked by Companies.—Table III. gives particulars of the working, during the years 1896 and 1897, of 25 undertakings worked by companies. As in Table I. the record values of the list are in heavy type, the corresponding values in the columns of wages at the station, repairs and maintenance at the station, generating costs, and distributing costs, have not been so picked out as these cost items have not been separately rendered in the accounts supplied us in the case of the towns left blank in these columns, viz., Leeds, Norwich, Birmingham and Hove. In the last column of the table are given the several figures obtained by adding to the total costs per unit an amount equal to 7 per cent. of the capital expended in pence per unit. We have considered it more in accordance with prevailing conditions to assume 4 per cent. as the rate of interest payable for capital when raised by companies as compared with the 3 per cent. assumed in the case of local authorities; the remaining 3 per cent. is, as before, intended to represent the charges on account of reserve funds.

In respect of output Westminster heads the list, and in 1896 had the highest ratio of output to generating plant capacity, but in 1897 the Charing Cross concern came out highest in this latter respect, and was also blessed with the highest load factor in both years. Of the 25 stations noticed in the list the Charing Cross —greatly to its credit as a London concern— stands with the lowest total revenue per unit sold in 1897. In this respect the Newcastle and District undertaking runs the Charing Cross Co. very close, having held the lowest figure in the list for 1896. In both years Leeds shows the lowest fuel, works and total costs, and also the lowest ratio of costs to revenue. As regards total costs the Leeds 1897 figure of 1·54d. is very closely run by Sheffield with 1·55d. per unit; in fact, these are the only two undertakings in the table with total costs below 2d. per unit.

Although Leeds total costs are well below the St. James and Pall Mall with 2·29d. and 2·23d. per unit the latter concern has, with a very slightly higher total revenue per unit, been able to show working profits in 1896 and 1897 respectively of 13·9 and 16·2 per cent. of the mean capital expended, as compared with the Leeds corresponding figures of 11·5 and 9·8 per cent. In this connection the last column in the table has an important signification, and Table IV. (p. 373), shows the six concerns with lowest values for total costs plus 7 per cent. of the capital expended, and is interesting, including, as it does, some other data having a bearing on the ultimate financial positions.

In 1896 it will be noticed that, although the Newcastle and District concern had the same total costs as St. James's, and a considerably lower capital expenditure per kilowatt capacity of plant, yet, in consequence of the latter's much higher "plant load factor," as expressed in units sold per 8 c.p. lamp capacity, its probable total charges on revenue, including capital charges, are lower, being as 3·98d. is to 4·29d. per unit. If we care to pursue the reason further, we find that although the St. James's "plant load factor" is higher than—

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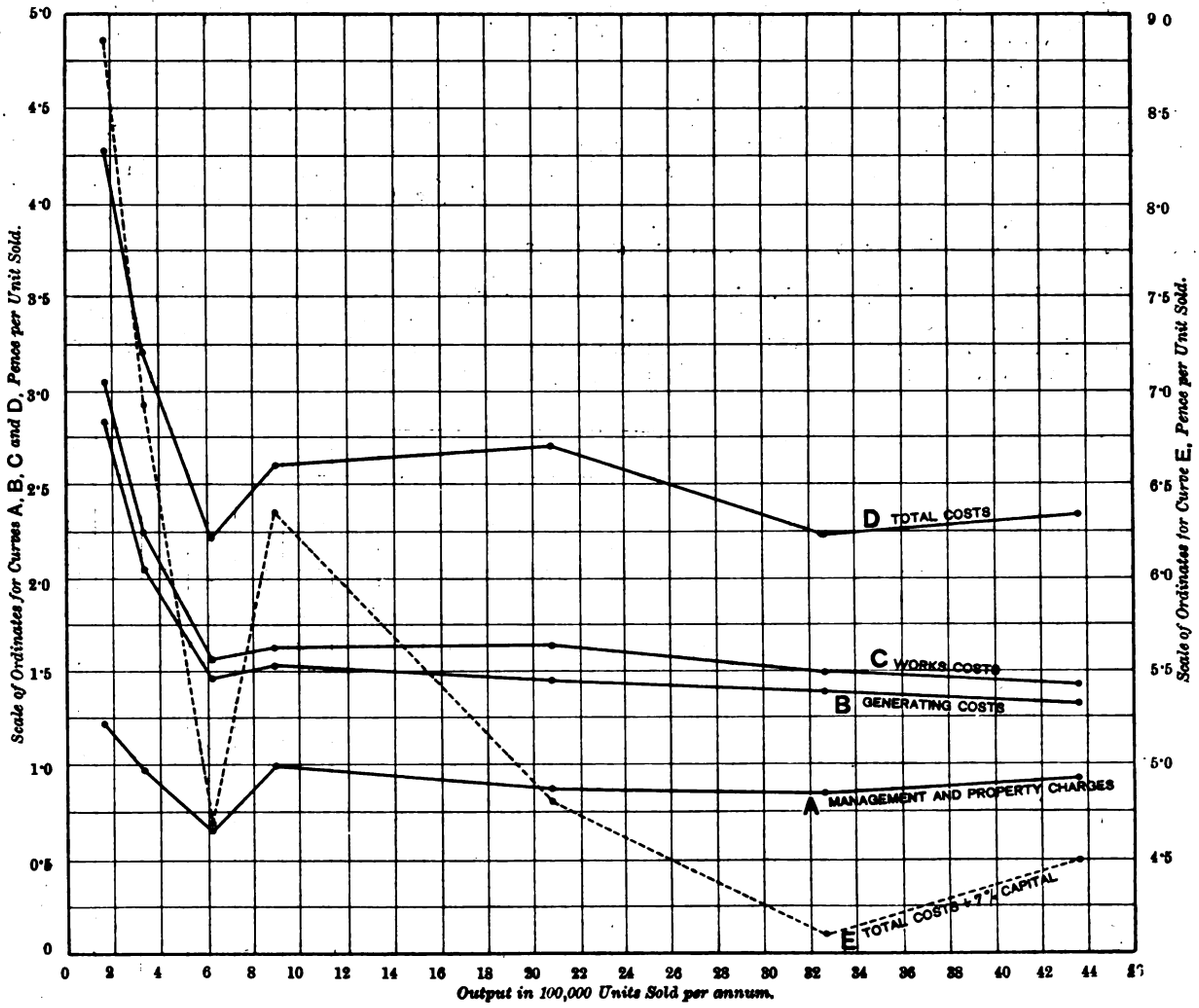

FIG. 6.—Company Undertakings. Connecting Costs per Unit with Output.

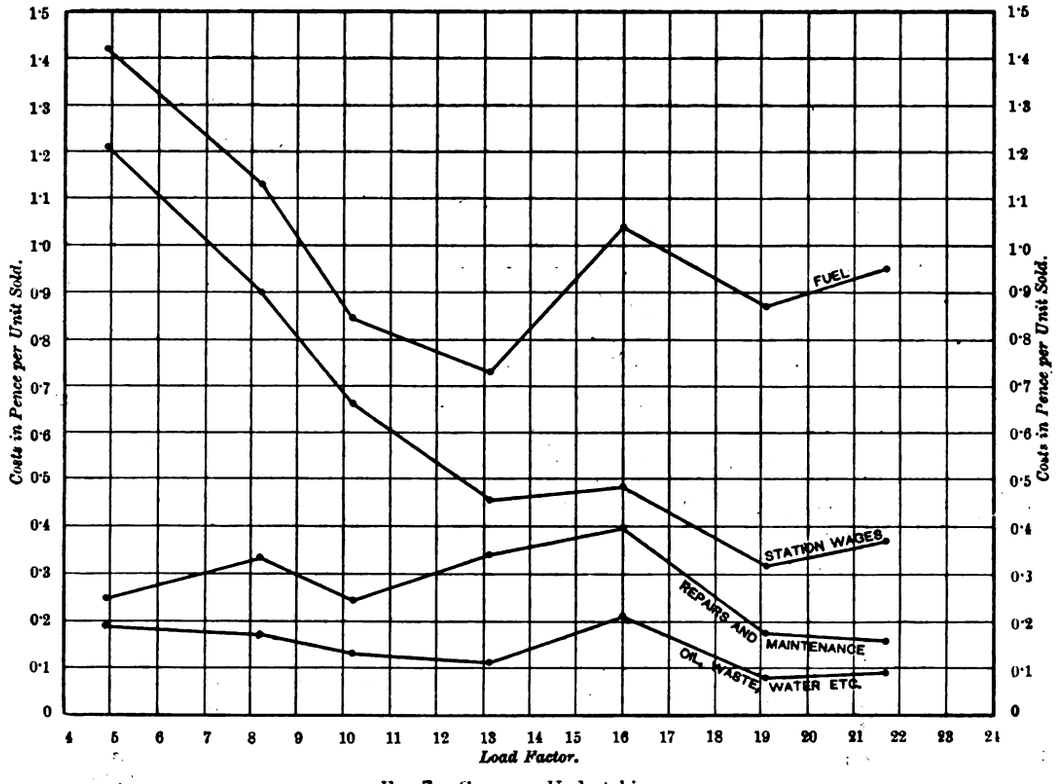

FIG. 7.—Company Undertakings.

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even double—that of the Newcastle and District, it is not because the load factor is higher—the reverse is the case. We are driven to the conclusion that there was a much larger proportion of reserve or spare generating plant in the Newcastle and District station than in the St. James's stations, since the batteries used in the latter are probably inadequate to the effect we are considering. Since the total costs and the capital expenditure at Leeds were much less than those of the St. James's; the difference in the plant load factor here again causes the difference in the total ultimate charges on the revenue. In this comparison, however, we must note that the St. James's has a higher load factor than Leeds.

Let us make another comparison, this time between St. James's and Westminster. The latter's "plant load factor" and capital expenditure per kilowatt are both higher, the total costs are slightly lower, but the total costs plus the estimated capital charges are higher, and in this case purely in consequence of the larger capital expenditure per kilowatt.

Passing to the 1897 results, we find the St. James's keeps its place of priority and has, further, improved upon its 1896 figure, and we find a stranger (to this little list) has crept into the second place, viz., the Newcastle-on-Tyne undertaking, by virtue of a not excessive capital expenditure and a good "plant load factor"—the total plant capacity in the station being very slightly in excess of the maximum demand. Norwich comes third in the list, and Sheffield, with the lowest total costs of the six, has to take a fourth place on account of its rather high capital expenditure.

It is interesting to observe that Charing Cross, even with its enviable load and plant load-factor, has to be omitted from the table, being seventh, on account of its rather high capital outlay; while Leeds had, in 1897, to take eighth place, on account chiefly of its low plant load factor.

Sufficient has now been said to show the paralysing effect of idle plant or, more generally, idle capital on the ultimate financial position of supply undertakings, and the figures in Table IV. are significant of the influence which the consulting and designing engineer may exercise almost equally with the resident engineer responsible for the more apparent every-day costs of working.

Figs. 5 and 6 graphically indicate the relation, so far as the data of our analyses to date afford, of the various costs to output. It should be noted, however, that in these curves and those relating costs to load factor, their consistency is somewhat marred by the fact that the data for the high outputs as well as the high load factors are, in the majority of cases, furnished by London concerns where the load is met by two, three or four separate stations, each of moderate outputs, and where, moreover, the conditions of working and of capital expenditure entail higher costs than elsewhere. It is necessary to bear this in mind in studying these curves, as their

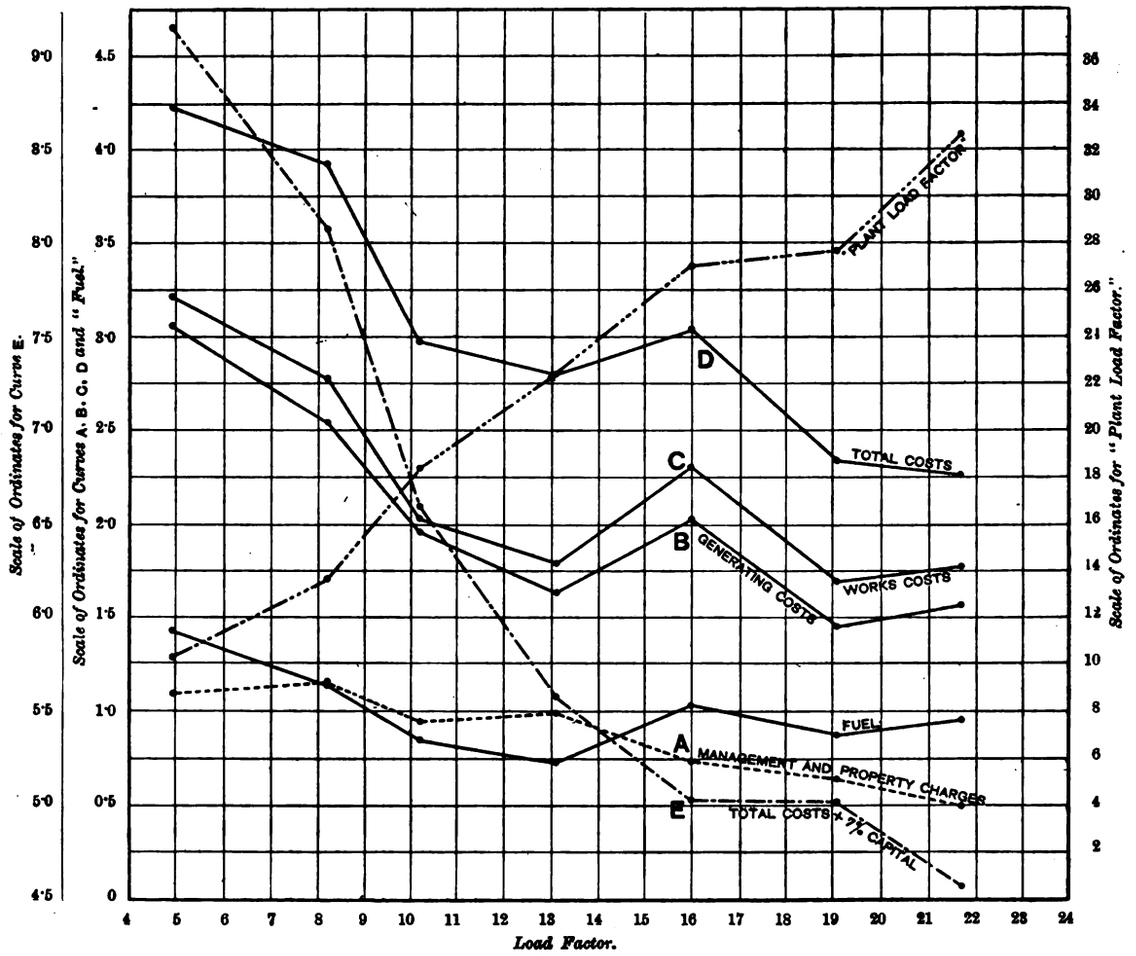

FIG. 8.—Company Undertakings.

significance is thereby somewhat strengthened, and the rise to be noticed at the right-hand end of most of the several curves explained.

Figs. 7 and 8 indicate the corresponding relationship between various items of cost and load factor. Considering the narrow limits of the latter, the curves are very consistent in their signification. The line of "plant load factor" has a slight, though an empirical, interest.

In conclusion, we might add that, had it been possible to place the various items of cost of working and supply by municipal and company undertakings upon an even basis of comparison, there is no doubt that the averages, being less influenced by the abnormals, would result in even more representative curves and figures; but, as things are, and especially since the Board of Trade form of rendering the accounts under the two conditions differ even in slight degree, we believe that the results given above are likely to prove more instructive than otherwise rendered.

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CARBONS FOR ELECTRIC LIGHTING AND OTHER PURPOSES.*

BY FRANCIS JEHL.

(Continued from page 303.)

Engineers have devoted a great deal of time to this question during the last 30 years, and their experiments have been so far successful that it is possible at the present day to build a furnace or system of furnaces which give very economical results, as nearly all the heat created can be effectually utilised.

If we investigate the conditions and requirements necessary for the baking of electric light carbons, &c., we will find that many of these conditions are practically the same as those necessary for baking high-grade ceramic articles. We find that in both cases one of the most important conditions in order to attain success is that the heating of the furnace should be very gradual, and that the rise in temperature should only proceed by small degrees, not by jumps, as the goods will warp or get contorted. The cooling must likewise be gradual, or else there will be many breaks and cracks. The heat of the furnace must also be evenly distributed, as otherwise we shall obtain an uneven and irregular quality of ware. The nearer we can fulfil and accomplish the above principal conditions, together with that of a high temperature, the more satisfactory and perfect will be the quality of the carbons when baked.

In glancing over the history of the numerous experiments that were made with furnaces of different design in connection with the pottery industry, we find that on the whole two great strides were accomplished—first, in the construction of the "ring furnace system"; and, secondly, that of the "chamber furnace system."

To Herr George Mendheim, of Munich, one of the most celebrated furnace engineers of Germany, is due the credit of inventing the ingenious gas ring and chamber systems of furnaces that are in wide use on the Continent. Mendheim's experience extends nearly two score years back, and it may be mentioned that he was the first to convert and adapt the ring system of furnaces so that they could be worked with gas, thus making them applicable for use in the better branches of the pottery industry. Formerly it was impossible to use them on account of the articles getting soiled by the soot and smoke that was caused by direct heating or combustion of the fuel in the furnace itself. No doubt Mendheim's experience with the ring system, and the information he imparted to his friend H. Escherich at the time, resulted, to some extent, in the construction of the well-known Escherich gas-ring furnace.

When the carbon industry began to flourish, in the eighties, some of the keen-witted manufacturers in Germany soon saw that the chamber or ring systems of furnace, mentioned above, were the only kinds to use in which economical and commercial results could be obtained in connection with the carbon industry, and it was not long before they had such systems in their works. It is almost impossible to believe that, after all these years of experience, there still exist some carbon manufacturers that have neither a ring or chamber system in their works. These manufacturers use principally ovens that are known under the name of "periodical half-gas furnaces," which are, as has already been explained in the chapter on carbons, very uneconomical in every respect when used for carbon manufacture.

Saving and economy in fuel, gradual increase of the intensity of heat, and gradual cooling of the wares can only be effected commercially in furnaces of the chamber or ring systems, as they work and are heated *continuously* and not *periodically*: at the same time the heat of the finished goods is utilised and won back again by allowing the air that is necessary for combustion to pass through the finished chambers, thus getting heated up in a similar manner as in a regenerator, while a gradual cooling of the carbons takes place.

In Figs. 36 to 38 we have various views of a Mendheim furnace that contains 18 chambers. The gas generators are shown at *a a*, and it will be noticed that they are somewhat similar in design to that shown in Fig. 34. The gas coming from the generators flows into the passage *b*, and thence either into the passage d_1 or d_2, according on which side of the furnace the chamber that is heated is situated. There are two valves, c_1 and c_2, by which the gas can be turned into either passage d_1 or d_2. From these main gas passages branches extend that lead under each chamber of the furnace system, as designated in the Figs. by e_1. Let us suppose that chamber VII. has just been finished and that we are going to start chamber VIII. In the first place the gas from the generator flows only along the passage d_1 as the valve c_2 is closed while c_1 is opened. The valve *e* of the branch passage e_1 at chamber VIII. is opened, and the gas flows into the passage as shown clearly in the transverse sectional view. It will be noticed that the floor of each chamber contains a large number of openings, seen in the plan at chamber I. These openings are just over the dividing partitions of passages *m* and *n* (clearly seen in the transverse section), at right angles to the passage e_1. The smaller passages *n*, it will be seen, communicate with the gas passage e_1, while the larger passages that supply air, communicate with each chamber by means of the openings *f f f*, in the walls between each chamber as shown in the plan and longitudinal sections. From the above explanation it will be seen that air and gases meet and mix at the openings in the floor of the chamber, and burn when they issue from it, while the gases resulting from combustion leave by way of the flues *f f f*, into the next chamber, and so on into the passage g_2 as shown by the arrows in the longitudinal section. From the passage g_2 they enter and circulate through the chambers X. to XV. and then into the flue *i*, by way of valve *h*, which is raised. Now the chambers IX. to XV. are filled with carbons that are to be baked, and it will be seen that the heat of the gases that result from combustion is absorbed in the chambers through which they flow, and by this means a gradual heating of carbons takes place. From the flue *i* the gases escape into the chimney *k*. The communication between chambers XV. and XVI. is barred by means of sheet-iron dampers placed at the entrances of the passages *f f f*, so that the combustion gases can only pass out at *h* into the flue *i*, and up the chimney.

The air that supplies oxygen for the combustion that is going on in chamber VIII. enters first into the furnace by way of chamber XVIII., as the entrance to that chamber is open; flows through the passage g_1, into chambers I. to VII., and then first into VIII., where it is wanted. The dotted arrows shown in the plan represent the air path, while the arrows drawn in full lines indicate the path that the combustion gases take. It will be seen that as chambers XVIII., I. to VII. have already been finished, and contain a great deal of heat, the air in circulating through gets heated up to a high temperature, so that when it arrives in chamber VIII. it may be as high as 600°C. to 700°C. This permits us to obtain a great heat in the combustion chamber, and, in fact, about 1,500°C. can be obtained (when using the system invented by Mendheim), at which carbons ought to be baked. Also the fact that the heat of the combustion gases as they pass out of chamber VIII. into the others, where that heat is taken up by the carbons, &c., makes this furnace system one of the most economical yet invented. The fact that over 200 Mendheim chamber furnaces exist in Europe, among which are some in well-known carbon works, speaks for itself, and the work he did for the pottery industry is now keenly appreciated by the best carbon makers on the Continent.

The chamber XVI. in the meanwhile is getting filled with fresh goods, while from XVII. the finished and cooled ones are taken. When chamber VIII. is finished with carbonising, the gas is turned off at e_1, and on at the corresponding valve at IX. The dampers at XV. are removed and placed in position in chamber XVI., while the same is done with reference to the

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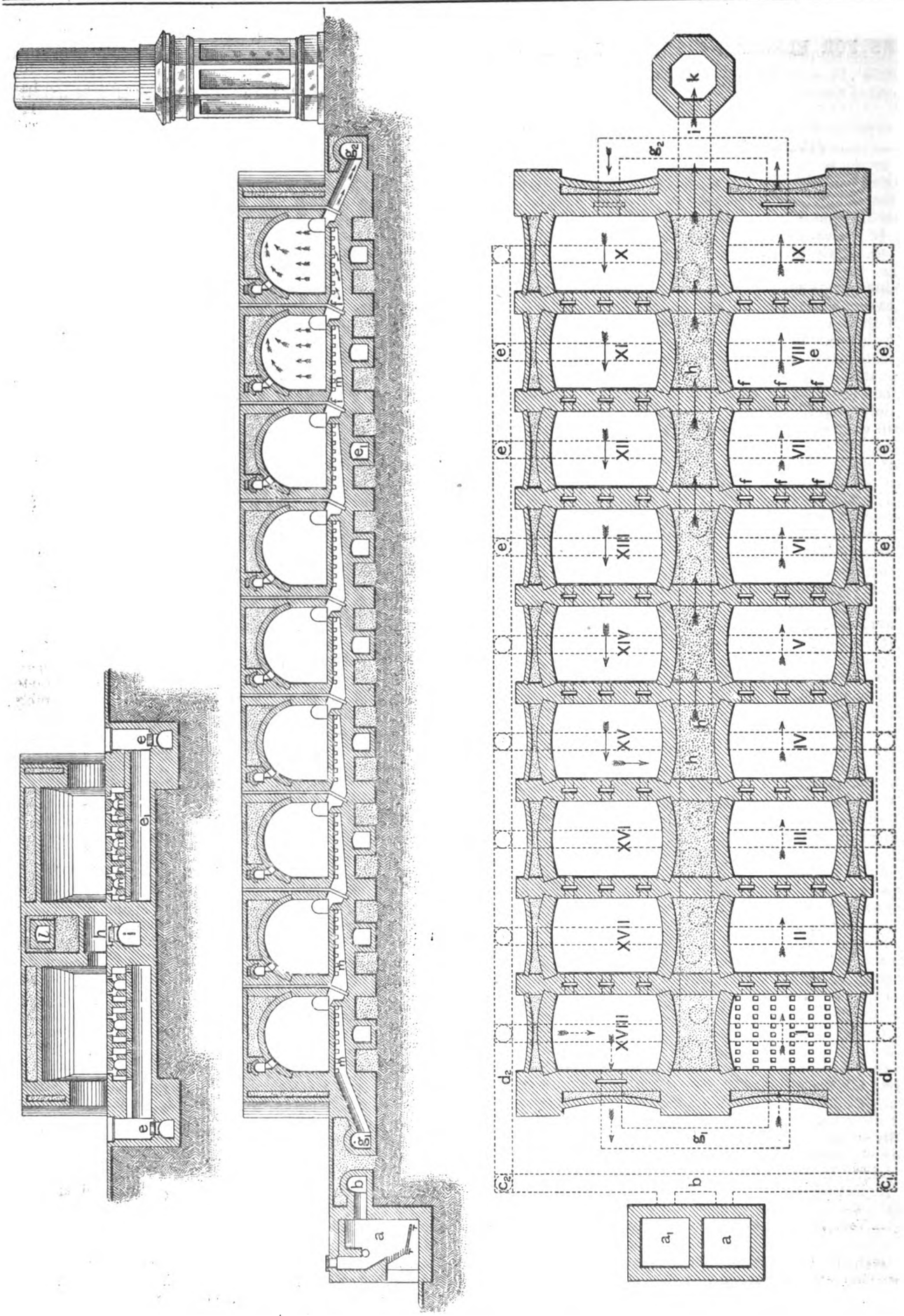

FIGS. 36—38.—Ground Plan, Longitudinal Section and Transverse Section of Mendheim's Chamber Furnace System.

valves *h*, and thus the operation is continued from time to time, there being a constant shifting, as one chamber is finished, to its neighbour, thus working continuously, and obtaining at the same time all the important conditions and requirements that have already been enumerated.

(To be continued.)

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LAMP-CONNECTION DIAGRAMS.

The increase in the number of central stations during 1898 is apparent at a glance from the length of the supplement which we issue this week, but an idea of the enormous number of lamps which have been connected to the public supply mains during the year is only obtainable by an addition

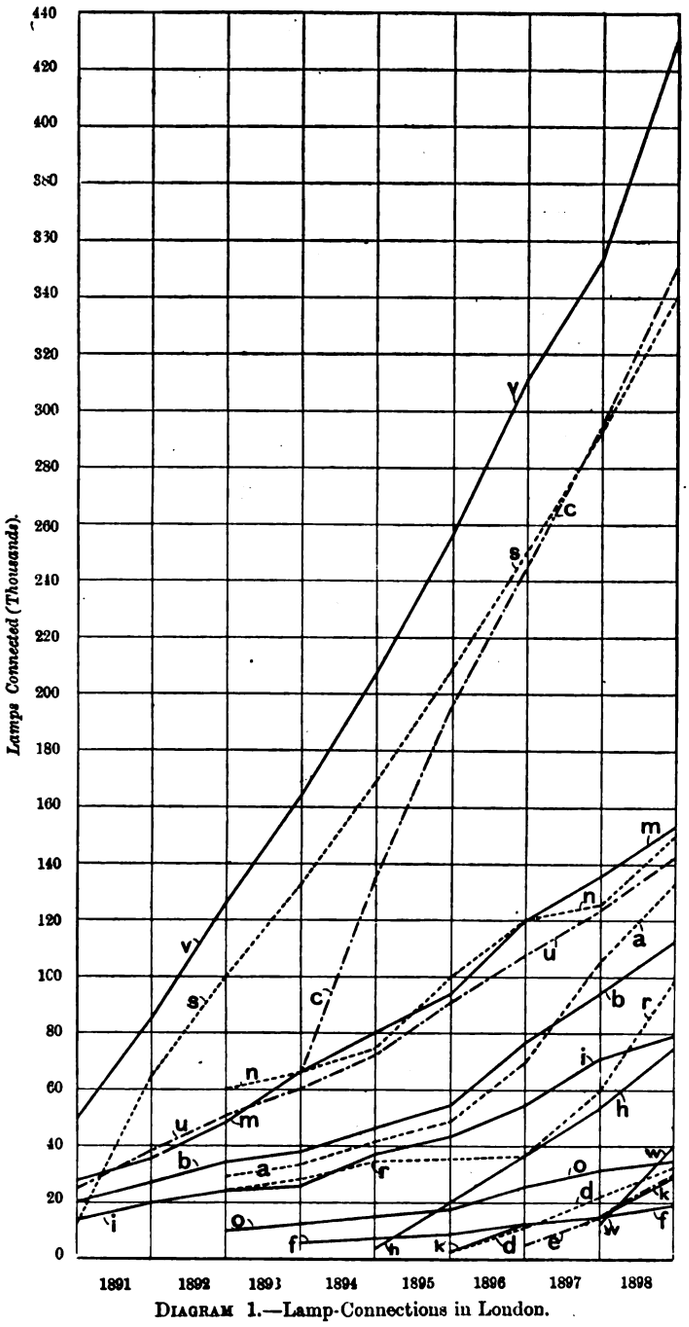

DIAGRAM 1.—Lamp-Connections in London.

a Charing Cross Company.
b Chelsea Company.
c City of London Company.
d County of London and Brush Provincial Co. (Clerkenwell).
e County of London and Brush Provincial Co. (Wandsworth).
f Crystal Palace Company.
h Hampstead Vestry.
i House-to-House Company.
k Islington Vestry.
m Kensington and Knightsbridge Company.
n London Electric Supply Corporation.
o Notting Hill Company.
r St. Pancras Vestry.
s Westminster Corporation.
u St. James' and Pall Mall Company.
v Metropolitan Company.
w Shoreditch Vestry.

of the items in the corresponding column. As in former years, we have effected this addition for our readers, and show the result in the form of a series of diagrams. Diagram 1 shows the rate of increase of the lamp connections of the London electric supply undertakings. The Metropolitan Company still leads in this respect by a large amount, the smaller increment which we had to record last year having during 1898 been compensated by a very steep rise. The City of London Company's curve still remains above that of the Westminster Company; had it not continued to rise so steeply the dilatoriness of the steam-pipe makers a month ago would not have resulted in such a serious departure from the normal supply pressure. The St. Pancras Vestry curve is now rising steeper than it has ever done before, and the fear that might have

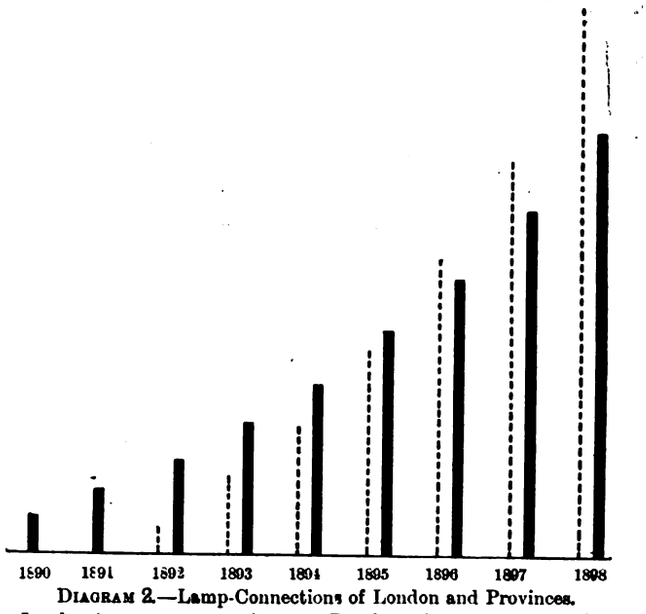

DIAGRAM 2.—Lamp-Connections of London and Provinces.
London (———). Provinces (- - - - - - - - -).
Scale: 1in. = 1,000,000 lamps.

been entertained last year, that the London Electric Supply Co.'s was approaching a maximum, is set at rest by almost the largest increase in lamp connections that this Company has recorded hitherto. This year the curves of the House-to-House and the Notting Hill Companies bend over considerably, especially the latter.

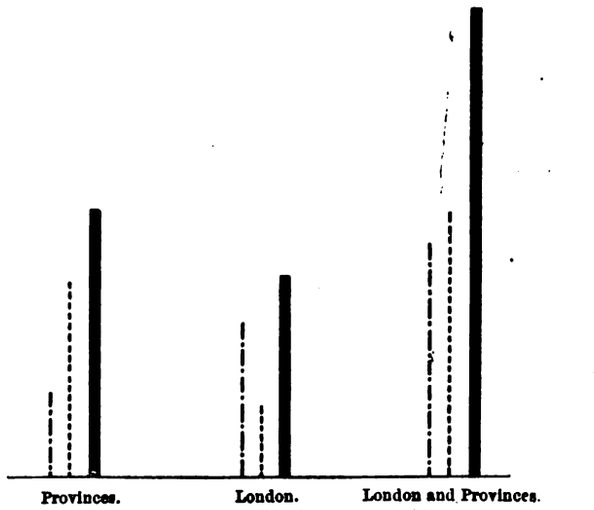

DIAGRAM 3.—Lamp-Connections to Continuous and Alternating Current Stations.
Alternate-Current (— — — — —). Continuous-Current (———).
Alternate and Continuous (— · — · — · —).
Scale: 1in. = 1,000,000 lamps.

The total number of lamp connections in the United Kingdom up to the end of 1898 is 5,206,000 8-c.p. lamps, or their equivalent, an increase of about 1,250,000 over last year, of which, roughly, one-third has been acquired in the metropolis and two-thirds in the provinces. This figure may be compared with the increase of 900,000 during 1897. Diagram 2 shows the steady rise in the total lamp connections in London and the provinces since 1880.

In diagram 3, which shows the relative number of connections to continuous and alternating current stations, the

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chain-dotted line has increased in length, partly at the expense of the dotted line, owing to a number of alternating stations having put down continuous-current machines for power supply. Thus the City of London Co. is added to the "mixed" stations this year, and in the provinces, Halifax and Salford among others, supply both continuous and alternating currents at present. Diagram 4, showing the relative strength of companies and municipalities in London and the provinces, still shows that the companies have the majority of the lamp connections. As hitherto, this is entirely due to the London companies, while the municipal load in the provinces continues to grow at a great rate. It is apparent that there will soon be as many municipal as company lamp connections in the United Kingdom.

Tables I., II. and III. give the figures used in the diagrams. It may be mentioned that all public supply stations are included in these figures; the lamp connections which have

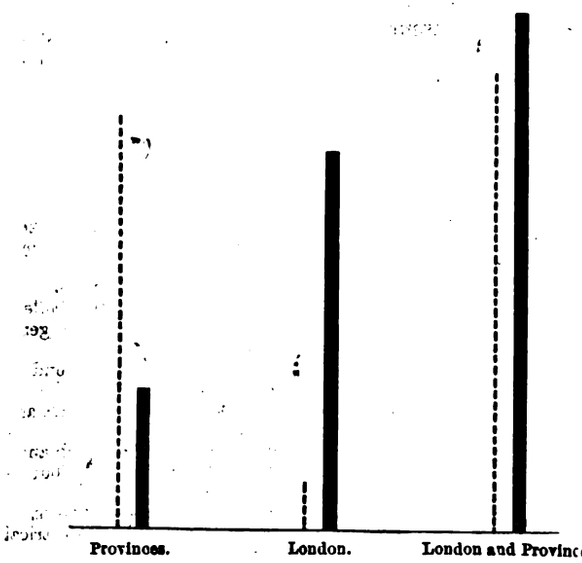

DIAGRAM 4.—Municipal and Company Lamp-Connections.
Municipal (– – – – – –) Company (————.)
Scale: 1in. = 1,000,000 lamps.

not been obtainable with accuracy, and which are, in consequence, not entered in the supplement sheet, have been estimated from data at our disposal.

Table I.—*Details of Lamp-Connections in London and Provinces.*

LONDON (2,268,000)	Municipal (251,000)	1S1S	130,000
		1S	121,000
		S	none
	Companies (2,017,000)	1S1S	947,000
		1S	258,000
		S	812,000
PROVINCES (2,938,000)	Municipal (2,200,000)	1S1S	1,127,000
		1S	680,000
		S	393,000
	Company (738,000)	1S1S	311,000
		1S	369,000
		S	58,000

Table II.—*Approximate Lamp Connections of Alternating and Continuous-Current Stations.*

—	1S	S	–	Totals.
London	812,000	379,000	1,077,000	2,268,000
Provinces	451,000	1,049,000	1,438,000	2,938,000
Totals	1,263,000	1,428,000	2,515,000	5,206,000

Table III.—*Approximate Municipal and Company Lamp-Connections.*

—	Municipal.	Company.	Totals.
London	251,000	2,017,000	2,268,000
Provinces	2,200,000	738,000	2,938,000
Totals	2,451,000	2,755,000	5,206,000

ELECTRIC LIGHTING NOTICES FOR 1899 SESSION.

The eliminating effect of the £50 cheque which promoters of Provisional Orders are compelled to lodge with the Board of Trade by December 21st has been trifling on this occasion, as only five applications, one metropolitan (for Kensal Town portion of Chelsea) and four provincial (Hythe (Kent), Hythe Sandgate and Cheriton, Romford and Rathmines (Dublin) have been dropped. According to custom, we give below particulars of the 109 remaining applications:—

THE METROPOLIS.

District.	Names of Applicants.
Battersea and Fulham	County of London and Brush Provincial Electric Lighting Co.
Bermondsey	Vestry.
Bermondsey, Rotherhithe, Deptford, Lambeth (portion), Lee and Lewisham	County of London and Brush Provincial Electric Lighting Co.
Bethnal Green	Vestry.
City of London	Charing Cross and Strand Electricity Supply Corporation.
	Metropolitan Electric Supply Co.
City of London, St. Luke (Middlesex) & Holborn	Smithfield Markets Electric Supply Co.
Kensington	Vestry.
Lee	Blackheath and Greenwich District Electric Lighting Co.
Lewisham	District Board of Works.
Plumstead	Vestry.
Stoke Newington, Hackney, St. Matthew, Bethnal Green, Poplar and Whitechapel	County of London and Brush Provinc'al Electric Lighting Co.

THE PROVINCES.

Alloa	Burgh Commissioners.
Arbroath	Corporation.
Ashford	District Council.
Audenshaw	District Council.
Aylesbury	District Council.
Barmouth	Mr. D. Davies.
Barnstaple	Urban Electric Supply Co.
Bexley	District Council.
Bexley, Crayford & Erith	West Kent Electricity Supply Co.
Bognor	District Council.
Bournemouth	Corporation.
Brentford	District Council.
Broadstairs, Birchington and Westgate-on-Sea	Isle of Thanet Light Railways Electric Co.
Buralem	Corporation.
Camborne	Camborne Electricity Supply Co.
Carshalton	Electrical Power Distribution Co.
Castleford	District Council.
Cheltenham	Corporation (extension of area).
Cheriton	District Council.
Christchurch, Pokesdown and Winton.	Bournemouth and Poole Electricity Supply Co.
Clontarf (Dublin)	Township Commissioners.
Cromer	District Council.
Crowborough	Crowborough District Gas Co.
Darfield	District Council.
Dukinfield	District Council.
Dumfries	Corporation.
Durham	Corporation.
East Barnet	District Council.
Eastbourne	Corporation.
East Retford	Corporation.
Erith	District Council.
Failsworth	District Council.
Farnborough	District Council.
Fenton	District Council.
Finchley	District Council.
Gateshead	Electrical Power Distribution Co.
Glossop	Corporation.
Gorton	District Council.
Grays Thurrock	District Council.
Guildford	Guildford Electricity Supply Co.
Halesowen	District Council.
Handsworth	District Council.
Hartlepool	Corporation.
Haslemere, Shottermill, Frensham & Thursley	Mr. E. O. Preston.
Haslingden	Corporation.
Hawick	Urban Electric Supply Co.
Heaton Norris	District Council.
Hendon	Electrical and General Engineering Co.
Heywood	Corporation.
Horsham	District Council.
Ilkeston	Corporation.

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District.	Names of Applicants.
Inverness	Corporation.
Keighley	Corporation.
Kilmarnock	Corporation.
Kirkcaldy	Corporation.
Knutsford	District Council.
Leamington	Corporation. / Midland Electric Light and Power Co.
Longton	Corporation.
Ludlow	Corporation.
Lye and Wollescote	District Council.
Lymington	Lymington Electric Light and Power Co.
Maerdy (Ystradyfodwg)	Mardy Electric Light Co.
Mansfield	Corporation.
Merthyr Tydfil	Merthyr Electric Traction and Lighting Co.
Mexborough	District Council.
Mirfield	District Council.
Musselburgh	Drake and Gorham Electric Power and Traction (Pioneer) Syndicate.
Newcastle-under-Lyme	Corporation.
Newport (I. of W.)	Ventnor Electric Light and Power Co.
Newton Abbot	Urban Electric Supply Co.
Partick	Kelvinside Electricity Co.
Pemberton	District Council.
Penzance	Urban Electric Supply Co.
Rawtenstall	Corporation.
Rhyl	District Council.
Rugby	District Council.
Runcorn	District Council.
Ryde	Corporation. / Ryde Electric Light and Power Co.
Sandown and Shanklin	Ventnor Electric Light and Power Co.
Shipley	District Council.
Slough and Datchet	Laing, Wharton and Down.
Stourbridge	District Council.
Sutton Coldfield	Corporation.
Swinton	District Council.
Swinton and Pendlebury	District Council.
Teignmouth	District Council.
Twickenham and Teddington	Twickenham & Teddington Electric Supply Co.
Walker	District Council.
Walton-on-Thames and Weybridge	Electric Works Co.
Wath-upon-Dearne	District Council.
Wednesbury	Corporation.
West Bromwich, Amblecote, Brierley Hill, Handsworth, Perry Barr, Quarry Bank, Smethwick, Kingswinford and Walsall (in Staffordshire), and Dudley, Lye, Wollescote, Oldbury, Stourbridge and Halesowen (in Worcestershire)	Midland Electric Corporation for Power Distribution.
Weston-super-Mare	Weston-super-Mare Electric Light and Power [Syndicate.
Winsford	District Council.
Worksop	District Council.

ELECTRIC TRACTION NOTICES.

Applicants.	Powers sought.
Aberdeen Corporation	To construct tramways, to employ electric traction, &c.
Audenshaw District Council	To construct tramways, to use mechanical traction, &c.
Barking District Council	To construct, work or lease tramways, to adopt electric traction, &c.
British Electric Traction Co.	To construct electric tramways in Birkdale and Southport, &c.
Clayton District Council.	To construct and work tramways, use mechanical traction, &c.
Devonport Corporation	To construct tramways, to adopt electric traction, &c.
Dudley and Wolverhampton Tramways Co.	To equip tramways electrically, &c.
Eccles Corporation	To work tramways, employ electric traction, &c.
Gravesend, Rosherville & Northfleet Tramways Co.	To construct additional tramways, introduce electric traction, to sell undertaking to Drake and Gorham Electric Power & Traction Co., &c.
Ilford District Council.	To construct and work tramways, to employ mechanical traction, &c.
Ilkeston Corporation	To construct and work tramways, adopt mechanical traction, &c.
Ipswich Tramways Co.	To construct additional tramways, to use electric traction, and to sell undertaking to Drake and Gorham Electric Power and Traction Co.
Matlock District Council	To construct and work tramways, use electric traction, &c.
Perth Tramways Co.	To construct tramways, &c.
Queensbury District Council.	To construct and work tramways, to adopt mechanical traction, &c.
Reading Corporation.	To construct and work tramways, use electric traction, &c.
Southport Corporation.	To construct and work tramways, to use electric traction, &c.
Weston-super-Mare Tramways Co.	To construct additional tramways, to use electric traction, &c.
Wrexham Tramways Co.	To construct additional tramways, to employ electric traction, and to sell undertaking to Drake and Gorham Electric Power and Traction Co.

PATENTS EXPIRING IN 1899.

The following is a list of the patents of interest to electrical engineers, which (unless specially extended by recommendation of the Judicial Committee of the Privy Council) will expire during the present year. The list includes only those patents of 1885 which have been kept in operation up to date by the payment of the necessary renewal fees.

Date (1885).	No.	Name of Patentee.	Subject of Patent.
Jan. 13	493	A. Riedler	Valves for pumps, &c.
Jan. 20	819	V. Willis	Improvements in contact-makers
Jan. 21	870	Société Anonyme "Le Ferro Nickel," Paris	Manufacture of metallic alloys.
Jan. 23	999	T. W. Worsdell	Compound steam engines.
Jan. 29	1,275	J. N. Paxman	Improvements in steam boilers.
Jan. 31	1,404	J. I. Thorncroft	Improvements in steam generators.
Mar. 2	2,765	A. Marchenay	Improvements in secondary batteries.
Mar. 2	2,776	W. H. Allen, R. Wright and Gisbert Kapp	Improvements in dynamos and motors.
Mar. 7	3,019	H. S. Maxim	Apparatus for working ordnance.
Mar. 16	3,379	C. Zipernowsky and Max Déri	Improvements in distributing electricity.
Mar. 24	3,813	F. B. Herzog	Electric signalling apparatus.
Mar. 25	3,857	S. Z. de Ferranti	Improvements in electrical switches.
Mar. 26	3,895	J. J. Hood	Manufacture of chromates and bichromates.
Apr. 15	4,071	D. G. Fitz Gerald	Primary and secondary battery plates.
Apr. 27	5,201	C. Zipernowsky, Max Déri and Otto Titus Bláthy.	Improvements in induction apparatus for transforming electric currents.
May 12	5,828	J. J. C. Smith	Vulcanising insulated conductors
May 19	6,110	J. N. Paxman and H. G. Plane	An improved steam boiler.
June 9	6,994	E. H. Cowles and A. H. Cowles	Smelting ores by electric current.
June 24	7,700	Maxime Lahaussois	Improvements in electromagnets.
July 6	8,171	William Buck	Contact-maker operated by passage of train.
July 11	8,416	A. Khotinsky	Electrode frames for secondary batteries.
July 14	8,511	J. Lea & R. Matthews	Signalling on board ship.
July 21	8,811	P. B. Delany	Improvements in synchronous movements and telegraphy.
July 21	8,812	P. B. Delany	Improvements in synchronous multiplex printing telegraphy.
July 21	8,813	P. B. Delany	Improvements in telegraphic apparatus.
Aug. 10	9,527	F. J. Sprague	Improvements in motors for electric railways.
Oct. 22	12,681	J. Brockie & B. Pell.	Improvements in arc lamps.
Nov. 2	13,207	Ed. Martin	Manufacture of wire.
Dec. 8	15,090	G. K. Winter	Railway signalling apparatus.
Dec. 11	15,251	S. Z. de Ferranti	Improved means for distributing electric energy.
Dec. 19	15,639	C. A. Knight (Babcock-Wilcox & Co.)	Improvements in steam boilers.
Dec. 19	15,658	B. M. Drake and J. M. Gorham.	Improvements in electrical switches.
Dec. 29	15,988	W. Elmore and Alex. S. Elmore.	Extraction of metals from their ores.

Map of the County of London.—Builders, architects, wiring contractors and others interested in building operations in the metropolis will welcome the large map of the county of London issued by our contemporary, the *Builder*, as a supplement to the new year's number. The map has been specially prepared from the official map of the London County Council, and corrected up to within a few weeks of publication.

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NEW ELECTRICAL JOINT-STOCK COMPANIES OF 1898.

The following are the more important limited liability companies connected with the electrical and allied industries registered during the past year, with their capital:—

	Capital.
Aberdeen Electrical Co.	£10,000
Aron Electricity Meter	250,000
Automatic Light Controlling Co.	10,000
Berrenberg Electric Lamp Syndicate	10,000
Berry's Electrical Co.	3,000
Bersey (W. C.) and Co.	5,000
Bright's Light and Power Co.	200,000
British Columbia Telephones	100,000
British Continental Electricity Co.	20,000
British Electric Meter Co.	5,000
British Electric Transformer Manufacturing Co.	50,000
British Free Electric Light Wiring Syndicate	10,000
British Polyphon Syndicate	10,000
British Schuckert Electrical Co.	200,000
Buenos Ayres and Belgrano Electric Tramways Co	850,000
Bute Electrical Manufacturing Co.	5,000
Camborne Electricity Supply Co.	10,000
Campbell's Patents	15,000
Canadian, British Columbian and Dawson City Telegraph Co.	300,000
Caoutchouc Co.	50,000
Chadburn's (Ship) Telegraph Co.	120,000
Chamberlain and Hookham	100,000
Chilian Electric Tramway and Light Co.	1,050,000
City of Mexico Electric Power Syndicate	5,000
Claud Hamilton	50,000
Clayton Engineering and Electrical Construction Co.	40,000
Clench and Co.	80,000
Cork Electrical Free Wiring Co.	10,000
Costa Rica Electric Light and Traction Co.	130,000
Cowans	30,000
Cowper-Coles Metals Extraction Syndicate	75,000
Crowdus Accumulator Syndicate	50,000
Crystal Electric Lamp and Rose and Bird	50,000
Dargue Acetylene Gas and Electrical Co.	5,000
Davey, Paxman and Co.	250,000
Deep Leads Electric Transmission Co.	20,000
Dennelle and Co.	10,000
Denner (Ernest G.) and Co.	5,000
Direct Telephone Exchange Syndicate	5,000
Doe Portable Electric Light and Power Syndicate	40,000
Douglas Sinclair and Co.	50,000
Doulton and Co.	750,000
Dowsing Radiant Heat Co.	12,000
Drake and Gorham Electric Power and Traction Co.	250,000
Drake & Gorham Electric Power and Traction (Pioneer) Synd.	20,000
Drummond Art Metal Works	5,000
Dutton and Co.	21,000
Edison-Bell Consolidated Phonograph Co.	110,000
Edison Gower-Bell Telephone Co. of Europe	75,000
Electric Installation Co.	100,000
Electric Lamp Supply Co.	10,000
Electric Light and Power Co.	6,000
Electric Lighting and Fittings Corporation	50,000
Electric Power Co. of Santiago de Chili	1,200,000
Electric Railway and Tramway Carriage Works	150,000
Electric Royalties Syndicate	10,000
Electric Supply Co. of Western Australia	100,000
Electric Works Co.	10,000
Electrical Inkless Printing Syndicate	70,000
Electrical Inventions Manufacturing Co.	5,000
Electrical Power Distribution Co.	20,200
Electrical Thawing Syndicate	25,000
Electricity	51,000
Electro-Smelting Co.	10,000
Ellis (H. G.) and Co.	15,000
Engineering Undertakings	5,000
English De Laval Steam Turbine Co.	100,000
Frank Suter and Co.	20,000
Freudenberg's Automatic Telephone Syndicate	10,000
Freudenberg's Multiple Telephone Syndicate	10,000
General Water Power Co.	21,500
Glover (W. T.) and Co.	200,000
Goodman (J.) and Co.	7,000
Hamilton, Motherwell and Wishaw Light Railways Co.	20,000
Hampstead Electric Supply Co.	200,000
Hart Accumulator Co.	40,000
Hart Secondary Battery Syndicate	5,000
Heswall Electric Light Co.	1,500
Highland Water Power Syndicate	20,700
Hiram S. Maxim Electrical Corporation	250,000
Hiram S. Maxim Elec. Light. and Engineering (Pioneer) Synd.	10,000
Hirst (A.) and Son	5,000
Hodges and Todd	25,000
Howell's "Simplex" Anti-Inductive Telephone Syndicate	12,000
Imperial Tramways Co.	300,000
Improved Telephone Patents	300,000
International Lighting Association	100,000
Irish Calcium Carbide Co.	60,000
John Spencer	75,000
Kidderminster and District Electric Lighting and Traction Co.	100,000
La Capital (Extensions) Tramways Co.	100,000
Lancashire Electrical Engineering Co.	5,000
Lancashire Light Railways Co.	50,000
Land and Water Electric Power Syndicate	10,000
Langdon-Davies Electric Motor Co.	70,000
Lloyd and Lloyd	450,000
Love's Electric Traction Co.	20,000
Lymington Electric Light and Power Co.	10,000
Macartney, McElroy and Co.	12,000
Mackey, Mackey and Co.	5,000
Marquand Accumulator Co.	20,000
Martini Ozone Co.	10,000
Medical Electro-Thermo-Generator Co.	5,000
Merthyr Electric Traction and Lighting Co.	1,000
Mexico Electric Tramways	500,000
Middleton (P. C.) and Co.	50,000
Milnes (George F.) and Co.	150,000
Motor Manufacturing Co.	300,000
Moutrie and Co.	5,000
Mutual Telephone Co.	250,000
Nernst Lamp Co.	17,000
New and Byrd	5,000
New British Incandescent Electric Lamp Co.	30,000
New Electricity Supply Syndicate	40,000
New St. Helen's and District Tramways Co.	150,000
Northallerton Electric Light and Power Co.	2,000
Northern Counties Electric and Motor Co.	10,000
Page and Miles	12,000
Paris Singer	100,000
Pearson Fire Alarm System	150,000
Perth (W.A.) Tramways	125,000
Pickup (J. H.) and Co.	50,000
Porous Accumulator Co.	3,000
Potteries Electric Traction Co.	400,000
Premier Electricity Meter Co.	25,000
Redditch District Electric Traction Co.	2,000
Reynolds and Branson	54,000
River Po Electric and Power Syndicate	10,000
Rochdale Electric Co.	5,000
Royston (James), Son and Co.	50,000
Salmony (H. M.) and Co.	25,000
Sandgate and Hythe Electric Co.	1,000
Shirras, Laing and Co.	30,000
Simplex Steel Conduit Co.	10,000
Smith (F. W.) and Co.	5,000
South American Electric Co.	100,000
Sphere Lighting Co.	12,000
Stiens and Earle	20,000
Suffolk Electricity Supply Co.	10,000
Synchronome Syndicate	15,000
Telegraph Manufacturing Co.	200,000
Telephone Construction Co	20,000
Tourtel Manufacturing Co.	18,000
Twickenham Electric Light and Power Co.	25,000
Tyer and Co.	25,000
United Ordnance and Engineering Co.	550,000
Universal Electrical Advertising Syndicate	20,000
Urban Electric Supply Co.	100,000
Veale and Co.	30,000
Vice Versa Portable Electric Lamp Syndicate	40,000
Volenite	80,000
Wenlock Electrolytic Co.	120,000
Werner Cadmium Electric Accumulator Syndicate	6,000
Western Canada Telephone Co.	60,000
West Kent Electricity Supply Co.	20,000
Whitstable Electric Light and Power Co.	5,000
Yarmouth (I. W.) Electricity Supply Co.	5,000

PUBLIC COMPANIES WOUND UP, DISSOLVED &c., IN 1898.

The following are amongst the principal electrical and engineering limited liability companies which have been wound up (either voluntarily or compulsorily) or dissolved during the past year. The asterisk denotes that the company was wound up by order of the Court:—

*Apostoloff Automatic Telephone Parent Syndicate.
*Ariel Arc Lamp Syndicate.
Automatic Electric Sign Co.
Automatic Fog-Signalling and Railway Appliances Syndicate.
B. C. Electric Syndicate.
Bedford Electric Light Co.
British Canadian Development Syndicate.
British Electrozone Corporation.
British Horseless Carriage and Motor Cycle Co.

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British Hydraulic Jointing Co.
Canterbury Electricity Supply Co.
*Cox Thermo-Electric Co.
Electric and Automatic Engineering Co.
Electric Coal-Cutting Contract Corporation.
Electric Guest Call Co.
Electric Light Regulating Syndicate.
Electric Time Distributing and Clock Co.
Esson Motor.
Globe Electrical Advertising Syndicate.
Harp Arc Lamp Syndicate.
Improved Electro Plating.
J. Goodman and Co.
John Dewhurst and Sons (Sheffield).
John Haynes Lighting Co.
Jones Bros. and Co. (Birmingham).
Knoeferl-Bonn Dental and Electric Manufacturing Co.
London Light Railways Construction Co.
*London-Provincial Electrical Co.
Manchester Suburban Electric Supply. [rators.
National Co. for the Distribution of Electricity by Secondary Gene-
Pioneer Syndicate of the Capital and Counties Electricity Supply Co.
Randall's Phonautograph Co.
Silicon Electric Lamp Syndicate.
Taylor and Tucker Art Metal Co,
Times Electric Lamp Co.
Town and Village Electric Light and Power Co.
United Ordnance and Engineering Co.
West Australian Electrical Trunk Power and Lighting Co.
Western Canada Telephone Co.

The following companies have been voluntarily wound up for purposes of reconstruction :—

British Incandescent Electric Lamp Co.
Carbon Syndicate.
Chamberlain and Hookham.
Coventry Electric Tramways.
Cowper-Coles Zinc Extraction Syndicate.
Crystal Electric Lamp Co. and Rose and Bird.
Dutton & Co.
Great Horseless Carriage Co.
Imperial Tramways Co.
Pearson's Automatic Fire Indicator Co.
Telegraph Manufacturing Co.

CORRESPONDENCE.

DR. LODGE'S SOUND-BOARD TELEPHONE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : In the talking and singing experiment which I showed to the Institution of Electrical Engineers on December 8th, I did not make it clear whether or not I was using any of the magnifying telephones that were on the table in addition to the sound-board telephone. In answer to inquiries, will you allow me to say that I was not. There was no magnification in the case. The speech currents were taken direct round the little coil attached to the deal board and suspended in a magnetic field. And only one such coil was in that instance used. The articulation of a sound-board telephone can be decidedly good as well as loud, and there need be no nasal twang such as is caused by a resonant trumpet or cone.—
Yours, &c., OLIVER J. LODGE.

THE PAST YEAR'S WORK.

We have received a number of reports relating to the past year's work in the electrical industries of a uniformly satisfactory character as to the bulk of orders, and optimistic as to the outlook for the current year. In several cases reference is made, we are glad to find, to a hardening in the prices ruling for heavy machinery. There is no doubt that, in this branch of electrical engineering work, competition has in the past decade been unduly keen and prices unduly cut. The following notes are extracted from reports received :—

Crompton and Co. (Limited).—During 1898 this firm has greatly developed its bare copper main system for electricity supply, the improvements in installation, &c., rendering it suitable for systems of supply at 440 volts across the outers of the three-wire system. Large orders received include the Corporations of Manchester, Edinburgh and Aberdeen, and the companies at Westminster, Harrow, Northampton and Hove. Amongst the municipal undertakings which have been supplied with Crompton plant are West Hartlepool, Canterbury, Stockport, Southampton, York, Gloucester and Wimbledon ; and extension orders have been received from Northampton, Yarmouth and Hove. The light and power works for Calcutta, under equipment by Messrs. Crompton and Co., have during the year made good progress, and it is anticipated that a supply of current will be available in February. The arc lamp department has been very fully occupied, orders having been received from West Hartlepool, Llandudno, Glasgow, Edinburgh, Canterbury, Leith, Lincoln, Islington, St. Pancras, Tunbridge Wells, Aberdeen, Dundee, Southampton, York, Barking, Plymouth, Coventry, Bury, Carlisle, Barrow and Calcutta. The trade in electric motors driven from central supply stations has, the report continues, made rapid progress, and this class of work has kept a considerable portion of the Chelmsford works very fully occupied. The manufacture of electric heating apparatus shows a steady increase, mainly owing, Messrs. Crompton consider, to the fact that this apparatus as now manufactured is very trustworthy. A fruitful cause of failure and annoyance in past years has been the liability of the apparatus to breakdown from accidental overheating by the users, but this liability has now been overcome, with the result that largely increased orders are being placed.

G. E. Belliss and Co. (Limited).—This firm forward a long list of corporations and companies who have been supplied with Belliss patent quick-revolution engines for electric light, power and traction work. The list includes a number of governments and shipping companies, &c., the orders in these cases being the supply of engines for ship and yacht lighting. The illustrations accompanying Messrs. Belliss' report show an installation of six sets supplied to the Charing Cross and Strand Corporation, who have in all 12 sets of these machines in use. Another illustration shows the engines for the Waterloo and City Electric Railway, supplied this year, numbering six 350 B H.P. engines in combination with Siemens dynamos. At the Croydon Corporation Electricity Works there are three 250 and two 350 B.H.P. sets of Belliss engines supplied to the order of the B. T. H. Co. At the Chester station there are 335 B.H P. and two 450 H.P. engines supplied to the order of Messrs. Thomas Parker (Limited). The general report of this firm is that the outlook is satisfactory.

Blackman Ventilating Co. (Limited) —This Company report that business in electric fans and motors is steadily growing, the new enclosed motor type being especially popular. The Company have largely extended their works and are putting down special plant for dealing with the extended demand. It is somewhat remarkable that even larger orders for this useful type of electrical apparatus are not forthcoming, as there is no doubt that, in crowded works and buildings, the electric fan is a great boon, and is, or might be made, an important factor in the day load of many stations. Amongst the contracts carried out by the firm during 1898 may be mentioned the British Museum, the Midland Railway Co.'s hotels, the Bank of England, the Birkbeck Bank, Bankers' Clearing House, the Junior Constitutional, Naval and Military, National Liberal and other clubs, and the offices of the Royal Exchange, Phœnix and other insurance offices, besides a number of well-known hotels and important industrial works in different parts of the country.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London :—

NOW READY.

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. The Author hopes that, besides Telegraph and Telephone Engineers, it may, perhaps, also prove of service to those in charge of cables for the transmission of light and power. The localisation of faults has been very fully investigated, including the different degrees in which the various methods are affected by the presence of a second fault or of general leakage.—*Extract from Preface.* Demy 8vo, fully illustrated. 10s. 6d., post free ; abroad 11s.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated ; price 12s. 6d.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net ; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition now ready.*

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

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"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"ELECTRIC MOTIVE POWER," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"WIRELESS TELEGRAPHY: SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES."—By Dr. O. J. Lodge, with many original illustrations. *Enlarged Edition*, 2s. 6d. net, 2s. 9d. post free.

"LABORATORY NOTES AND FORMS."—With the above title we have ready the New Edition of a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated. price 1s. 6d.; post free, 1s. 9d.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. Prospectus on application.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. A fine large paper edition with wide margins for notes can also be supplied. Price 12s. 6d.; post free, 13s.; abroad, 13s. 6d. *New Edition in the press.*

"THE ALTERNATE CURRENT TRANSFORMER," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *New Edition.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Flemin, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth 2s. 9d. Single Primers, 3d. each, post free.

"ARMATURE WINDINGS OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free; abroad, 6s. 6d. Digest post free.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free; abroad 13s. 6d. Prospectus post free.

IN THE PRESS.

"THE ELECTRIC ARC."—By Mrs. Ayrton.

"THE MANUFACTURE OF CARBONS FOR ALL ELECTRICAL PURPOSES."—By Francis Jehl.

"ELECTROMAGNETIC THEORY." By Oliver Heaviside. Vol. II.

"SECONDARY BATTERIES, THEIR DESIGN AND MANUFACTURE."—By E. J. Wade.

"PRIMARY BATTERIES: THEIR CONSTRUCTION AND USE."—By W. R Cooper.

"PRACTICAL TELEPHONY."—By Dane Sinclair and F. C. Raphael.

"'THE ELECTRICIAN' WIREMAN'S POCKET-BOOK."

"The Electrician" Electrical Trades' Directory and Handbook.—An important announcement in connection with the 1899 issue of the "Big Blue Book" will be found in an advertisement on another page of the present issue, to which our readers will please refer.

TENDERS INVITED.

The Commissioners of *Govan* invite tenders for the supply and erection of (1) water tube boilers and feed heater; (2) engines and dynamos, equalising transformer, boosters, &c.; (3) lead-covered armoured cables; (4) storage batteries; (5) arc lamps; and (6) arc lamp pillars. Specifications may be obtained from Mr. Arnot, C.E., 79, West Regent-street, Glasgow, and tenders must be delivered to the town clerk (Mr. A. Macdonald), Hillock House, 752, Govan-road, Govan, by 23rd inst. Further particulars are given in an advertisement on another page.

The Corporation of *Lowestoft* invite tenders for the supply and erection of the following plant:—(*a*) boilers and fittings, economisers, feed pumps, &c.; (*b*) pipe work, &c., for engine and boiler house; (*c*) steam dynamos and motor boosters; (*d*) storage batteries; (*e*) main switchboard and connections; (*f*) overhead travelling crane; (*g*) underground mains and conduits, road work, &c.; (*h*) arc lamps and posts; (*i*) station lighting. Plan, &c., may be obtained at the offices of Mr. W. C. C. Hawtayne, consulting engineer, 9, Queen-street-place, London, E.C., after 16th inst. Further particulars are set out in an advertisement elsewhere, and tenders must be addressed to the Town Clerk, at the offices, 115, High-street, Lowestoft, by noon of Feb. 6.

The *Southampton* Corporation invite tenders for the supply of transformers and fittings. Specifications, &c., can be obtained at the office of the town clerk (Mr. George B. Nalder) or at the offices of the engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, London, S.W. Further particulars are given in an advertisement, and tenders must be sent to Mr. Nalder, Municipal Offices, Southampton, by 2 p.m. on the 16th inst.

The *Edinburgh* City Council require tenders for the supply of switchboards and boosters for their Macdonald-road electricity station. Tenders to Mr. Thomas Hunter, W.S., City Chambers, Edinburgh, by *Jan. 9, and not Jan. 2* as previously announced.

The *Glasgow* Corporation invite tenders for providing and erecting generating plant at one or other of their new electricity works, including two 200 I.H.P., two 400 I.H.P., three 1,100 I.H.P. and two 2,200 I.H.P. engines, with dynamos and condensing plant. Tenders to town clerk (Sir J. D. Marwick), City Chambers, Glasgow, by *Saturday, Jan. 21.*

The *London* County Council invite tenders for four continuous-current dynamos, one motor generator, two switch-boards with switches, measuring instruments and other work required for the proposed Victoria Embankment electric generating station. Tenders, addressed to Mr. C. J. Stewart, to the County Hall, Spring-gardens, S.W., by 10 a.m., Jan. 31.

The *London* County Council also require tenders for the erection of four gas engines at the proposed Victoria Embankment electric generating station. Tenders to the clerk by 10 a.m., Jan. 31.

The Gas committee of the borough of *Rochdale* require tenders for the erection of electricity station buildings. Tenders to town clerk by Jan. 17.

The *Shanghai* Council invite tenders for a concession, for a period of thirty years, for the exclusive right of establishing and working a telephone system in Shanghai. Particulars of Messrs. J. Pook and Co., 8, Jeffrey's-square, London, E.C. Tenders to Mr. J. O. P. Bland, Shanghai, by noon of March 31.

The *Shanghai* Council also invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system. Particulars from Messrs. John Pook and Co., 8, Jeffrey's-square, London, E.C. Tenders to Mr. J. O. P. Bland by noon of March 15, 1899.

TENDERS RECEIVED AND ACCEPTED.

The *Bolton* Town Council have accepted the following tenders:—Hicks, Hargreaves & Co. for three Lancashire boilers, with accessories, water-feed, blow-off, and drain pipes; Musgrave & Sons for steam exhaust pipes, &c.

The Museum Committee of the *Bristol* Corporation has accepted the tender of Messrs. Mendham and Co. for the extension of the electric light into the curator's department in the Bristol Museum.

The *Leeds* Tramways Committee have accepted the tender of W. T. Henley's Telegraph Works Co. for cables, &c., for the electrical equipment of the Headingley, Chapeltown and Hunslet Tramways, at £8,966. The tender of Messrs. Greenwood and Batley for switchboards, boosters, &c., has also been accepted at £5,330. The Council on Wednesday accepted the tenders of Messrs. G. E. Belliss and Co. for the supply of two 1,000 H.P. engines at £6,150 and £6,000 respectively, and of Messrs. Daniel Adamson and Co. for the supply of four boilers, pipes, &c., at £6,278, and for four superheaters at £648, was also accepted.

The National Electric Free Wiring Co. has secured the Contract for the complete incandescent and arc lighting of the *Preston* Electric Railway and Tramway Carriage Works, Preston. The order

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for the complete plant and wiring of Messrs. Welch, Margetson and Co.'s premises in Long Lane, Bermondsey, has also been placed with this Company, which is also carrying out the electric lighting of the Cooper School of Art, Canterbury, and the installation of electric motors at Messrs. Lovibond's brewery, Greenwich

The *Stirling* Police Commissioners have provisionally accepted tenders for the erection of the electricity generating station. The total amount of the accepted tenders is slightly over £3,000

The *Belfast* Corporation have accepted the tender of Messrs. Mather and Platt for the supply of four 400 kw. steam dynamos at £14,500.

APPOINTMENTS VACANT AND FILLED.

The Bristol Corporation require a station superintendent for their electricity department. Salary, £175 per annum. Applications to the city electrical engineer (Mr. H. Faraday Proctor), Temple Back, Bristol, by Jan. 10.

The Lighting Committee of the Shrewsbury Corporation require an electrical engineer and manager for their electricity works. Salary £250 per annum. Further particulars are set out in an advertisement elsewhere, and applications must be sent to the town clerk (Mr. H. C. Clarke) by 12th inst.

Two assistant engineers are required at the Hanley electricity works. Applications to Mr. C. A. Cowell, Town Hall, Hanley, by 16th inst.

A stoker mechanic is required by the School Board for London for the training ship "Shaftesbury" off Grays, Essex. Particulars of salary, &c., will be found in an advertisement, and applications have to be sent in to Mr. A. E. Garland, School Board Offices, Victoria Embankment, London, W.C., by noon of Jan. 11.

A competent man, experienced in installation of engines and machinery, to take charge of contract work and to act as resident engineer, is required by the British Thomson-Houston Co. See advertisement.

An engineer, capable of looking after gas engine, dynamos and storage cells, is required for the Manchester Municipal Technical School. Applications to the director (Mr. J. H. Reynolds). See advertisement.

The Electric Lighting Committee of the Portsmouth Corporation are prepared to take pupils with a mechanical training. Particulars from the superintendent (Mr. E. Price), Corporation electricity works, Portsmouth. See advertisement.

Mr. H. M. Harding, of the London Electric Supply Corporation, has been appointed electrician-in-charge at the Hammersmith Vestry electricity works.

Mr. H. W. Miller, who has resigned the position of engineer and manager to the Guernsey Railway Co., has accepted an appointment with the British Thomson-Houston Co.

BUSINESS NOTICE.

Mr. W. R. Cassels has retired from the managing directorship of the River Plate Electric Light and Traction Co. (Limited) and the position will in future be filled by his brother, Mr. Frank Cassels, technical director of the company.

Mr. George W. Webb has been appointed sole London representative for Messrs. H. W. Sambidge and Son, electric light fittings manufacturers, Birmingham.

BANKRUPTCIES, LIQUIDATIONS, &c.

Creditors of the Lamina Accumulator Co. have expressed surprise that no intimation has been made to them of the appointment of a receiver and manager. It is explained that Mr. R. Rabbidge, of 28, Poultry, E.C., the receiver, has been appointed by the Court of Chancery on behalf of debenture holders for between £700 and £800. Mr. Rabbidge expects to get the matter settled directly the Courts open after the present vacation, meanwhile the business is in "temporary suspense." The only hope creditors have of any division of assets in their favour is the sale of the Company's undertakings and patents as a going concern. General creditors will be notified of the result of the action in the Courts as soon as possible.

The creditors of L. V. Riley and Co. met at the Guildhall Tavern, London, on Wednesday, to discuss the proposal made by the debtor for a composition. A letter was read from the solicitors of Messrs. Johnson and Phillips notifying that, as no satisfactory guarantee for the proposed composition was forthcoming, proceedings would at once be taken to issue judgment and execution. The liquidation will, therefore, take the usual course, the debtor filing his petition.

The adjourned petition for the winding-up of the Mannesmann Tube Co. (Limited) will be heard on the 11th inst. in the High Court.

A meeting of the Station Indicator Co. (Limited) will be held at 30, Moorgate-street, E.C., on Feb. 6, to receive an account of the winding-up.

Mr. F. W. Davis, 95 and 97, Finsbury-pavement, London, E.C., has been appointed trustee in the bankruptcy of Thos. King, engineer, St. Peter-street, Maidstone.

Sale by Auction.—Messrs. Fuller, Horsey, Son and Cassell will sell by auction, at the Mart, Tokenhouse-yard, London, E.C., on the 25th inst., at noon, the Bravington Engine Works, Bravington-road, Paddington, London, W.; also the whole of the modern plant and machinery at the Works. The premises are held on lease for 21 years, and are suitable for the business of electrical engineers, scientific instrument makers, &c. Further particulars are set out in an advertisement elsewhere.

Plant for Sale.—Messrs. Furber, Price and Furber announce in our advertisement columns that they will sell at the auction rooms, 77, Chancery-lane, London, W.C., on Tuesday, the 10th inst., at noon, a quantity of electric lighting plant. Catalogues may be obtained from the auctioneers, Warwick-court, Gray's Inn, W.C.

A Caution.—We understand that electrical engineering contractors and engineers generally have recently been given a call by a man soliciting guinea subscriptions for a presentation portrait in oils of Mr. Robert Hammond, and we are informed that the names of a considerable number of firms are shown on the list which the man presents for inspection, it being a condition that an artist's proof shall be given to each subscriber. Not long since the name of Mr. J. W. Swan was used in a similar canvass, and we, therefore, thought it desirable to inquire of Mr. Hammond whether this man has been authorised to collect subscriptions for the object mentioned. Mr. Hammond informs us that he knows nothing of the proposed presentation, and that he has not sat for a portrait in oils. He, however, adds that some time ago he consented to an enlargement being made from a portrait of his by an artist unknown to him, and it is possible that an attempt is being made to sell such enlargements under a bogus "presentation" scheme, just as the attempt was made in the case of Mr. Swan's portrait.

Ambroin.—Messrs. Estler Bros., of 27, Leadenhall-street, London, E.C., forward some particulars of this insulating material, the good qualities of which have led to its adoption by many of the leading electrical manufacturers in this country. It is well known that, on the Continent, ambroin holds an important place in the limited list of really effective insulating materials. Ambroin is composed of fossil copal (which, having been subjected to the action of the atmosphere and water for centuries, no longer contains any substances liable to decay) and silicates. The silicates are thoroughly saturated and mixed with the copal by a patent process so that their capacity for absorbing moisture is entirely destroyed. There is no sulphur or other oxidising substances, and it is weatherproof. After being subjected to pressure, ambroin does not undergo variation in volume, so that the most complicated pieces can be accurately moulded without the necessity of subsequent machining. This is of special importance where the insulation consists of several parts, as all the parts are interchangeable, and the parts particularly subjected to wear are easily replaced. Screws can be moulded in ambroin, which is being largely used for the insulating parts of dynamos, motors and transformers, and also for accumulator boxes, switch bases, resistance plates, fuse boxes, &c.

Battery Hydrometers.—Mr. James J. Hicks, of Hatton Garden, London, E.C., forwards latest particulars of the Hicks patent battery hydrometer, which is now extensively used in the science classes at South Kensington, and by many of the leading scientists. The largest form of this hydrometer has a hooked top, so that it may hang inside the accumulator. It has four differently coloured beads in the tube, indicating different gravities, and the correct gravity is shown on the bead which floats nearest the centre of the tube. A somewhat smaller and cheaper form of the same instrument, loaded with shot at one end, and made to float in the battery, is in extensive use by electric battery makers and supply companies. Other forms are made, all of which, it is claimed, differ materially from other hydrometers and provide an open scale, which renders easy absolutely accurate reading.

Prepayment Meters.—We have on a previous occasion referred to the merits of the Long-Schattner prepayment meter, and we have to acknowledge receipt of a circular setting out some of the advantages which Messrs. Schattner and Co., of Timberhill, Norwich, claim for this instrument. Copies of the circular can be obtained by the trade on request.

Rawhide Leather, &c.—Mr. S. Schreiber, of 8, Victoria-avenue, London, E.C., who is general European agent for the Chicago Raw Hide Manufacturing Co., forwards particulars of the Company's specialities, which include machine belting, ropes to any thickness for the transmission of power, sewing and lashing laces, packing for hydraulic presses and machines, pinions for noiseless gear, and other important industrial purposes. The particulars received include instructions how to use these goods

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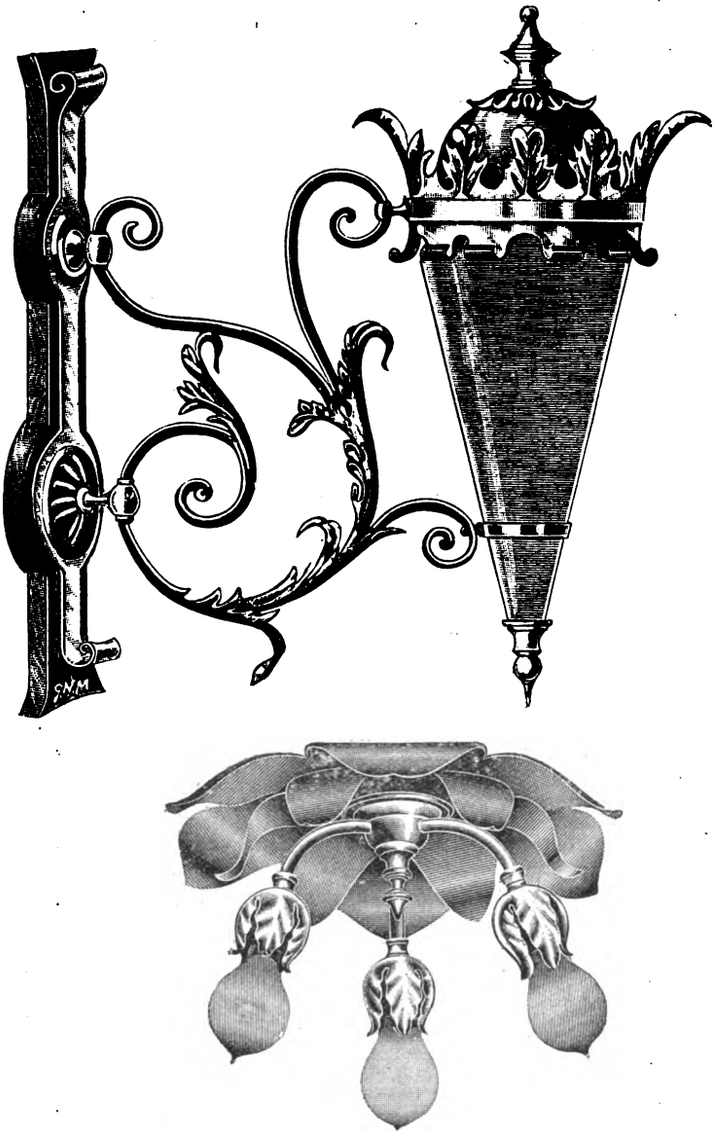
to the best advantage, and the size and prices at which the articles manufactured by the Company are supplied.

The Ediswan Catalogue.—An advance portion (Section VI.) of the complete Ediswan catalogue is to hand this week, and merits a much more complete review than space at our command will permit us to give. In commenting upon the general excellence of previous sections of this bulky tome we have had occasion to offer a hearty welcome to the conspicuous care and judgment observed in the arrangement of the book. The Ediswan Co., perhaps to a larger extent than any other trading concern in the electrical industry, and by reason of its immense manufacturing and supply business, both home and export, was early in the field with exhaustive publications of this character; and it is, perhaps, for this reason that the company continue to rely mainly upon the wood engraver for illustrations rather than the direct photo process method. It is this latter method, however, that we strongly commend for catalogue work, because, although the wood engraver's



Ediswan Fittings (Catalogue Figs. 3,459 and 3,667).

work is, as is clearly shown by the catalogue under notice, sharper and much more clearly defined, there are many advantages in the absolute facsimile to the actual goods which the photo process method secures. This is very well shown on page 65 of the catalogue. This is the only word of criticism we have to offer upon a work which gives evidence on every page of careful thought and arrangement. There is no crowding; he who runs may read, and the buyer is afforded every help in selecting from one of the largest stocks of electric light fittings of every kind offered by any manufacturing firm in the world. The catalogue opens with a commanding list of agents who handle the company's goods in all parts of the globe, and while the Ediswan Company in this way keeps its well-known manufactures and its even better-known name prominently before the world's buyers, it need have no fear of competition, however keen—and we fully recognise that in this particular branch competition is keen. The catalogue has a smart appearance and is tastily printed, and from every point of view is a credit to the officials responsible for its production. There are a hundred illustrations worthy of inclusion in this notice, but it must suffice if we show two examples which strike us as being particularly good specimens of the metal workers' art, as well as being typical of very useful and ornamental classes of electric light fittings.

The Edison and Swan Co. have recently laid down further special plant to enable them to cope with the increasing demand for the new type F instruments, recently introduced. The company are holding large stocks of all standard ranges. Voltmeters in six different ranges between 20 and 160 volts and ammeters in five different ranges between 4 and 110 amperes are stocked at low prices.

British Goods for Far Eastern Markets.—We have received from the "Eastern Press" (Limited), of 3, Chancery-lane, London, E.C., a copy of the current issue of the Japanese and English *Journal of Commerce*. This journal was established in 1892 in the light of suggestions repeatedly made by consuls abroad that English manufacturers should appeal to Far Eastern buyers in their own language. The journal is printed throughout in Japanese, and is a very creditable production. The contents include a number of articles of industrial interest, mainly in relation to the world's trade generally and in its relation to Eastern markets particularly. From the same publishers we have received a copy of the *Chinese Journal*, prepared on similar lines and also produced in London, and which circulates throughout China. Both publications are issued quarterly, and serve a very useful purpose.

Calendars, &c.—Messrs. W. H. Willcox and Co. issue a large quantity of circulars and stationery in connection with their well-known engineers' stores and general supplies, and amongst several of these just to hand is a useful pad calendar, upon each sheet of which is illustrated a number of the firm's specialities.—Messrs. Hodges and Todd, Limited, forward a neat and useful hanging month-by-month calendar for 1899.—Messrs. Croggon and Co., Limited, have sent a handy-sized office calendar, illustrating a number of their special manufactures.—From Messrs. J. H. Holmes and Co. comes a calendar blotting pad.

The "Engineering Magazine."—The January issue of this magazine contains articles on "The Relations of the United States to their New Dependencies," by Capt. T. A. Mahan; "The Engineer and the Policy of Imperialism," by C. B. Going; "The Fighting Engineers at Santiago," by A. Warren; "Machine Shop Management in Europe and America," by H. F. L. Orcutt; "Equipment, Management and Economic Influence of the Ship Canal," by W. H. Hunter; "The Building of Oxford, from an Engineer's Point of View," by J. W. Parry; "Machinery and Power Applications in the Lumber Industry," by Wm. Adams; "The Evolution of Safety in Railway Travel," by Ch. Hansel; "Mining the Iron Ores of Arctic Europe," by D. A. Louis; and "The Commercial Aspect of Electric Lighting in Great Britain," by Robert Hammond. The Review of the World's Engineering Press is also given. Copies of this number can be obtained at the offices of *The Electrician*, 1, 2 and 3, Salisbury-court, Fleet-street, London, E.C.

"Cassier's Magazine."—The January number of this magazine contains articles on "The Electric Motor for Small Industrial Purposes," by Alfred H. Gibbings; "Block-Setting Titan Cranes," "An Early Locomotive," "Aristotle and Modern Engineering," "Subaqueous Rock Excavation without Explosives," "The Valve Gear of the Willans Engine," "How the Pyramids were Erected," "Engine-Room Experience in War Time," and "American Locomotive Repair Shops."

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Dec. 29 to Jan. 3, with the ports of destination:—

Argentina—Rosario, £621 (including £60 telegraph material). *Australasia*—Adelaide, £1,593 (telegraph material); Melbourne, £25; Port Pirie, £15; Sydney, £170; Wellington, £80. *Ceylon*—Colombo, £89. *Columbia (Republic of)*—Santos, £12. *Egypt*—Alexandria, £17. *France*—Bordeaux, £17. *Germany*—Hamburg, £118 (including £110 telegraph material. *Holland*—Amsterdam, £30. *India*—Bombay, £24; Calcutta, £108; Madras, £32. *Italy*—Spezia, £548. *Japan*—Yokohama, £320. *Malta*—£97. *Norway*—Christiania, £617 (including £444 telegraph material). *South Africa*—Cape Town, £58; Durban, £2,569 (including £2,405 telegraph material); Port Elizabeth, £135. *Spain*—Barcelona, £10. *Straits Settlements*—Singapore, £252 (telegraph material). *Uruguay*—Monte Video, £536. *West Indies*—Trinidad, £70. Total (for six days) £8,163, against £107,375 (and 3,000lb. telegraph cable) for eleven days last year (Dec. 25 to Jan. 4).

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MUNICIPAL, FOREIGN AND GENERAL NOTES.

Aldershot.—The District Council will consider at its next sitting a report from the Electric Lighting committee recommending that steps be taken for the erection of electricity supply works in the district. The estimated cost of an electricity station capable of supplying current to the equivalent of 6,000 8 c.p. lamps is put at £11,000 by the engineer, Mr. Nelson Dennis.

American Pacific Cable Schemes.—Mr. Corliss, of Michigan, has introduced into the House of Representatives a bill to secure the laying, under Government control, of cables connecting the mainland of the United States with Hawaii, the Philippines, Japan and China. Under the bill the President is authorised to cause the cables to be laid, and the House is asked to appropriate a sum sufficient to provide for cables of a minimum efficiency of 15 words per minute. The cable, when completed, is, under the terms of the bill, to be handed over to the United States Post Office Department for working as part of the postal service. A tariff not exceeding $1 per word is fixed for private messages, and a sinking fund is to be formed by receipts from the cable service beyond cost of operation. In connection with his bill Mr. Corliss calls attention to the fact that the concession obtained by Mr. Scrymser for landing rights for the Pacific cable at Hawaii gives the Pacific Cable Co. exclusive landing rights for 20 years. A bill is now before both Houses of the United States Legislature to provide for grants being made in aid of the Pacific Cable Co.'s scheme of $100,000 per year for 20 years. Dated Dec. 31, Reuter states that Secretary Hay, at the instance of the Hawaiian Commission, has formally expressed his disapproval of the rights secured by the Pacific Cable Co. as above-mentioned.

Brierley Hill.—The District Council will oppose the application of the Midland Electric Corporation for power distribution.

Bucharest.—A Belgian syndicate has purchased the tramways of this city for 17,500,000 francs (about £600,000). It is proposed to equip the lines on the overhead trolley system, and also to supply current for lighting.

Bury St. Edmund's.—The Local Government Board have sanctioned the Town Council's modified electric lighting scheme. The amount proposed to be borrowed is between £15,000 and £16,000.

Colwyn Bay.—Messrs. Lacey, Clirehugh and Sillar have been instructed by the District Council to prepare a scheme which will provide for both public and private electric lighting in this district. Hitherto the Council have adopted only a small scheme for lighting the promenade.

Crewe.—A Local Government Board inquiry has been held to inquire as to the application of the Town Council to borrow £26,000 for electric lighting purposes. Mr. F. Cooke, the town clerk, said that the Corporation had secured a site for a generating station which the consulting engineer (Mr. B. Hopkinson) considers an extremely good and central one. The estimated capital expenditure entailed by the scheme is £24,198. There was practically no opposition.

Derby.—The borough electrical engineer (Mr. T. P. Wilmshurst) has presented a report on the extension of the electricity buildings and the provision of additional machinery at the station to meet increasing demands. The estimated cost of the extensions, including structural alterations, is £25,000. The Electric Lighting committee have endorsed Mr. Wilmshurst's recommendations, and advise the Council to apply for sanction to borrow the money. The proposals were approved by the Council on Wednesday.

Dewsbury.—Owing to the Town Council having decided to construct a system of electric tramways, the scheme of the British Electric Traction Co. is to be opposed.

Disclaimer.—We are requested to state that Major Hector Tulloch, C.B., retired R.E., and lately chief engineering inspector of the Local Government Board, is not the person who was a Director of the West Australian Trading Syndicate, two of the Directors of which are under prosecution by the Public Prosecutor.

Dorking.—The Council are about to appoint a consulting engineer for their electricity scheme, and Messrs. W. C. C. Hawtayne, W. H. Trentham and J. S. Raworth have been invited to attend before the Electric Lighting committee.

Dublin.—Mr. M. Ruddle, the electrical superintendent, has been granted a bonus of £50 for extra work owing to the recent failure of the electric light cables. The Corporation have decided to apply to the Local Government Board for a supplementary loan of £7,000. The estimated cost of renewing the cables and mains, which was originally put at £22,000, is now found to be at least £26,000.

Dudley.—The Council on Tuesday appointed Mr. R. P. Wilson consulting electrical engineer, when it was decided to obtain tenders for electric generating plant. The Railway, Tramway and Electric Lighting committee have been authorised to borrow £7,500 for the erection of a station.

Dundee.—The Town Council have decided to extend the electricity generating station to accommodate plant for tramway purposes. The whole of the extensions are estimated to cost about £15,500.

Garston.—The District council propose to transfer their provisional order to the British Insulated Wire Company, who offer to establish electricity works in the district, and to supply current for private lighting at 5d., and for public lighting at 3d. per unit. The company also undertake to erect, in conjunction with the electricity works, a refuse destructor, and to burn refuse at 9d. per ton. The council reserve right to purchase. The matter is to be discussed at the next meeting of the council.

Gateshead.—The Town Council, on Wednesday, adopted the agreement with the Electrical Power Distribution Co. as to the terms, &c., upon which the latter are to supply electric current in the district.

Glasgow.—As the result of a further conference between the representatives of the Kelvinside Electricity Co., and the subcommittee of the Glasgow Corporation as to the purchase of the company's undertaking, the city electrical engineer (Mr. W. A. Chamen) has been instructed to draw up a fresh report. It will be remembered that the company offer to sell at £50,000. and the Corporation offer £30,000.

In a report prepared by the tramway manager (Mr. John Young), it is stated that the overhead system has been in operation for over ten weeks. A full service has been given for a portion of the time, and the horse cars altogether withdrawn. For the first few weeks, when the number of electric cars was small, and the service novel, the receipts per car mile were abnormally high. The drawings for the whole period from October 13 to December 24 averaged 16·01d. per car mile. Taking the last five weeks, during which they might safely assume the receipts had reached their normal, the average had been 14·88d. per car mile. For the corresponding five weeks of last year the receipts from the horse cars was 11 per mile, but the average for the route throughout the period from Jan. 1, 1897, to Oct. 8, 1898, was 12·24d. per car mile. Taking the larger figure for the horse cars, the electric cars show an increased revenue of 2·46 per car mile. It was rather soon to give a definite figure as to working expenses under electric traction, as the condensing plant had not yet been in operation; but after including a fair sum for maintenance and renewals, it might be taken that the total working expenses would not exceed 6½d. per car mile. The average working expenses under horse traction might be taken at 6½d. per car mile, although during the last financial year the amount worked out at slightly under that figure. This shows a saving in working expenses for electric over horse traction of at least 2d. per car mile. There was no doubt that even with the small power station at Springburn, were all the available power utilised, as it would be when the route to Govanhill was opened, a still larger saving would be effected. The result, so far, had been an increased revenue of 2·64d. and a decreased expenditure of 2d. per car mile, being a total gain of 4·64d. This gain on the present mileage on the Springburn route (2·40 miles of double track) would amount to £10,000 per annum.

The Clyde Navigation Trustees have decided to adopt electric lighting. At first the installation will be confined to the large open spaces where night work is conducted. The Trustees have decided to purchase the current required for the north side; and current for the south side will be provided by an independent installation. The supply and erection of the lamps, &c., and the laying down of the installation will be let by tender.

In the report by the city engineer on the ventilation of the City Chambers, it is recommended that electric fans be introduced.

Gothenburg (Germany).—In March, 1897, a committee was appointed to collect information, &c., bearing upon electric tramways in relation to the projected electric lines to be established in Gothenburg. This committee has now reported recommending the erection and equipment of an electric power station and electric tramways on the overhead system, the track to be leased by the existing tramways company, and the lease to be for 20 years after the lines are completed. At the expiration of this period the city will work the line after paying to the company the value of the rolling stock. The Gothenburg Tramways Co. (which now uses horses) has been granted a concession up to 1917, and the present proposal is intended to be a compromise between the municipality and the company. Two other persons have asked for concessions to build electric tramways, but have been refused. Messrs. Siemens and Halske, of Berlin, have furnished an estimate giving the total cost of construction (value of sites for the buildings not counted and value of the old tramways deducted) at about £100,000, of which the city's share would be £68,500, which includes cost of the power plant (£19,300). The yearly working expenses are put at £16,000. The proposed contract provides that the company will pay yearly to the city 8 per cent. of the cost of construction of the track, &c. (power plant excluded), £8,500. If the gross receipts of the com-

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pany in any one year exceed £21,500 the company pays the city 12 per cent. of the excess. The city reserves the right to arrange workmen's trams before eight o'clock in the morning, and stipulates that passengers who have paid regular fare on one tramway line may continue on another by paying half fare in addition to the sum first paid. The work is to begin in May, 1899, and two of the lines must be finished before November, 1899, and the remainder opened for traffic by September, 1900. The railways will have a length of 13,347 yards, of which 13,041 yards is double track.

Hampton.—The surveyor (Mr. J. Kemp) has prepared a report for the District Council, and recommends the erection of electricity supply works. The cost of an installation, capable of supplying current to about 5,000 8 c.p. lamps, is put at £14,000, and after allowing for sinking fund and interest a net annual profit of about £120 is shown.

Hereford.—The Town Council recently received 17 tenders for the supply and erection of electric lighting plant. As the cost of the generating plant and mains will amount to about £12,000 application is to be made to the Local Government Board for sanction to borrow £20,000 for carrying out the scheme. The proposal to utilise water power has been abandoned.

Ilfracombe.—The District Council have decided to engage a consulting engineer to advise them upon electric lighting matters, and more particularly as to whether the Council should engage in the business of electricity supply.

Leeds.—The newly appointed Electric Lighting committee presented their first report on Wednesday, and recommended that an expenditure of £16,409 be authorised to carry out extensions of sub-stations, and to lay mains to the Hunslet district at a cost of £8,408. The committee are desirous of supplying current to Hunslet, where a large number of big engineering works are established. The committee's proposals were adopted by the City Council.

The Tramways sub-committee have decided to proceed with the electrical equipment of the Beckett-street and York-road sections of the tramways. It is hoped that these lines will be in operation electrically by July or August next.

Leith.—The Council anticipate being able to supply electric current to private consumers next week.

Manchester.—The Electricity committee have been requested by the Council to report as to the steps they are taking for providing the necessary electrical equipment and power to enable the Tramways committee to commence working the tramway system of the city and suburbs by electricity in 1901; and also as to the advantages and disadvantages of supplying current for the tramways at a pressure of 400 volts.

Oswestry.—The Oswestry Electric Lighting Company have offered to light the whole of the district by incandescent electric lamps at £3 per lamp per annum. The proposal is at present under consideration by the council. The company further offer to erect and supply current, free of cost, for one month for four 1000 c.p. arcs, after which, if the lamps are required, current will be supplied at 2d. per unit.

Paris.—The electric light has been introduced into the Chamber of Deputies, Paris, under the direction of the commission presided over by M. E. E. N. Mascart. There are 4,610 lamps in all, 1,440 in the various parliamentary services outside the Chamber, 2,640 in the Hotel de la President and the Grand Saloon, and 530 in the anterooms. The Chamber is not yet lighted, as a new and much finer room is in course of construction. Gas engines are employed to drive the dynamos, and a battery of Tudor accumulators is also installed.

Postal Telegraph Clerks and their Grievances.—A petition is, it is stated, to be presented to Parliament setting forth the grievances under which the postal telegraph clerks of the country are alleged to suffer. The question of wages, compensation for partial abolition of classification, insufficiency of salary increments, and other questions are to be placed before Parliament. The petition asks that a select committee be appointed to consider the whole question of the present and future position of the operatives.

Redditch.—The District Council have entered into an agreement with the National Electric Free Wiring Co. for the wiring of premises in the district on "easy" terms. A loan of £10,911 at 2¾ per cent., repayable in 25 years, has been taken up by the Council for electric lighting purposes.

Sheffield.—The undertaking of the Sheffield Electric Light and Power Co. was formally taken over by the Corporation on Saturday, when a cheque for £260,000 was handed to the chairman of the company (Alderman Franklin).

Southport.—The Town Council have taken up a loan of £21,178 for electric lighting purposes.

Southport-Lythom Electric Tramway.—The Preston Town Council have decided to oppose the bill for the construction of this line.

Teddington.—As a result of a conference with a committee of the Twickenham District council, the Teddington council are recommended to make early application for a provisional order. This decision is due to an application lodged by Edmundson's Electricity Corporation.

Telegraph to Klondyke.—A Reuter's telegram from Winnipeg announces that a statement is published that the Federal Government contemplate the construction of telegraph lines and a wagon road from Ashcroft to Dawson City, a distance of 1,400 miles. The line, it is said, is to take the road cut out more than 30 years ago when a scheme was on foot for reaching Europe by telegraph through Siberia.

Telephone Trunk Extensions.—Cirencester, St. Austell, Truro and Penzance are now on the telephone trunk line system of the country.

Tunbridge Wells.—The Town Council decided on Wednesday to borrow a further £25,000 for electric lighting extensions.

Twickenham.—The District Council are recommended by the Lighting committee to apply for a provisional order, and to take steps to oppose the application of Edmundson's Electricity Corporation.

Warrington.—The Town Council have before them a report from the Electric Lighting committee recommending the erection of electricity supply works. The Council's consulting engineer (Mr. A. H. Preece) advises the adoption of the low-tension continuous-current three-wire system of distribution with a pressure of 440 volts between the outers. The total cost of the scheme, exclusive of buildings, is £30,000.

Whitfield (Glossop).—The District Council have created a special committee to consider the erection of electricity works and the construction of tramways.

York.—The City Council have arranged with the National Telephone Co. for placing the telephone wires underground.

Dinner.—The head office staff of the National Electric Free Wiring Company dined together at the Holborn Restaurant on the 30th ult. The chair was taken by the manager (Mr. B. H. Jenkinson).

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom all information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

November 27, 1898.

24,965. G. T. HANCHETT and F. B. SAGE, Manchester. A new or improved electrical resistance measuring instrument.*

24,982. W. R. SMITH. London. Improvements in appliances for overhead electric traction.

25,009. C. VERNIER. London. A new or improved electric arc lamp.

25,013. A. VOSMAER. London. Improvements in or connected with electric arc lighting.

25,023. O. BRENNECKE and I. TIMAR. London. Method of heating electrically propelled tramway cars and other vehicles.*

November 28, 1898.

25,051. C. A. GILLESPIE. Glasgow. Improvements in or relating to combined pressure or vacuum registers and electric alarms.

25,058. H. G. SOLOMON. London. The spring automatic fuse replacer for electrical cut-outs.*

25,098. S. P. THOMPSON. Liverpool. Improvements in electric surface contact tramways.

25,109. J. W. BROWN and A. J. G. SIMPSON. London. Improvements in electric hoisting machinery.

November 29, 1898.

25,202. L. SCHOTT. London. Improvements in electric alarm clocks.

25,217. R. ECHTERMEYER. London. Improvements in and relating to the production of electric currents.*

25,221. J. J. RATHBONE. London. Improvements in electric arc lamps.

November 30, 1898.

25,259. K. OBST. Liverpool. Improvements in electrical revolution indicators.*

25,260. H. NUNNS. Halifax. Improvements in electricity meters.

25,314. C. D. ABEL. London. Improvements in apparatus for transforming alternating into continuous electrical currents and conversely. (La Société Anonyme pour la Transmission de la Force par L'Electricité, France.)

December 1, 1898.

25,327. L. RIDOUT. London. An improved electrical terminal.

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December 2, 1898.

25,417. J. Eck. London. A switch for electric circuits.
25,479. F. W. Canfield. London. Electric igniter or sparker, for gas, oil or vapour engines.*

December 3, 1898.

25,537. W. P. Thompson. Liverpool. An improved contact device for electrical igniting devices of gas engines. (Bluhm and Co. and J. Bauer, Germany.)
25,567. Siemens Bros. and Co. (Limited). London. Apparatus for transmitting motion to a distance by means of electrical energy. (Siemens and Halske, Aktien Gesellschaft, Germany.)*

December 5, 1898.

25,592. F. W. Heaton and H. Smith. Manchester. An improved fusible cut-out for electric circuits.
25,632. J. S. Blackwell and W. A. Charles. London. Improvements in electric arc lamps.
25,657. L. Jacob. London. Improved electrical signalling devices for railways.

December 6, 1898.

25,667. S. W. Cuttriss. Leeds. Improvements in electrical resistance coils.
25,670. T. C. Kinraide. London. Improvements in electrical induction apparatus.*
25,734. W. Schlothauer and A. E. Preece. London. Improvements in secondary batteries.
25,746. F. Christy and L. F. Christy. London. Improved means for electrically heating ovens, hot chambers, rooms and the like.
25,747. J. W. Swan. London. Improvements in or connected with incandescent electric lamps.
25,752. G. L. Addenbrooke. London. Improvements in electrometers and in keys for operating the same.
25,764. W. F. Stamp. London. Improvements in devices for making and breaking surface contact on electrical tramways.

December 7, 1898.

25,850. J. E. Barnard. London. Improvements in electric lamps for use with the microscope or similar optical instruments.*
25,863. Siemens Bros. and Co. (Limited). London. Improvements in and in connection with radiating axles for electrically-propelled railway or tramway cars. (Siemens and Halske, Aktien Gesellschaft, Germany.)*
25,877. A. J. Boult. London. Improvements in or relating to contact devices for electric igniters of explosion engines. (Société Nouvelle des Etablissements Decauville Ainé, France.)

December 8, 1898.

25,895. P. G. Ebbutt and Veritys (Limited). Birmingham. Improvements in and relating to electric switch or key lampholders or sockets.
25,896. P. G. Ebbutt and Veritys (Limited). Birmingham. Improvements in connection with electric lampholders or sockets.
25,961. C. Pellenz. London. Improvements in insulator brackets for electric conductors.
25,985. P. Pickard. London. Improvements in methods and means o electric ignition for explosion motors.*

December 9, 1898.

26,014. J. McQueen and D. Barker. Manchester. Improved electric stop motion for drawing frames.
26,020. H. W. Cox. Nottingham. Improvements in and relating to electrical switches.
26,026. W. G. Heys. Manchester. Improvements in and relating to galvanic batteries. (Siegfried Silberberg, United States.)*
26,033. H. W. Miller, W. Turvey and G. C. Weston. London. Improvements in connectors for electrical cables or wires.
26,038. W. B. Buer, T. W. Legge and J. Tabrar. London. New or improved means for electrically-operating clocks.
26,063. W. A. Gent. Birmingham. An improved switchboard for use in connection with electrically-illuminated signs and display frames.
26,067. H. C. Gover and C. F. Proctor. London. A new or improved holder for electric glow lamps.*
26,068. Siemens Bros. and Co. (Limited). London. Improvements in electrical glow lamp fittings. (Siemens and Halske, Aktien Gesellschaft, Germany.)*
26,073. A. F. Hills. London. Improvements in or connected with the arrangement of conductors for transmitting electrical energy from a generating station upon land to a movable structure in water.
26,074. A. F. Hills. London. Improvements in or connected with electro-motors.

December 10, 1898.

26,092. A. G. G. Cumming. Scotland. An improved mode of winding for the armatures of dynamos and electro-motors.
26,116. W. G. Heys. Manchester. Improvements in and relating to galvanic batteries. (Siegfried Silberberg, United States.)*
26,136. K. Lehner. Liverpool. An improved electrical measuring instrument.*
26,145. A. O. Berry. London. Improvements in continuous current dynamos, motors and motor-dynamos.
26,153. Siemens Bros. and Co. (Limited). London. Improvements in and in connection with telephonic microphone apparatus for electric signalling. (Siemens and Halske, Aktien Gesellschaft, Germany.)*
26,164. C. B. Callow and J. Eck. London. A resistance switch for electric motors.

December 12, 1898.

26,191. E. W. Coawn and A. Still. Cheshire. Improvements in electric switchboards.*
26,210. F. O. Prince. London. Improvements in dynamos and electric motors.
26,214. E. P. Phillips and W. H. Bray. Leicester. Improved electrical furnace.
26,239. J. Wetter. London. Improvement in electric measuring instruments for three-phase systems. (The Elektrizitäts Aktiengesellschaft vormals Schuckert and Co., Germany.)
26,248. J. W. Gibbs. Liverpool. Improvements in or relating to starting switches for electromoters or the like.
26,251. O. T. Blathy. London. Improvements in the construction of electrical transformers with ventilating passages.*
26,257. L. de Coincy. London. An improved method of and apparatus for regulating the difference of potential at the terminals of dynamo-electric and like machines. (Date applied for under Patents &c., Act, 1883, Sec. 103, 6th June, 1898, being date of application in France.)

December 13, 1898.

26,285. S. H. Heywood and H. W. Heywood. Manchester. Improvements in switches for electrically worked lifts, hoists and the like.
26,310. G. A. Clark, W. McAulay and J. A. McLaren. Glasgow. Improvements in junction boxes, switches, wall plugs and distribution boards for use in electric wiring.
26,315. J. M. Murphy. London. Improvements in ball bearings for electric motors.*
26,322. L. de Coincy. London. Improvements in and relating to apparatus for regulating the difference of potential at the terminals of dynamo-electric and like machines. (Date applied for under Patents, &c., Act, 1883, Sec. 103, Oct. 7, 1898, being date of application in France.)
26,323. E. S. D'Odiardi. Croydon. Improvements in the frigorific electro-spray.
26,325. E. S. D'Odiardi. Croydon. Improvements in electrodes of deep penetration.
26,326. E. S. D'Odiardi. Croydon. Improvements in abscess bells and electrolysers.
26,327. E. S. D'Odiardi. Croydon. Improvements in electro-inhalers and nascent ozone producers.
26,328. E. S. D'Odiardi. Croydon. Improvements in electro-vaporisers and ozonisers.
26,334. W. J. Ferguson and W. G. H. Stump. London. Improvements in electric switches.*
26,343. C. Brault. London. Improvements in the manufacture and production of plates or elements for secondary batteries or electrical accumulators.
26,351. J. Wetter. London. Improvements in galvanic elements or batteries. (M. Mass, United States.)*

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1897.

25,869. Möller. System for the distribution of electric currents and apparatus therefor.
25,890. Bell and Bell. Electrolytic cells.
26,530. Dargue, Griffiths and Wright. Apparatus for heating buildings and the like by means of hot fluids or electricity.
26,671. Boult (Moutardier and Boudet). Electrical indicating apparatus for use in hotels, restaurants, workshops and for analogous purposes.
26,732. Andrews. Systems of electrical distribution.
27,433. Nisbett and Bates. Electric cables.
28,460. Payen. Electrical accumulator. (Date applied for under International Convention, May 14, 1897.)
28,492. Rowbotham. Variable electrical resistances.
28,519. Watson. Electrical tumbler switches.
28,800. Peloux. Electric meter.
29,530. Davis. Lighting of miners' safety lamps and the like by electricity.
29,575. Mortimer and Head. Adjustable electric light fittings with detachable and rotary contacts.
29,821. Schindler-Jenky. Electric heaters.
30,020. Soames and Crawley. Prepaid electric meters.
30,441. Mengfs. Primary and secondary galvanic batteries.

1898.

121. Batault. Electric meters.
571. Bierley and Foster. Means for making electrical connection upon railway trains.
932. Pollak. Manufacture or production of electrodes for secondary batteries.
1,145. Allingham and Fennell. Electric cables.
1,735. Adamson, Allen and Allen and Adamson (Limited). Electrical accumulators or storage batteries.
2,382. Picard. Electric telegraphy.
6,992. Weston. Improvements in electrical measuring instruments.
7,450. Daniel. Conductors, conduits and collectors for electric railways and tramways.
10,900. Wise (Hubble). Electric arc lamps.
10,901. Wise (the Moore Electrical Company). System for producing luminous effects, Röntgen rays, or similar electrical effects, and apparatus for use therein.
14,362. Shaw. Rising and falling pendants for gas, oil or electric lamps.

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15,303. LAKE (Feely). Method of and apparatus for generating and utilising electricity.
15,885. LANGGUTH. Electro-magnetic ore separators.
17,418. MARKT. Electric tumbler switch appliances and their base plates.
18,531. BALDWIN and ROWLAND. Means for electrically operating electrical railway switches.
18,940. ABEL (Swoboda). Alternating current arc lamps.
19,248. THOMPSON (Bradley). Alternating current electric motors.
19,936. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). (Case). Controllers for electric motors.
19,937. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). (Linn.) Electric braking apparatus adapted especially for use in electric tramways.
19,939. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). (Haskins.) Electric meters.
19,941. THE BRITISH THOMSON-HOUSTON CO. (LIMITED) (Thomson.) Electrostatic measuring instruments.
20,154. ROYCE and CLAREMONT. Form of electrical resistance.
21,045. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). (Berg). Means for driving the speed indicators of electric motors.
21,240. RICHTER. Telephone call counter.
21,241. RICHTER. Telephone switchboards.
21,265. OXLEY. Certain drums for holding electric cables.

COMPANIES' MEETINGS AND REPORTS.

United River Plate Telephone Company (Limited).

A general meeting of this Company was held on Tuesday, under the presidency of Mr. J. IRVING COURTENAY.

The SECRETARY (Mr. Robt. Herring) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, the object of this meeting is to place before the shareholders the position of the Company at the expiration of the first six months of its current financial year. It has been thought desirable by the Directors that such a statement should hereafter be given at about this time. The shareholders are widely scattered, and the place where our business is carried on is so far from most of them that if the information directly emanating from the Board is made public only once a year they are not likely to be as well informed as they ought to be as to how the business stands, and what its immediate prospects are. For several years things were in such an unsettled state in Argentina that it was difficult to say with any certainty how matters would turn out, and, consequently, your Board has felt it necessary to be most conservative in their action and guarded in their statements, and to allow what they thought to be ample margins for contingencies, with the result that the Company has actually been stronger and its prospects brighter than would appear from the mere facts and figures set forth in the reports from time to time. We now hope and believe that our future is more settled. While we cannot expect perfectly smooth sailing, for this is not in the nature of a telephone business, we may with confidence look forward to fair progress and to a sound business, which, though not free from the fluctuations that are incidental to this class of business generally, may with reason be considered as certain and safe in its results as any such business can be. With the field in the River Plate constantly widening, with the increasing demands in every direction for telephone services, with improvements in telephones, switchboards, cables, and plant, you can understand that the business is of magnitude, and that it requires constant thought and attention in dealing with it, in order that it should adequately serve its purpose and maintain a satisfactory position before the public and the shareholders. The results in our case give, we think, ample indications that the business has been attended to with care and judgment, and the Directors have been most gratified to find at the annual meetings that the shareholders have appreciated the work that has been done as well as the results that have been obtained. One of our local Directors, Mr. Adolph Fels, is present with us to-day, and he fully agrees in this view. During the half-year just elapsed there has been an all-round improvement, an increase in subscribers and the like in revenue, while the outlook justifies an anticipation of a continuance of this satisfactory condition of things. But it must be noted that the expenses in the River Plate will be increased this year chiefly on account of the fall in the gold premium, which increases the sterling value of all salaries, wages and other expenses payable in Argentine currency. Our manager (Mr. Chappell) assures us that he has steadily persevered in his endeavours to keep down expenses to the lowest possible point, and to keep our plant, &c., in the highest state of efficiency. It may be thought that a large part of the expenses incurred for such improvements could without impropriety be charged to capital expenditure, but, in the judgment of the Directors, the course pursued by this Company, in charging these outlays to revenue, is the correct one for a telephone company to follow, the right theory being that a telephone subscriber is entitled to the best service that can be given, and that the plant, as a part of the working expenses, should be so kept up, renewed and renovated, at whatever cost may be necessary, as to ensure such a service. It is with this idea that we are proceeding towards a complete renovation of our central system in Buenos Aires, to be followed, we anticipate, with similar procedure in Rosario and also with the sub-offices in both districts, and in the meantime we hope with a perfected telephone connection between the two cities. All of this work, of course, means a good deal more than the up-keep of existing plant; it means large capital expenditure as well, but expenditure that will be spread over a considerable period; and we do not doubt that as needed it will be possible to obtain the requisite funds. For the present we have before us the completion of our new building in Buenos Aires, the erection of the new switchboard with an immediate capacity for over 4,000 subscribers, and an underground plant with metallic circuits for the same. This latter work is partly done. In regard to the Provincial Telephone Company of the Province of Buenos Aires, in which we have a large interest, steady progress can be reported. It will take time to properly cover the various districts, but the important points are gradually being occupied by the Provincial Company, and we are naturally affording them every assistance. The financial position of our Company is stronger now than ever before, the gold premium notwithstanding. In anticipation of expenditure upon our Central Office building and otherwise, as stated in my remarks at the general meeting in July, there has been a further issue of the Five per Cent. Debenture Stock, and £28,000 has been allotted. The balance of £20,000 is not required at present—probably it may be in another six months or so. The subject of an interim dividend is one to which the Board has given attention. In view of the large expenditure before us, we do not feel it prudent, as yet, to make such recommendation In closing my remarks, I wish to mention that our Managing Director, Mr. F. W. Jones, shortly leaves for the River Plate to go over the districts where the operations of the Company are carried on, and inspect the work he has had so much to do with ever since the telephone became known in that country. There is no resolution to be proposed, and no accounts to be presented, and if there are no questions to be asked, that will conclude the business of the meeting.

Mr. STOBART and Mr. LEA SMITH, having referred to the passing of the interim dividend, the latter shareholder asking if the debentures would be offered *pro rata* to the shareholders,

The CHAIRMAN said they could not say at that time what the amount of expenditure would be. He did not think it wise to increase the capital account; he thought it better in prosperous times, when they were getting a fair dividend, to devote part of their revenue to capital purposes. When half-yearly meetings were advocated he felt that the shareholders would at the same time like to have an interim dividend, but this was a point which was delicately avoided at the last meeting. The question was before the Board, and they would like to pay an interim dividend, but in view of the large expenditure to which he had referred, they did not think it prudent to announce an interim dividend. The debentures would be offered *pro rata* to the shareholders.

A vote of thanks to the Chairman and Directors terminated the proceedings.

NEW COMPANIES, STATUTORY RETURNS, &c.

ELECTRIC RESISTANCE AND HEATING CO. (LIMITED).—This company was registered on Dec. 31 with a capital of £120,000 in £1 shares, to acquire certain inventions in relation to the manufacture of electrical resistance material, and of any existing or future patents (except for Austria and the Balkan States), and to carry on the business of electricians, electrical, mechanical and general engineers, suppliers of electricity, electrical apparatus manufacturers, fitters, wire drawers, metal workers, &c. The first subscribers are: A. Conder, J. T. Clary, W. Chaplin, T. G. Fort, W. Andrew, F. W. White and G. F. Honig.

CHATHAM, ROCHESTER AND DISTRICT ELECTRIC LIGHTING CO. (LIMITED).—The annual return to March 31 was filed on Dec. 23. The nominal capital is £50,000 in £5 shares, of which 1,863 are considered as fully paid, and the full amount has been called on the remainder.

CONNOLLY BROTHERS (LIMITED).—The annual return to Dec. 1 has been filed. The nominal capital is £20,000 in £5 shares, of which 2,360 have been taken up. 1,793 shares have been issued as fully paid, and the full amount has been called on the others.

HALIFAX AND BERMUDAS CABLE CO. (LIMITED).—The annual return to Dec. 28 gives the capital as £50,000 in £5 shares, of which the whole has been taken up, and all the shares have been issued as fully paid.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Oct. 13, 1898). Price of silver 27¼d. per oz. (Jan. 5). Consols (2¾ per cent.) 110⅛—110⅝ for money, 110¾—110⅞ for account; 2½ per cent. 103⅝—104¼ (Jan. 5). Stock Exchange Settling Days: Stocks and Shares Continuation Days, Jan. 11 and 25; Ticket Days, Jan. 12 and 26; Pay Days, Jan. 13 and 27; Mining Share Carry over Days, Jan. 10 and 24.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LIMITED).—The coupons on the Five per Cent. Debentures (Nos. 1 to 100), due on 1st inst., will be paid on 2nd prox. at the Charing Cross branch of the Union Bank of London.

CITY OF LONDON ELECTRIC LIGHTING CO. (LIMITED).—Warrants for the interest due on the £400,000 Five per Cent. Debenture stock have been posted.

CROMPTON AND CO. (LIMITED)—The directors of this company have declared an interim dividend at the rate of 5 per cent. per annum for the half-year ended Sept. 30 last.

DOULTON AND CO. (LIMITED).—The whole of the letters of allotment of the Five per Cent. Preference shares of this company have now been

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posted. The work of allotment has been very heavy, the customers of the firm alone having applied for the whole issue many times over.

NEW YORK LIGHTING TRUST.—A company, entitled the New York Gas and Electric Light, Heat and Power Co., has recently been formed in New York for the purpose of securing control of the electric light, heat and power undertakings of New York City. Its capital is $25,000,000, and its leading spirit W. C. Whitney, prominently identified with the Metropolitan Street Railway Company of New York, which owns many miles of conduits, and a power house having a capacity of 70,000 h.p. The Mount Morris Electric Company, the Manhattan and the Edison Electric Illuminating Company have already been acquired, and the only company not acquired is the Westinghouse Electric Company. It is stated that the control of the electric facilities by the new concern is absolute.

SALISBURY ELECTRIC LIGHT AND SUPPLY CO. (LIMITED).—The third ordinary general meeting of this company was held last week at Salisbury. The directors reported that under their contract Edmundson's Electricity Corporation (Limited) had laid mains in the principal streets of the city, and constructed an electric lighting station complete with turbines and all machinery and appliances for the generation by water and steam power and distribution of a supply of electric current, and under their management supply was commenced on June 22 last; one month's free lighting being offered to persons who should have their premises wired by that date. The equivalent of 962 8-c.p. lamps connected to the company's mains at the commencement of lighting had now considerably increased. Ample space for additional plant, when required, had been reserved. Payment for these works would be made under the contract by an allotment of fully paid shares and 5 per cent. debentures. No further share capital beyond the 3,807 shares already issued could be offered to the public without the sanction of the contractors, who had also the option of subscribing at par for any further capital which the company might find it necessary to issue. The contractors had agreed to complete the remainder of the works and hand over the whole undertaking as a going concern on January 1. The Chairman moved the adoption of the report, and congratulated the shareholders upon the progress made. There was a specific item as to the issue of shares under the contract with Messrs. Edmundson. They had insisted, and rightly insisted, that when the company wanted to raise any more money they were to have the first right to take the shares. This tended to increase the value of the shares, for the reason that Messrs. Edmundson would have to pay par for the shares instead of their having to sell them to raise money, or to offer more debentures. They would not therefore have to appeal to the public of Salisbury again. There were connected on the 31st Oct. 1,527 lamps. Since that they had had 276 more, and up to the 17th of Dec. 221 extra, making in all 2,024 lamps actually connected. There were 207 in process of being connected, so that very shortly there would be 2,231 lights in use amongst 60 consumers. They could very reasonably look forward to a very large increase from private supply in the city. The report was adopted.

SHEFFIELD ELECTRIC LIGHT AND POWER CO. (LIMITED).—An extraordinary meeting was held on Wednesday to authorise the winding up of the company consequent upon the purchase of its undertaking by the Sheffield Corporation. The undertaking was formally handed over to the city on Saturday last. On handing over their share certificates shareholders will receive a payment at the rate of £17. 10s. per share. The balance in hand will probably amount to 8s. or 9s. per share. The resolution to wind up was unanimously carried, and Messrs. Franklin and Gamble were appointed liquidators.

SIEMENS AND HALSKE AKTIEN GESELLSCHAFT.—An extraordinary meeting has been called for Jan. 12 to authorise the increase of the capital from 40,000,000 to 45,000,000 marks (£2,000,000 to £2,250,000). The capital was increased in March last from 35,000,000 to 40,000,000 marks.

WESTERN UNION TELEGRAPH CO.—This Company have issued their report for the quarter ended Dec. 31. The following statement exhibits the condition of the Company at the close of the quarter ended Sept. 30, 1898:—

Surplus July 1, 1898, as per last quarterly report......		$7,963,235 12
Net revenues, quarter ended Sept. 30, 1898		1,527,236 79
		$9,490,471 91
From which deducting for—		
Dividend of 1¼ per cent. paid Oct. 15th	$1,216,985 00	
Interest on bonded debt	224,272 92	
		$1,441,257 92
Left a surplus Oct. 1, 1898, of..................................		$8,049,213 99
The net revenues of the quarter ending December 31, based upon nearly completed returns for October, partial returns for November, and estimating the business for December, were about		1,450,000 00
		$9,499,213 99
From which appropriating for— Interest on bonds		224,273 00
		$9,274,940 99
It requires for a dividend of 1¼ per cent. on capital stock issued, about		1,216,985 00
Deducting which leaves a surplus, after paying dividend, of		$8,057,955 99

In view of the preceding statements, the Committee recommend that a dividend of 1¼ per cent. on the capital stock of the Company be declared payable on and after the 16th inst.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1898	£	£		£	£
*Birmingham Tramways.	Dec. 31	3,823	− 236	...	...	...
Blackpool Corporation...	„ 29	144	+ 34	39	16,326	+ 2,431
Blackpool and Fleetwood Co.	„ 31	216	...	25	14,476	...
*Bristol Trams & Carriage	„ 30	3,195	+ 541	26	77,683	+ 8,944
City & South London Ry.	Jan. 1	1,036	− 14	1	1,036	+ 14
Dover Corporation	Dec. 31	193	+ 43	39	7,198	...
Dublin United (Southern)	„ 30	782	+ 245	52	23,715	+ 7,791
Liverpool Overhead Rly.	Jan. 1	1,291	− 66	...	...	...
*Sheffield Tramways......	„ 1	1,523	+ 191	52	54,248	+ 2,940
*South Staffs. Trams......	„ 30	955	+ 236	52	33,143	− 781

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Dec. 28.		Price Wednesday, Jan. 4.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Week Ending Jan. 4. Highest	Lowest
			ELECTRICITY SUPPLY COMPANIES.					£ s. d.			
6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	11	11½	11	11½	—	—	—	..
6,000	10	4/8 1/10	Do. 4½ per Cent. Cumulative Pref.	10¾	11½	10¾	11½	4 4 0	—	..	—
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	11½	12½	11½	12½	2 16 0	February & August	..	..
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6¼	6	6½	3 9 8	„ „	—	..
£34,000	5	2/6	Chelsea Electricity Supply Ordinary	9	10	9	10	3 0 0	March	9⅞	9⅞
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	113	115	113	115	3 18 3	June and December	—	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red)	103	105	103	105	4 15 8	—	..	..
50,000	10	5/0	City of London Elec. Lighting Ord. 40,001 to 90,000	22	24	22	24	5 4 2	February & August	23	22½
10,000	10	1/9	Do. Ordinary 90,001 to 100,000	21	23	21	23	..	..	..	—
40,000	10	6%	Do. 6% Cumulative Pref.	16½	16½	15½	16½	3 11 9	January and July	15⅞	—
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.) xd	127	132	125	130	3 16 11	June and December	129	..
30,000	10	—	County of London & Brush Prov. Ord. (1 to 30,000)	12½	13½	12½	13½	—	—	12⅞	12½
10,000	10	..	Do. (30,001 to 40,000)	10	11	12	13	..	—	—	—
20,000	10	6/0	Do. 6% Cumulative Preference	14½	15½	14½	15½	4 0 0	March & September	—	—
15,660	5	2/6	House-to-House Electric Lighting Supply Ord.	9	10	9	10	2 0 0	—	..	—
17,000	5	3/6	Do. 7 per Cent. Preference	9½	10½	9½	10½	3 6 8	March & September	—	—
15,000	5	10%	Kensington and Knightsbridge Ord.	13	14	13	14	3 18 7	..	—	—
10,000	5	6%	Do. 6% 1st Pref.	7¾	8¼	7¾	8¼	3 12 9	January and July	..	—
110,000	3	—	London Electric Supply Ordinary	3	3½	3	3½	—	—	—	—
48,050	5	—	Do. Preference	6	6½	6	6½	—	—	6½	6 3/16
£[illegible]	Stock	..	Do. 4% 1st Mort. Deb.	..		102	104	3 16 11	Mch., June, Sept., Dec.	103	—
69,500	10	5/0	Metropolitan Electric Supply Ordinary	17½	18½	17½	18½	3 4 10	April and October	18½	17 11/16
27,500	10	—	Do. (£4 paid)	—		10½	11½	..	—	—	—
£[illegible]	Stock	4½%	Do. 4½% Deb. Stock First Mortgage xd	117	121	115	119	3 15 8	June and December	117⅞	117
6,452	10	6/0	Notting Hill Electric Ordinary	17	18	17	18	3 6 8	March	—	..
10,000	5	—	Oxford Electric Ordinary	..		6	6½	—	—	6½	..
275,000	1	—	Rand Electric	¾	1¼	¾	1¼	—	—	—	..
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb xd	88	93	89	91	5 9 1	—	—	—
150,000	$100	$2	Royal Electric Company of Montreal Shares	150	155	150	155	5 8 8	—	—	—
130,900	100	4½%	* Do. 4½% 1st Mort. Debs.	104	106	105	107	4 5 10	April and October	—	..
31,980	5	5/0	St. James and Pall Mall Electric Ordinary	16	17	16	17	4 14 2	February & August	16⅛	..
20,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	„ „	..	—
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.)	105	108	..		..	June and December	..	—
65,000	5	..	South London Electric Supply Ordinary (£3 paid)	7¾	8	7¾	8¼	..	..	8	—
79,900	5	5/0	Westminster Electric Supply Ordinary	15½	16½	15½	16½	3 18 9	March & September	16½	15⅞
18,848	5	5%	Yorkshire House-to-House	7¾	8	7¾	8	3 2 6	February and July	—	—
18,626	5	5%	Do. (£4 paid)	5¾	6¼	5¾	6¼	3 18 5	February and July	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Dec. 28.		Price Wednesday, Jan. 4.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 4.	
								£ s. d.		Highest	Lowest
			TELEGRAPHS								
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red) xd	101	105	103	104	3 16 11	January and July	..	..
25,000	10	..	Amazon Telegraph	3	4	3	4	..	..	..	..
£125,000	100	5%	Do. 5 per Cent. Debentures xd	92	95	91	94	5 6 5	..	..	..
£905,560	Stock	15/0	Anglo-American	65	67	63	68	4 9 3	Feb., May, Aug., Nov.	67	63
£3,047,220	Stock	30/0	Do. Preferred	116	117	116	117	5 3 8	" "	117	116½
£3,047,220	Stock	5/0	Do. Deferred	16¾	17½	16¾	17½	..	..	17⅜	16¾
130,000	10	3/0	Brazilian Submarine xd	15½	15¾	15½	15¾	4 8 11	Mar., June, Oct., Dec.	15½	15½
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906) xd	111	115	110	114	4 7 9	June and December	..	..
10,000,000	$100	$2½	Commercial Cable Capital Stock	180	190	180	190	4 4 3	Jan., Apr., July, Oct.	..	..
£1,332,523	Stock	4%	* Do. 4 per Cent. Debenture Stock xd	104	106	103	105	3 16 2	" "	104	..
16,000	10	8/0	Cuba Submarine Ordinary (Deferred)	10	11	10	11	6 7 3	February and August	10½	..
6,000	10	10/0	Do. Preference 10 per Cent.	16½	17½	16½	17½	5 14 3	" "	..	..
12,981	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October	..	..
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	..	..
£80,000	50	4½%	Do. 4½ per Cent. Debentures xd	105⅞	108⅞	104⅞	107⅞	4 4 1	January and July	..	..
60,710	20	3/0	Direct United States Cable	11⅞	12½	11⅞	12½	5 6 1	Jan., Apr., July, Oct.	12½	..
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red) xd	103	106	102	105	4 5 9	.. ..	..	..
£4,000,000	Stock	..	Eastern Ordinary	173	178	173	173	3 19 0	Jan., Apr., July, Oct.	175½	173½
£1,295,000	Stock	17/3	Do. 3½ per Cent. Pref. Stock	104	107	104	107	3 5 5	" "	108	..
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	124	128	124	123	3 2 6	May and November	..	..
£89,900	100	5%	* Do. 5 per Cent. Debentures, 1899	101	104	101	104	4 17 0	February & August	..	..
£500,000	Stock	£/9	Do. Provisional Certificates 50% paid	54	57	£4	57	..	..	..	..
250,000	10	2/6	Eastern Extension	17½	18	17½	18	3 17 9	Jan., Apr., July, Oct.	..	..
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	129	125	129	3 2 4	February & August	..	..
£16,200	100	5%	* Do. 5 p. c.(Austln.Gov.Sub.)Deb.1900(reg.)xd	101	105	99	103	4 17 1	January and July	..	..
£64,400	100	5%	Do. (Bearer) xd	103	105	100	103	4 17 1	" "	..	..
£35,100	100	5%	*Eastern and S. African 5 p.c. Mor. Deb.,1900(reg.)xd	101	105	99	103	4 17 1	" "	..	..
£46,500	100	5%	Do, (Bearer) xd	102	105	100	103	4 17 1	" "	..	..
£800,000	100	4%	* Do. 4% Mortgage Debentures,1909	104	107	104	107	3 15 8	February & August	..	..
£200,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	104⅞	107⅞	104⅞	107⅞	3 15 2	May and November	..	..
180,227	10	1/9	Globe Telegraph and Trust	12½	12⅝	12½	12⅝	4 0 9	Jan., Apr., July, Oct.	12⅝	12⅝
180,042	10	6%	Do. 6 per Cent. Preference	16⅝	17½	16⅝	17½	3 9 7	" "	18⅛	..
150,000	10	5/0	Great Northern of Copenhagen	28½	29½	28½	29½	3 7 10	January, April, July	..	..
£150,000	100	5%	* Do 5 per Cent. Debs., 1888 Issue Series "B"	100	103	101	104	4 17 7	March & September	103	..
£97,800	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red)xd	101	104	100	103	4 7 5	June and December	..	..
17,000	25	12/6	Indo-European	£5	£8	56	53	4 4 9	May and November	..	..
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	109	112	109	112	5 7 7	March & September	..	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs.(red) xd	105	108	104	107	3 14 9	June and December	..	..
11,889	8	4/0	Reuter's xd	7	8	7	8	5 0 0	April and October	7	..
3,881	£100 Cert.	6%	Submarine Cables Trust	134	139	134	139	4 6 9	" "	..	..
15,609	10	..	West African Telegraph	..	..	..	..	..	..	..	..
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	101	103	100	103	4 18 6	March & September	..	..
80,008	2½	..	West Coast of America	½	1	½	1	..	..	..	..
£150,000	100	4%	* Do. 4 per Cent. Debentures xd	103	106	102	105	3 16 2	June and December	..	..
88,321	10	1/6	West India and Panama	2	2½	1⅞	2½	..	May and November	2⅛	2
34,568	10	6 0	Do. 6 per Cent. 1st Preference	10½	10⅝	10½	10⅝	5 11 7	" "	10⅝	10½
4,669	10	6 0	Do. 6 per Cent. 2nd Preference	8⅞	9⅛	8⅞	9⅛	6 6 4	" "	9⅛	..
£80,000	100	5%	* Do. 5 per Cent. Debentures xd	106	109	104	107	4 13 6	January and July	..	..
64,269	15	5.0	Western and Brazilian Ordinary	12½	12⅝	12½	12⅝	4 13 2	May and November	..	..
33,129	7½	3.9	Do. 5 per Cent. Preferred Ordinary	8	8⅛	8	8⅛	4 8 2	" "	..	..
33,129	7½	1/3	Do. Deferred Ordinary	4	4⅛	4	4⅛	..	" "	..	..
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock xd	107	110	105	108	3 14 1	June and December	..	..
1,163,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	..	..	..	..	6 7 10	Feb., May, Aug., Nov.	..	..
£158,100	100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	93	103	98	103	5 16 6	March & September	..	..
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	2⅝	3⅛	2⅝	3⅛	6 8 1	August	..	..
224,850	10/0	1½d.	Consolidated Telephone Const. & Manufacturing	1/16	3/16	1/16	3/16	6 7 0	July	..	..
28,000	5	4/0	Monte Video Telephone 6 per Cent. Preference	..	..	..	..	..	October	..	..
£84,597	5	3/0	National	5½	5⅞	5½	5⅞	5 4 4	February & August	5⅞	5½
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	13	15	13	16	4 0 0	" "	..	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	13	15	13	15	4 0 0	" "	..	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	5⅜	5⅝	5⅜	5⅝	4 8 11	" "	..	..
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.) xd	100	103	99	102	3 8 8	June and December	100½	..
171,504	1	0/4	Oriental	⅜	⅝	⅜	⅝	6 13 4	April and October	..	..
58,000	5	6/0	United River Plate	4½	4⅝	4½	5	6 0 0	July	4⅝	4⅝
£151,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.) xd	104	107	102	105	4 15 2	June and December	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	2	1/2½	Brush Electrical Engineering	1⅝	1⅞	1⅝	2	3 0 0	..	..	..
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	..	..	..
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	111	115	111	115	3 19 0	February & August	..	..
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.) xd	101	105	101	104	4 6 7	June and December	..	..
£20,000	5	5/0	Callender's Cable Construction	9½	10½	9½	10½	6 8 7	" "	..	..
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red) xd	112	115	110	113	3 19 8	November and May	..	..
300,000	1	9/8	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	..	..	..
50,000	1	..	Chadburn's Ship Telegraph Ordinary	1⅛	1⅜	1⅛	1⅜	..	..	..	..
50,000	1	7½	Do. 6 per Cent. Cumulative Pref.	1	1⅛	1	1⅛	4 16 0	..	..	..
32,098	3	1/6	Crompton and Co. (Nos. 1 to 32,098)	1⅞	2⅛	1⅞	2⅛	..	..	2⅛	..
£82,850	100	5%	* Do. 5% First Mort. Deb. (red.) xd	91	96	89	94	5 6 5	January and July	..	..
99,261	5	2/1½	Edison and Swan United ("A" Shares) (£3 paid)	2⅛	2⅜	2⅛	2⅜	6 1 9	February & August	..	..
17,139	5	3/1½	Do. (£5 paid)	4	5	4	5	6 0 0	" "	..	..
£194,023	Stock	4%	Do. 4% Mortgage Debenture Stock (red.) xd	97	99	95	97	4 2 6	June and December	..	..
17,400	5	5%	Edmundson's Electric Corporation Ord (fully paid)	5	5½	5	5½	4 10 11	Half-yearly	5½	..
110,000	2	1/2½	Electric Construction Co. (Limited)	2⅛	2⅜	2⅛	2⅜	4 12 0	February & August	2⅜	2⅜
25,000	2	2/9½	Do. 7 per Cent. Cumulative Pref.	2⅞	3⅛	2⅞	3⅛	4 6 2	August	..	..
£111,100	Stock	4%	Do. 4% First Mortgage Deb. (red.)	105	107	105	107	3 16 2	..	..	..
91,196	1	—	Elmore's Patent Copper Depositing	⅛	⅜	⅛	⅜	..	..	..	..
12,500	10	8/0	Henley's Telegraph Works Ordinary	22	23	22	23	5 13 1	February & August	22½	..
3,000	10	7/0	Do. 7 per Cent. Preference	18	19	18	19	3 13 8	" "	..	..
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 8	" "	..	..
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	4 8 11	" "	..	..
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	102	106	102	106	3 15 6	March & September	103½	102½
37,350	12	12/0	Telegraph Construction and Maintenance	37	41	37	41	4 6 2	March and July	..	..
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899 xd	104	107	102	105	4 15 2	January and July	104	103½
18,400	5	..	Do. Manufacturing Ordinary	..	..	7	7½	..	..	..	..
13,410	5	..	Do. 5% Cum. Pref.	..	..	5½	6	..	..	..	..
£80,000	5	4/0	Willans and Robinson Ordinary	7⅜	8½	7⅜	8½	4 17 0	April and October	8½	8½
£30,000	5	3/0	Do. 6% Cumulative Preference	6⅜	7½	6⅜	7½	4 2 9	" "	..	..
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	105	108	106	109	3 18 8	May and November	107	..
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	..	Blackpool and Fleetwood Tramways	19	20	19½	2 1	..	..	20½	19½
25,000	10	6%	Bristol Tramways and Carriage xd	119	122	21½	22	2 4 7	..	..	..
25,000	10	6%	Do. (£7. 10s. paid)	18⅝	18⅞	1⅝	18⅞	1 14 1	..	..	..
£90,410	Stock	4%	Do. 4% Debenture xd	121	123	120	121	3 6 2	..	121	120
80,000	10	..	British Electric Traction Ordinary	15½	16½	15½	16½	..	..	..	..
10,000	10	2/4.7/8	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm.pd.)	13	13½	13	13½	4 8 11	..	..	..
£100,000	Stock	6/2 3	Do. 5 Perp. Deb.	..	..	119	121	..	..	120½	120½
40,000	5	..	Buenos Ayres & Belgrano 6% Cum. Pref. (£3 paid)	..	..	2½	3½	..	..	..	..
27,500	5	..	Do. do. do. (fully paid)	..	..	3½	3⅝	..	..	..	..
£260,000	Stock	..	Do. do. 5% Deb. xd	..	..	100	105	4 15 3	..	..	..
£35,250	10	3/0	Central London Ordinary xd	9½	10½	9½	10½	2 18 6	June and December	10	..
178,303	10	1/9½	Do. (£6 paid) xd	5⅞	6½	5⅞	6½	2 16 6	" "	6	..
£630,000	Stock	2½%	City and South London Railway Con. Ordy.	65	68	67	69	2 18 0	January and July	6 ½	..
22,500	10	..	Do. Ordinary (£4 paid)	3½	4	3½	4	..	..	..	..
9,251	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	3 4 6	January and July	..	..
£187,701	Stock	4%	Do. 4% Perpetual Debenture	133	135	133	135	2 19 7	May and November	..	..
20,000	10	6%	Imperial Tramways Ordinary (old £6 shares)	115	117	17	17½	3 8 7	March & September	..	..
10,000	10	6%	Do. 6% Preference	15½	15½	15½	15½	3 17 5	" "	..	..
£70,000	Stock	4½%	Do. 4½% Debenture xd	1 7	118	117	118	3 16 3	.. ..	118	117
37,500	10	3/6	Liverpool Overhead Railway Ordinary	10	10½	10	10½	3 4 2	February & August	..	..
10,000	10	5%	Do. 5% Preference	14⅜	15½	14½	15½	3 5 7	" "	..	..
125 000	Stock	4%	Do. 4% Debenture xd	108	110	106	108	3 14 1	January and July	..	..
20,000	5	3/3½	New General Traction 6% Cumulative Pref.	4½	5½	4½	5½	..	..	..	..
£540,000	Stock	3%	Waterloo and City Ordinary	111	114	111	114	2 13 4	June and December	..	..

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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—	Name of Company or Loc Authority. (Figures in brackets indicate popu	Miles of Conductors in Mains, including feeders.	TERS.	U 18 (Appr n ind.
1	Barking Urban District C	...	*Private.*—Thr *Street.*—Armo	son ...
2	Bromley Electric Light Power Co.	...	*L.T.—Feeders*— core. Both *H.T.*—Callender	ti.....
3	Charing Cross and Strand tricity Supply Corpora	...	Bitite in c armoured	Ferranti ookham
4	Chelsea Electricity Supp	...	Bitumen ins	ti and kham
5	Chislehurst Electric Lig Co.	...	*L.T.—Feeders*— core. Both C *H.T.*—Callender	ti and kham
6	City of London El Lighting Co.	...	Triple conc and some	nberger homson
7	County of London & Brus vincial Electric Lighti	...	*H.T.*—Paper insu *L.T.*—Bitumen *Power*—India-ru	on ... 5
8	Ditto ditto	...	*H.T.*—Vulcanise centric cables *L.T.*—Bitumen	on ... 5
9	Croydon Corporation .... [112,000]	about 26	Lead-covere Vulcanised	ion ... 5
10	Crystal Palace District tric Supply Co.	...	Lead-covere Rubber cabl	ti and kham 4
11	Ealing Urban District C [33,000]	160	Arm'd ld.-c *L.T.* cables	nberger homson 3
12	Guildford Electricity S Co. [11,0 0]	...	Concentric Cable, with lead, with ya all, serving in the	2
13	Hammersmith Vestry ... [110,000]	...	*Distributors*— Jute impregn Jute, impregn	am & nson
14	Hampstead Vestry	51·3	*H.T.*—Concen. *L.T.*—Triple c insulated. *F*	nberger homson
15	¶Hampstead Electric S Co.	33		..
16	Harrow Electric Ligh Power Co. [8,373]	...	Bare wire c Callender c	ti and nson 8
17	House to House Electric Supply Co.	29 of trench	Lead cover cables	nberger homson
18	Islington Vestry ..... [336,764]	...	H.T. and L.T. insulation o	am and nson 90
19	Kensington and Knights Electric Lighting Co.	...	Bare copper (Henley's	Ferranti ookham
20	Kingston Corporation... [31,000]	15	Armoured c	shallen- nd Thom- 32
21	Leyton Urban District C [50,000]	...	Concentric,	ti and nson
22	London Electric Supply poration	60	All concent Siemens	ti and nson
23	Metropolitan Electric S Co.	35	Insulated ca	nberger homson
24	Notting Hill Electric ing Co.	...	Bare copper Cables	Ferran- kham
25	Richmond (Surrey) E Light and Power Co.	...	Bare copper st Silvertown arr	ti ... 18
26	St. James' and Pall Mal tric Light Co.	...	Bare copper cables	3.85
27	St. Pancras Vestry	About	Fibrous insulat ground. Rub	Ferranti, m and 1,53

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Units Generated.		Price per Unit.		Tariff System. (W. indicates "Wright.")	Price of Gas in District.	REMARKS
98. (Estimate.) Actual	1897. (Actual.)	Lighting. Small figures (1) indicates first hour, (½) 1st ½ hours, &c.	Power. Small figures (1) indicates first hour, (2) first 2 hours, &c.			
..	...	6d.(1)—2d.	...	W.	4/6	Supply will be commenced early in January.
..	...	7d.(1)—4d.	3d.	W.	3/-	Station already running, with temporary arrangements, on a small load. Plant capacity includes Chislehurst, which will have sub-station supplied from H.T. plant in Bromley.
..	...	6d.—4d.	4d.—2d.	Discounts	3/-	(1) MacPhail and Simpson's steam superheaters. (2) Ellis and Eave's induced draught and MacPhail and Simpson's superheaters.
..	...	6d.	3d.	...	3/1	.....
..	...	8d.	4d.	W.	3/-	*See* remarks to **Bromley.**
..	...	7d.	3d.	Discounts	3/-	Alternators paralleled.
35,000	333,140	7d.(1½)—3d.	6d.(1)-2d.	W.	3/-	Alternators run in parallel. Mechanical stokers and economisers. Transformer sub-stations under the streets.
31,000	162,151	7d.(1½)—3d.	6d.(1)-3d.	W.	2/3	Alternators run in parallel. Step-up and down transformers to 5,000 volts. Mechanical stokers and economisers.
0,000	350,000	6d.	3d.	...	2/8	Alternators paralleled. Hand firing.
8,000	331,026	7d.—6d.	...	Discounts	2/7	The 2-wire network is fed at several points from each of the eight sub-stations.
8,600	379,857	6d., 5d., 4½d., 4d.	3d.	...	2/11	Alternators paralleled. Mechanical stokers. Effluent from sewage works used for condensing. 1,000 h.p. to be added during 1899.
8,333	...	8d.	4d.	...	3/-	.....
..	301,928	6d.(2)—4d.	2½d.	M.	2/11	Parallel running. No meter rents. Hand firing. Welsh coal.
..	840,002	6d.(2)—2½d.	2½d. dawn to dusk	W.	3/0	Alters. paralleled. Induced draught. Hand stoking. Best Welsh coal. Two Willans-Siemens 350 kw. steam dynamos on order.
..	...	...	...	...	...	No information to be obtained from this Company.
9,900	56,650	8d.	4d.	W. under consideration	4/3	Economiser. Hand stoking. Best Welsh smokeless. coal. No public lighting.
..	811,255 (sold)	6d.	3d.	Discounts	...	Discounts: 1d. for 6,000 units per annum, 1½d. for 20,000 per annum, 2d. for 30,000 per annum.
0,000	503,569 (sold)	7d.(1) 6d.(1) 4d.	Day 3½d.	W.	3/0	Alternators paralleled. Forced draught. Hand stoking
..	...	100v. 6d. 200v. 5d.	4d.	Discounts	3/-	.....
0,000	269,035	6d.(2)—4d.	3d.	W.	2/11	Alternators paralleled. Mechanical stokers. 2 Siemens arc lighters.
..	128,000 (sold)	5d.(1½)—2d.	5d.(1½)-2d.	W.	3/- & 4/-	.....
..	...	6d.	...	Discounts	3/-	The 1,000 unit machines generate direct at 10,500v. Smaller units at 2,500v. which is transformed up to and transmitted at 10,500 v. Alternators run in parallel.
..	...	6d.	4d.	Discounts	3/-	.....
..	378,206	6d. and 4d.	...	...	2/9	.....
5,500	152,052	7d.	6d.	...	4/-	.....
0,000	3,386,944	6d.—4d.	3d.	Discounts	3/-	.....
...	1,847,182	6d.(1½)—3d. Day 3d.	3d. Storage batts.	W.	3/-	Arc lighting system throughout all main roads in parish designed so that every alternate lamp is fed from low-tension mains.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

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CONTENTS OF THE CURRENT NUMBER.

NOTES	395	Reviews	410
Meetings of Scientific Societies	397	Electromagnetic Theory. By O. Heaviside. Illustrated. Concluded	410
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe	398	The Water-Power Installation at Paderno. By G. Semenza. Illustrated. Concluded	413
The Hamilton 20,000 Volt Power Transmission. Illustrated	399	Modified Bridge Method of Measuring Resistances containing Earth Currents. By R. R. Black. Illustrated	416
Improvements in Magnetic Space Telegraphy. By Dr. O. Lodge, F.R.S. Illus. Concluded	402	Trade Notes and Notices	417
Ætheric Telegraphy. By W. H. Preece, C.B., F.R.S. Illus.	405	Companies' Meetings & Reports	424
Electricity Works Accounts	407	New Companies, &c.	424
MUNICIPAL JACKS-OF-ALL-TRADES	408	City Notes	425
		Companies' Share List	426

NOTES.

A POST OFFICE circular, dated 6th inst., announces that the POSTMASTER-GENERAL, with the consent of the TREASURY, has decided that the practice of requiring bonds from established officers holding Civil Service certificates shall be discontinued. This decision is in conformity with a recommendation of the TWEEDMOUTH Commission, and will relieve a large section of telegraphists who are employed at public counters from an irrational and vexatious impost. In the opinion of the Commission, the pension to which established Civil Servants are entitled is itself sufficient security, if not against fraud, against pecuniary loss to the Crown, all claim to pension being forfeited by misconduct. It now only remains for the Guarantee Society, which has been run more for the personal benefit of a few official shareholders than in the true interests of the service, to promptly wind itself up, and restore their money to the aggrieved bondholders.

THE summary of Mr. PREECE'S work in connection with induction telegraphy, recently brought before the Institution of Electrical Engineers, will be welcomed by everyone interested in the subject. But Mr. PREECE is either badly informed or unduly modest in his statement in the first paragraph of his Paper, for we think more attention has been paid to his work than he supposes. He has presented yearly reports on the subject to Section A of the British Association, and, in many instances, it is true, these have not been made public property, yet all those to which he himself appears to attach the greatest importance have appeared in the columns of *The Electrician*—in fact, we find that a great portion of the text of his present Paper is the same as his British Association Paper, read at Oxford in 1894. In our reprint of the former, in another part of this issue, we have added footnotes to indicate where accounts of the majority of the experiments referred to may be found, and we trust that this will facilitate reference and comparison, and enable the reader to gain a fair idea of the magnitude and importance of Mr. PREECE'S experiments on an extensive scale in induction telegraphy.

THE most efficient thickness for transformer sheet iron is a matter of considerable importance to electric supply undertakings that are wedded to alternate currents. Messrs. F. BEDELL, R. M. KLEIN and T. P. THOMPSON have brought out a short monograph on the subject, which is practically a reprint of a Paper read by them last year at the Boston meeting of the American Association for the Advancement of Science. The authors find that there is a wide working range for the best thickness of plate, say from 10 to 15 mils, which, for practical purposes, will be sufficiently near the absolute best, for any ordinary range of induction, frequency and thickness of insulation. This result has been arrived at, not by direct experiment with different thicknesses, but by means of a graphical investigation of STEINMETZ'S equations for hysteresis loss and eddy current loss. It will be seen, then, that the validity of the conclusion entirely depends upon the applicability of the equations over the range of thicknesses investigated, a matter which is open to considerable doubt.

A RECENT issue of the *Electrical World*, of New York, describes a telephone cable patented by Mr. S. D. FIELD, in which strands of soft iron wire are laid between the insulated conducting wires. In his specification, Mr. FIELD says that he has found experimentally that this insertion of iron wire produces beneficial effects. The idea is by no means new, however, Mr. OLIVER HEAVISIDE in many of his Papers having considered the effects of iron on telephone circuits, both when forming part of the conductors, when combined with the insulator, and when exterior to both. Perhaps his clearest discussion of the question, or at any rate that which will appeal most to the "practician," is in Vol. I., § 218, of his "Electromagnetic Theory," in which "Various Ways, good and bad, of increasing the Inductance of Circuits" are considered without mathematics and from a practical point of view. The employment of iron wires in a similar way to Mr. FIELD'S is mentioned, and it is pointed out that what is really wanted is iron subdivided in planes perpendicular and not parallel to the conducting wires. It is doubtful whether

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in Mr. FIELD's pattern the large increase in capacity caused by the introduction of the iron wires will not quite counterbalance the advantage of increased inductance. The cable may, perhaps, have advantages for single-wire circuits, for, just as in the Tatham cable, in which strands of tinsel, connected to the lead sheathing, were laid between the insulated wires, the effect of external electrical disturbances will be diminished.

ON the 17th inst. an important American telephone patent will expire, one which has had a very great influence on the telephone industry in the United States. The patent in question is the Firman multiple switchboard patent, covering broadly all types of multiple exchange switchboards. The claim is as follows:—"The combination of two or more switchboards at the central office of a telephone exchange system, to each of which the same telephone lines are connected, whereby any two of these lines may be connected together upon either of the multiple switchboards." This patent has been the property of the American Bell Telephone Co., and, in consequence, all of the "independent" telephone concerns have been obliged to make use of more or less clumsy transfer arrangements as soon as their number of subscribers has exceeded a few hundred. We have commented on these in our editorial columns on a previous occasion. Although the expiry of this patent allows independent companies more latitude in the design of their switchboards, many types will still remain for some time the exclusive property of the Bell Company. The multiple system with series or "break" jacks will be free, but the patent for the "branching system," in which the jacks of the multiples are in parallel instead of in series, remains valid both in this country and in the United States. In both cases it is the property of the Western Electric Co., who manufacture in America solely for the Bell Co. Nor will the independent companies be able to employ the "engaged test" used by the Bell Co. (and also by the National Telephone Co. in this country) as that is also still covered by a patent in the United States. We may, therefore, look forward with interest to hearing what our inventive cousins will devise as a substitute for this test, for, in spite of the advocacy of transfer systems and the be-littling of the importance of multiple switching on the part of those who were unable to use the latter, we may safely anticipate that several of the American independent telephone companies will now be converted to more modern methods.

A CURIOUS problem of a minor order has arisen in connection with the proposed electric tramways at Southampton. Antiquarians are justly proud of the historic Bargate, which stands in one of the principal streets; but the structure as it now stands is as a stumbling-block to those who wish to use the overhead trolley system for the tramcars that pass under the quaint old gateway. It is manifestly impossible to run the trolley wires through the arch as it is at present constructed, but the proposed alteration of the structure has raised a great outcry among the townsfolk. An alternative proposal is to lay down a few yards of conduit under the archway, thus leaving the Bargate absolutely untouched. Considering that this would involve a double equipment for every car, one for the trolley and one for the microscopic length of conduit; and taking also into consideration the two halts which conversion from the one system to the other and back again would necessitate, this seems somewhat a heroic expedient. Would it not be simpler to station a horse or two at the Bargate?

THROUGHOUT the United Kingdom and, indeed, in all parts of the world where electric supply is available, a variety of rules and regulations are in force, relating to such matters as free-wiring, hiring out motors, &c., systems of charging for current, &c. These regulations are so numerous and varied in character that we now earnestly invite officials of electrical undertakings to forward to us copies of their regulations, in order that a systematic comparison between them may be made in our columns. We have already made such comparisons from time to time, and are assured of their utility to the electrical profession; but in order that the most up-to-date and complete information may be embodied, it is necessary for us to be supplied promptly with the official regulations; and we hope that, in the interests of the profession, this will be done.

Cable Interruptions.—

	Date of Interruption.
Para—Maranham	Nov. 15, 1898

Long-Distance Telephone Line in Japan.—According to the *Engineer*, a telephone line has been opened between Tokyo and Osaka, a distance of 356 miles.

Lectures on Dynamo and Transformer Construction.—Mr. James Swinburne commenced yesterday a course of lectures upon "Dynamo and Transformer Construction," at the Electrical Standardising, Testing and Training Institution, Faraday House.

Telegraph Operators in Cuba.—It is stated that the United States war department is experiencing difficulty in obtaining efficient telegraph operators for the military lines in Cuba. A large number of operators were enlisted in the Volunteer Signal Corps, but these were in most cases released from regular positions on the understanding that they might resume them at the end of the war. A great many have, therefore, returned to the telegraph companies, and, in consequence, the military authorities are short of men. The war department has about 300 miles of telegraph line under its control, and it is expected that many more lines in the island will be transferred to the American government.

American Calcium Carbide Regulations.—Steps have been taken in New York to control the trade in calcium carbide, and regulations have been issued governing the transportation, storage and sale of the product, which firemen declare to be the source of danger in a burning building. The regulations require that hereafter, in transit or in storage, calcium carbide must be enclosed in hermetically sealed iron receptacles marked "Dangerous, if not kept dry." No package may contain more than 100lbs. The carbide must be stored in isolated buildings that are fireproof and waterproof, and no artificial light or heat will be permitted in the building where it is stored. The manufacture, transportation, storage, sale and use of liquefied acetylene is absolutely prohibited within the limits of the city. The regulations were framed by the Bureau of Combustibles, and the Fire Department has ordered their enforcement.

Personal.—The Postal and Telegraph staff of the Metropolitan Northern District have presented to their late Postmaster, Mr. James Laister, M.I.E.E., a gratifying testimonial on his retirement, consisting of a massive and beautifully-fitted walnut writing table and chair. The telegraph messengers, on their own account, added a handsome hall clock. The presentation took place in the Barford Saloon, Agricultural Hall, Islington, where a large number of postal and

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telegraph officers assembled, on Saturday evening last. Mr. Laister commenced his career as a boy telegraph clerk with the Electric and International Telegraph Co. as far back as 1851.

We learn that, without any request on his part, the salary of Mr. Steinitz, the borough electrical engineer at West Ham, has been increased by £200 per annum, an example which might well be copied by some other municipal bodies.

It is announced that Sir Spencer Walpole, K.C.B., permanent secretary to the Post Office, retires from that position to-morrow (Saturday) having completed his sixtieth year. He became permanent secretary in 1893.

Converse of the Zeeman Effect.—Prof. G. F. FitzGerald writes to *Nature* as follows:—

I have not seen it noticed that a converse action to the Zeeman effect should exist. A radiating atom in a magnetic field gives out circularly polarised light. A circularly polarised beam of light should cause a directed rotation of the electrons, so that the absorbing gas should be magnetised and exhibit magnetic force. If all the molecules in a cubic centimetre of gas were caused to rotate their electrons in the same direction, it would possess quite a considerable magnetic moment. It is very improbable that the action of a circularly polarised beam of light would control the motions to such an extent as that; but it is quite possible that, if a circularly polarised beam of sunlight were passed through a strongly absorbing gas, it would magnetise it to an observable extent. The same effect would probably exist in any medium in which absorption was principally due to syntony and not mostly due to viscous actions. Hence I would expect some effect with absorbing substances like fuchsine. It is doubtful whether lampblack, iron, or other metals have a sufficiently syntonous absorption to exhibit the effect. My assistant, Mr. Thrift, is engaged in trying the experiment, but in the meanwhile I thought it might be of general interest to point out that such an effect should exist.

Telegraph and Telephone, 1898.—Extensions of British Trunk Telephone wires during the past year were as follows:—In January extensions took place to Banbury, Banff, Elgin, Inverness, Peterhead, Rugby and Ware; in February to Pentre (South Wales), Spennymoor, Cromer, Buckie and Newmarket; in April to Coldstream; in May to Weybridge; in June to Hereford and Bradford-on-Avon; in July to Cowbridge; in August to Wexford, Waterford and Market Harborough; in December to Dunoon, Rothesay and Nairn. Various extensions and improvements relating to land and submarine telegraphs abroad have taken place. A reduction was made in the rates to British Guiana, as well as to Mexico and certain of the West India Islands. An alternative route has been provided to Jamaica by means of a new cable from Bermuda, *via* Turk's Island. In the British and French possessions on the West Coast of Africa, and in the Italian possessions on the East Coast, a number of additional telegraph stations have been opened. Lastly, the capture of Khartoum has been promptly followed by the establishment of telegraphic communication with that city.

An "Electric Pony."—A small 550-watt locomotive, mounted on a single wheel, and used for drawing a small two-wheeled chaise is described under the above title in a recent number of the *Énergie Électrique*. The motor is geared to the wheel by means of a train of spur wheels, and the same wheel is used for steering, a handle, resembling in appearance that of a bath chair, being fixed to it. The motor weighs some 65lbs., and drives the wheel at 9½ miles an hour. The locomotive wheel carries a tray, in which are 15 to 20 Fulmen cells, each weighing 15½lbs., and having a capacity of 80 to 85 ampere hours at a normal discharge rate of 20 amperes. The chaise can run 30 to 45 miles without recharging. The motor is series wound, and the speed is regulated by a rheostat, there being four positions for forward motion. In the fourth position the rheostat is short-circuited, and the field shunted by a resistance. There are also two backward speeds, and an intermediate position of the controller handle short-circuiting the motor. The controller is placed under the seat of the carriage, the handle being at the side. There are two pedal brakes, one being merely a switch to interrupt the current, and the other a band-brake. The weight of the carriage is about 1½cwt., that of the "pony" about 4cwt. MM. Mildé are the manufacturers of this miniature automobile.

"Electric Gas Lighting."—A writer in the *Electrical Engineer*, of New York, states that an experimental electrical laboratory recently visited by him had Bunsen burners of the ordinary kind for heating small articles, and that these were lit without the aid of matches. Over the bench, located so as to be within easy reach of the gas burner, is fixed a copper brush, made of the frayed ends of incandescent lamp cord. This brush was connected to one side of a 110 volt circuit in series with a large magnet, wound with fine wire, and consequently having high self-induction. The Bunsen burner was connected to the other side of the 110 volt circuit by a wire running inside the rubber tube, connecting it to the gas-cock. Before reaching the gas-pipe, however, a short length of metal pipe was inserted in the rubber tube, and connection was made to this to avoid grounding the circuit on the gas-pipe. To light the burner, gas is turned on, and the tip of the burner is simply touched to the brush and drawn away again. The circuit is closed as soon as the burner touches the brush. When the burner is taken away a flash ensues, because of the high self-induction of the circuit, and the gas is lit. The method, as installed there, is entirely safe, and eliminates whatever fire risk may be connected with matches as well as saving time and making it more of an inducement to turn out the gas when it is not wanted.

The Municipal Electrical Association.—We have received a copy of the *Proceedings* of this Association for 1898. It includes a full reprint of the Papers read at last year's Annual Convention in London, and of the discussions which followed them. From the Secretary's report it appears that the number of municipal electricity committees elected to membership of the Association during the year 1897-8 had been 14, increasing the total number to 55. Seventeen electrical engineers had been elected and five had retired, the total being 63, and the number of assistant engineers who were Associates of the Association had increased from 45 to 54. The approval of the sub-committee to the "Standard Clauses for Specifications," drawn up by representatives of the Electrical Engineering Plant Manufacturers' Association and the Municipal Electrical Association (see *The Electrician*, Vol. XL., p. 662), was endorsed at the General Meeting, and the clauses are reprinted in the volume of the *Proceedings* before us. It is to be regretted, however, that Mr. R. P. Sellon's name should have been printed as Salon. A scheme for the creation of a benevolent fund, brought forward by Mr. Wordingham, has met with the approval of the Council and Members of the Association. It is hoped that those who are willing to contribute to it will send their remittances to the Secretary, Mr. A. B. Mountain. With a view to encouraging the reading of Papers by Associates, the Council has decided to offer a prize of five guineas for the best Associate's Paper presented, and we may mention that for the present the Council have generously decided to subscribe the necessary amount among themselves, so as not to burden the funds of the Association. It is also announced that the Council has arranged to keep a record of any plant corporations may have for disposal, and corporations wishing to buy or sell second-hand plant are requested to communicated with the Secretary.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, January 13th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting, when Dr. Archibald Barr will deliver an address on "The Application of the Science of Mechanics to Engineering Practice."

TUESDAY, January 17th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers to be read with a view to discussion: (1) "The Effects of Wear Upon Steel Rails," by W. G. Kirkaldy; (2) "On the Microphotography of Steel Rails," by Sir William C. Roberts-Austen, F.R.S.

WEDNESDAY, January 18th.

INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Students' Meeting in the Library of the Institution. Paper to be read: "The Effect of Governors on the Parallel Running of Steam Alternators," by L. Wilson.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Ordinary Meeting at 20, Hanover-square.

THURSDAY, January 19th.

INSTITUTION OF CIVIL ENGINEERS.

2:30 p.m. Students' visit to the Testing and Experimental Works of Messrs. David Kirkaldy & Son, 99, Southwark-street, S.E.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Properties of Reflected Cathode Rays.—Previous to 1881 it was generally believed that cathode rays came to an end when they encountered a solid obstacle. In that year, however, Goldstein discovered evidences of the reflection of cathode rays. Recently (*see* Vol. XLI., p. 848) Starke has measured the reflective powers of various metals for cathode rays, and found them to vary roughly with their densities. Ernest Merritt has made an interesting test to find whether the velocity of the cathode ray particles is sensibly altered by reflection at an anticathode. The latter was perforated, so that some of the cathode rays proceeded to the other end of the tube, while another portion was reflected at right angles into a side tube. The direct and reflected rays could thus be examined under identical conditions as regards potential and exhaustion. The experiments agreed in showing no difference in the deflection of the direct and reflected rays by the same magnetic field; hence the velocity of the particles is not sensibly changed by reflection. Since the cathode particles are able to pass through metallic films it cannot be the target, as a whole, which reflects them; hence it must be the metallic molecules themselves, and their unchanged velocity is a valuable confirmation of the view that they must be very small in comparison with the molecules. They rebound as rubber balls would rebound from a heavy projectile.

[Merritt, *Phys. Review*, Nov., 1898.]

Electrothermal Relations.—In a Paper covering 72 pages of *Wiedemann's Annalen*, E. Riecke works out a mathematical theory of the relations between thermal and electric phenomena, based, not upon Maxwell's system, but upon the conceptions underlying Weber's theory, which, as he points out, still holds the field in electrolytic theories and all theories involving ions of the liquid state. Several efforts have been made to reduce metallic conduction to an electrolytic phenomenon. Riecke boldly assumes the identity of the particles involved in thermal and electric conduction, and, after a few pages bristling with symbols, he arrives at such equations as

$$\frac{g_p}{g_n} = \frac{\mu_p c^2{}_p u}{\mu_n c^2{}_n v},$$

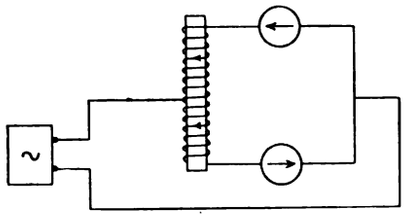
where g is the "specific rate of displacement by heat," μ the mass of a particle, c a constant characteristic of the particle (the suffixes denoting the positive or negative sign), and u and v the speed of the positive and negative ions wandering with the current. The thermo-electric and thermo-magnetic effects are dealt with in detail in a manner which requires careful study to fully appreciate, and eventually the author enters upon new ground by transferring his conceptions from metallic conductors to vacuum tubes. The Paper at this point becomes distinctly exciting: The movable negative particles are the same for all metals; the ratio e/m being assumed as 512×10^{15}, the constant c_n becomes a velocity of $4{\cdot}02 \times 10^5$. Cathode ray particles are the negative particles responsible for part of the thermal and electric conduction in metals. Canal rays are positive particles which turn out to be the metallic ions themselves, and $c_p = 6{\cdot}90 \times 10^3$cm. sec.$^{-1}$. Zeeman's particles are negative ions moving in circular orbits of radius $0{\cdot}021 \times 10^{-6}$mm. The author even calculates the diameter of Ampère's molecular currents. The whole Paper is either a magnificent extension of our boundaries of knowledge or a terrible waste of time.

[Riecke, *Wied. Ann.*, Nos. 11 and 12, 1898.]

Electric Cohesion.—T. Tommasina has observed a peculiar phenomenon of adhesion or cohesion under the influence of the electric current, which may serve to elucidate some obscure points in the properties of coherers. He was engaged in experiments with an elementary coherer in the shape of a simple pendulum with a bob of nickel-plated brass resting lightly on a pinch of nickel filings, supported by a horizontal copper plate. The coherer was inserted in a circuit operating a relay, which lighted a small lamp when the current passed. The author found that when the copper plate was lowered the connection between the pendulum and the nickel filings was not immediately broken, but was maintained by a mobile and flexible little chain of filings, sometimes as long as 2cm. Only one such chain was formed at a time. While it lasted it continued to keep the lamp burning. On cutting off the current the chain collapsed in a short time. Filings of several metals were tried, and it was found that the chains were readily formed by the noble metals, but not by iron, magnesium, antimony and bismuth. The author does not attempt an explanation, but if the phenomenon is due to electrostatic attraction, it is evident that the contact between the particles must be very intimate indeed, and this is more likely to be the case in noble metals than in others.

[Tommasina, *Comptes Rendus*, Dec. 12, 1898.]

Chemical Rectification.—The rectification of alternating currents by means of electrolytic cells containing aluminium electrodes facing carbon or lead electrodes was first proposed by Graetz and Pollack. A similarly unsymmetrical action was obtained by Eichberg and Kallir in the case of a metal-carbon arc, and by Nichols in a spark-gap between a point and a sphere. L. Kallir discusses the theoretical aspects of the "aluminium valve" on the supposition that the current in one direction is completely stopped, while for the other direction each cell has a definite ohmic resistance. He traces a current curve for a single valve, which is intermittent and approximately sinusoidal. He proposes a new arrangement for a non-intermittent current, as illustrated by the annexed diagram, in which the arrows indicate the direction of the transmitted current. The author shows that if the inductance



in the circuit is large in comparison with the resistance, the current is nearly uniform. There is no throttling. Only one half of the magnetising circuit shown is, of course, traversed at each alternation, but that does not signify when only external effects are to be created. The arrangement shown could be used for the self-exciting of alternate-current generators.

[Kallir, *Zeitschr. für Electrotechnik*, Dec. 18, 1898].

Condensation Nuclei.—The study of the condensation of water vapour on nuclei produced by various agencies has lately been called in to furnish evidence concerning the nature of the agencies concerned. C. T. R. Wilson has extended these researches to the nuclei produced by Röntgen rays, uranium rays, ultra-violet light, sunlight, metals in contact with a gas, ultra-violet light acting on a negatively electrified zinc plate, and the discharge of electricity from a pointed platinum wire. The author measured the supersaturation required to produce condensation by the sudden expansion of a given volume of saturated air until a fog or shower of drops was produced. He found that the action of strong X-rays on the gas differs from that of weak rays merely in the number of nuclei produced, the supersaturation required to cause water to condense on the nuclei remaining unaltered. Uranium compounds, whether inside the expansion apparatus in immediate contact with the gas or in a glass bulb outside produce nuclei requiring four-fold supersaturation, as in the case of X-rays. When the expanded air is exposed to an electric field the clouds are eliminated, owing to the fact that the nuclei are charged, and are therefore rapidly removed along the lines of force. The only uncharged nuclei are those obtained by the action of ultra-violet light on moist air and the action of metals on air.

[Wilson, *Proc. Roy. Soc.*, No. 405.]

New Sources of Becquerel Rays.—The researches on the active principle concerned in the crypto-radiation of pitch-blende, commenced a few months ago by P. Curie and

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Mme. Curie, have been continued by them and G. Bémont with somewhat sensational results. In addition to the supposed new metal "polonium," which resembles bismuth in its general chemical properties, the authors claim to have discovered another, whose chemical reactions are those of barium. But, although it is always found associated with barium, its separate identity is made exceedingly probable by three circumstances. In the first place, barium itself exhibits no radio-activity. Secondly, the activity of the chloride of the new substance, mixed up as it is with barium chloride, may be considerably enhanced by repeated precipitations with alcohol. As obtained from the pitchblende, its radio-activity, measured by its power of imparting an electric conductivity to air, is about 60 times that of metallic uranium. After a few precipitations it becomes 900 times more effective. In the third place, the spectrum of the substance shows a line not due to barium, and this line becomes more and more prominent as the activity is increased by fractional precipitation. The authors have not succeeded in completely eliminating the barium. If they did they would probably obtain a substance of enormous radio-activity, which they propose to call "radium." The most important discovery of all is that the two new substances are capable of producing a photographic impression in half a minute instead of several hours, like uranium and thorium, and that they are, like Röntgen rays, capable of exciting fluorescence on a platino-cyanide screen. Here we have apparently a source of light requiring no supply of energy to maintain it, and if these substances do infringe the second law of thermo-dynamics the consequences cannot be over-estimated.

[CURIE, MME. CURIE and BÉMONT, *Comptes Rendus*, No. 26, 1898.]

Uranium Radiation.—At a time when Becquerel rays are attracting the closest attention of scientific men, it is very useful to have a careful and exhaustive investigation into the characteristics of uranium rays. This has been provided by E. Rutherford. His observation that uranium rays exhibit neither refraction nor polarisation removes the only distinction which hitherto was thought to separate the properties of these rays from those of Röntgen rays. The author's work deals more particularly with the power of rendering gases electrically conducting, and he shows that all the facts are consistent with the theory of ionisation, which involves the production of charged carriers throughout the volume of the gas, the existence of a saturation current, the partial separation of positive and negative ions, and the proportionality between the ionisation, the intensity of radiation, and the pressure. Experiments with a gradually increasing number of layers of the same aluminium foil show that uranium radiation is complex, and that there are present at least two distinct types of radiation—one that is very readily absorbed, and the other of a more highly penetrative character. This exhibits another analogy to X rays. The author calls the first kind the α-radiation, and the second kind the β-radiation, and shows that aluminium is 100 times more transparent to the latter than to the former. The author does not hazard a guess at the source of energy of uranium radiation, beyond referring critically to Thomson's suggestion of a re-grouping of the constituents of the atom. It might be expected that the rate of such a re-grouping would vary with the temperature, which uranium rays do not. What we know is that uranium, thorium and their compounds behave like anti-cathodes in an X-ray tube. The question remains: What are the rays which impinge upon them?

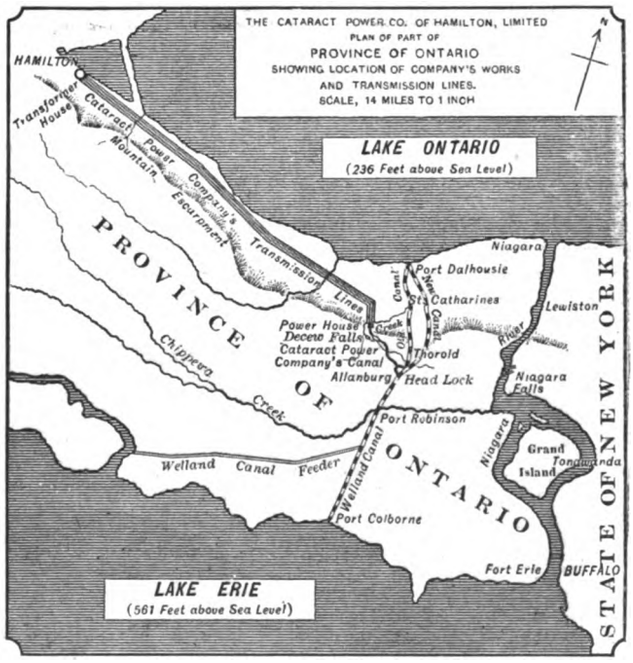
[RUTHERFORD, *Phil. Mag.*, January, 1899.]

An Aerial Underground Cable.—According to the *Énergie Électrique* the Paris Edison Co. has constructed a tunnel between its station at St. Denis, outside Paris, and the Avenue Trudaine central station, in order to run bare 2,100 volt cables between the two, and actuate a pair of 1,200 kilowatt continuous-current transformers in the latter, the present plant being overloaded. The tunnel is 6ft. high, so that a workman can walk through easily from one end to the other. This man is to be completely dressed in india-rubber.

THE HAMILTON 20,000 VOLT POWER TRANSMISSION.

A very large-power transmission plant has recently been put into operation on the Canadian side of the Niagara river, by the Cataract Power Co., of Hamilton. It is of especial interest, owing to the high-pressure of 20,000 volts, which is employed on the transmission line, and for the distance over which the power is conveyed. The generating plant is at Decew Falls, about 12 miles west of Niagara Falls and a few miles south of the shore of Lake Ontario (*see* map). This point is 85 miles distant from Hamilton, to which place the power is transmitted. The power is really a part of that of Niagara Falls, the water being taken from Lake Erie and discharged into Lake Ontario, and the immediate source being a feeder of the Lake Erie level of the Welland Canal, from which the water is taken at Allanburg. The power-house stands at the foot of a high escarpment, which can be traced for many miles east and west, forming as it does the edge of the table-land that serves, so to speak, as a dam for the waters of Lake Erie, and through which the Niagara stream has cut its famous gorge.

The Hydraulic Equipment.—The water is brought from Allanburg to the edge of the escarpment by a canal about 4½ miles in length, cut in the clay, with a minimum cross-



The Lake Erie—Lake Ontario Hydraulic Power District.

section of about 97½ sq. ft. below the water level, the canal being 13ft. wide at the base, the sides having a 1½ slope and the normal depth being 5ft. of water. At one point a valley is crossed by a trestle work carrying a rectangular, closed, wooden flume, which is maintained under a slight head to keep the whole of the flume wet. At the lower end of the canal there are three storage reservoirs, one natural and two artificial, giving an aggregate surface for storage of 1,250,000 sq. ft. area. From the forebay, the water is carried down the inclined surface of the escarpment to the power-house in a steel penstock 750ft. in length; the diameter of this pipe varies from 7½ft. to 8½ft. It is supported entirely from the upper end, where it is embedded in concrete in a channel cut in the rock. This arrangement was made necessary by the lack of proper anchorage points at the bottom of the slope. About two-thirds of the way down the hill there is a horizontal shelf, and at this point there is placed a slip joint to allow for temperature changes. This joint, in addition to taking care of the expansion and contraction, is so designed as to support that portion of the pipe below it, so that the whole pipe, expansion, joint and all, is hung from the top. The pipe will be covered with a wooden sheath to prevent the formation of ice at times of light load.

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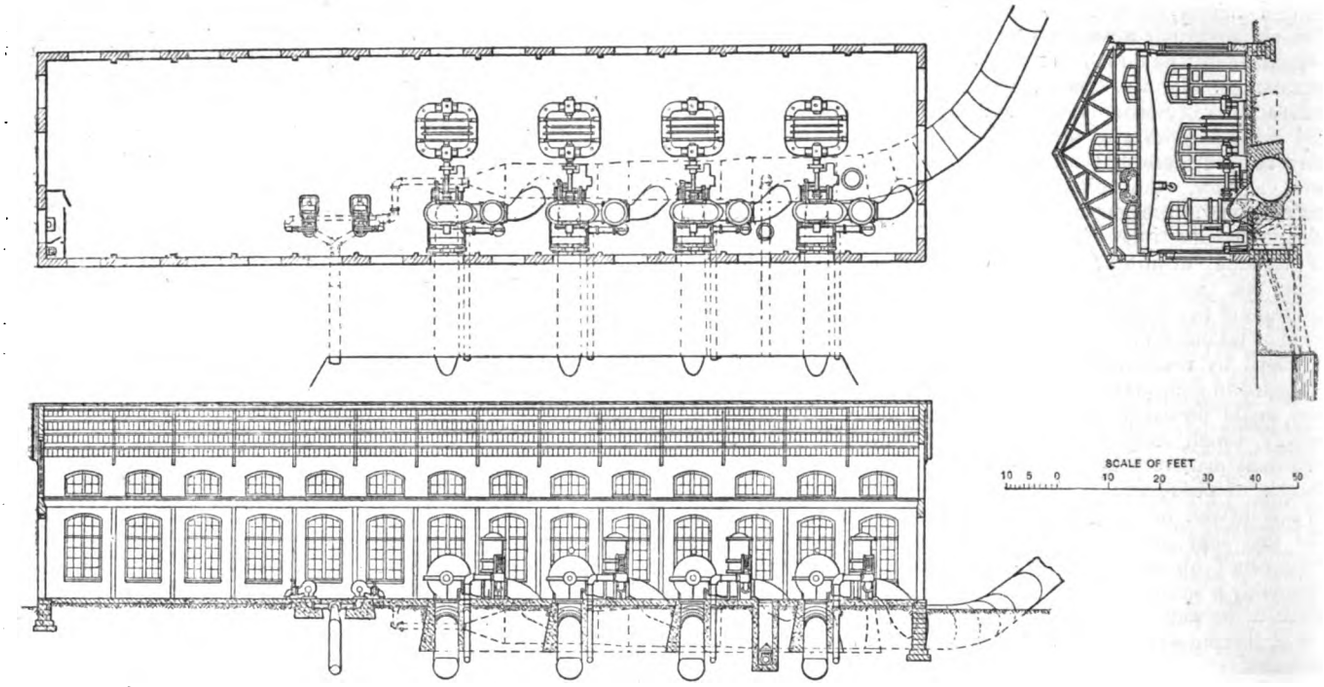
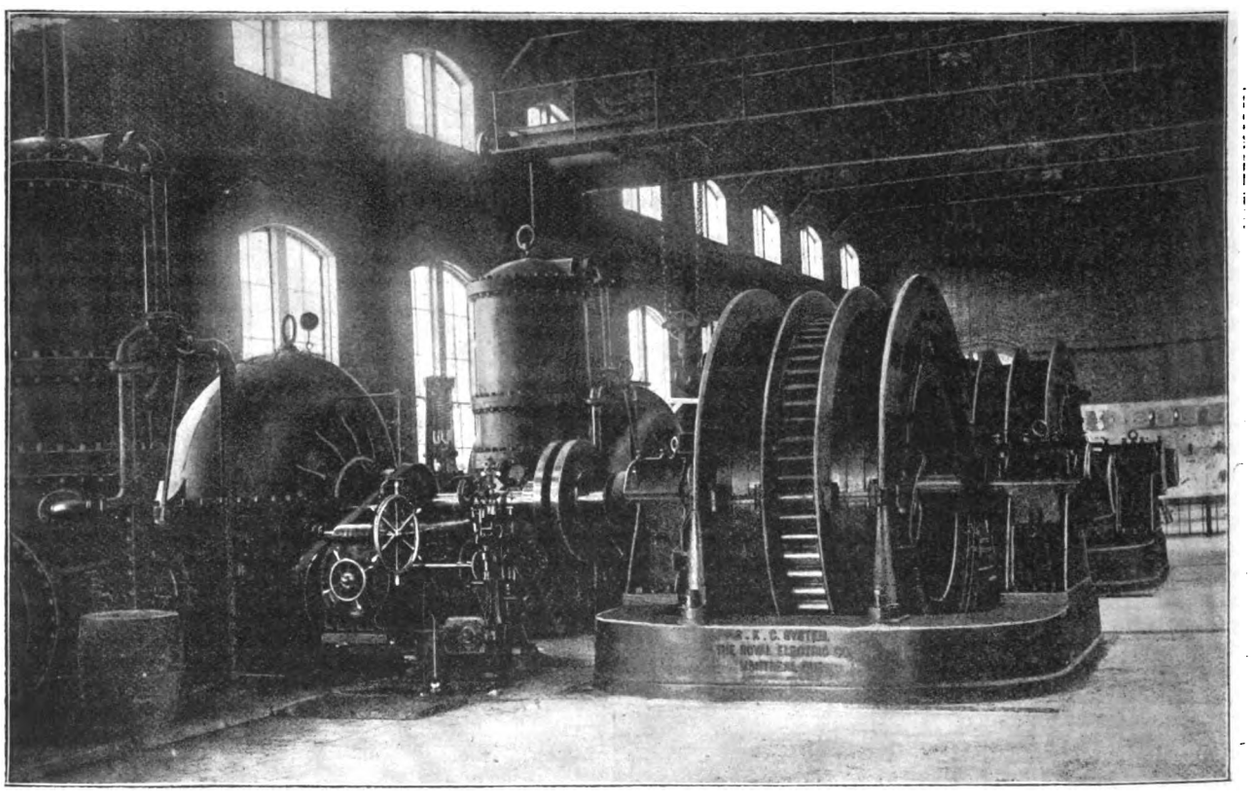
The Power House.—The power house, nestling in the valley of Twelve-Mile Creek, into which the tail-water discharges, is a plain brick structure, 174ft. long and 42ft. wide, covered with a roof supported on steel trusses. The penstock receiver runs under the floor, with four vertical branches curving over in quarter turns to the main wheels, and beyond them two similar branches for the exciters. The main gates are 36in. in diameter, and were built, as were the wheels, by the Stilwell-Bierce and Smith-Vaile Co. They are each operated by a hydraulic ram under penstock pressure, and are not fitted with by-passes. The four-way valve for operating the ram is moved by a long handle, on the other side of which is a 12in. spring-closed relief valve, there being no air chambers on the penstock.

The wheels are of a different style from those generally supplied by this Company, and may be described as an inward-flow, radial type. One of the interesting features of this plant is the employment of the reaction type of turbines with the very high head of 260ft. The intake pipe is horizontal, and the draft tube passes vertically down through the floor and is sealed in the tail race to give the added head of 14ft. by suction. The governing gate is a ring of the register type between the guide chutes and the buckets of the runner, and it is moved axially by two rods connected with the



Plan and Elevations of Power House.



Interior of the Power House.

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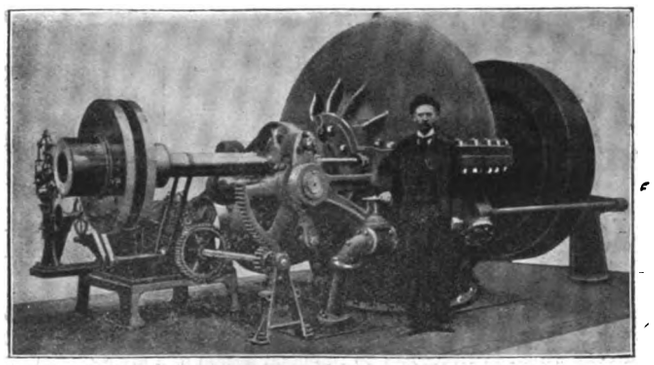
governor mechanism. The governor is of the Giesler electro-mechanical type, the centrifugal balls operating electrical contacts, the currents from which in turn energise clutches driven by belting from the main shaft. The wheels are rated at 1,950 H.P. each at 400 revolutions per minute, under the normal head.

On one of the shafts is a 7½-ton flywheel, with an outboard bearing, and the other end is attached through an insulating coupling with the electrical generator. The latter are of the inductor type, and were supplied, as was all the electrical equipment, by the Royal Electric Company, of Montreal. The inductor weighs 15 tons, and is fitted with ten poles on each ring, and, therefore, at the speed of 400 revolutions per minute, generates 66⅔ ∽ per second. The machines generate two phases at 2,000 to 2,400 volts, the windings being, as is customary with these machines, of the coil type and not distributed. These coils are wound of bare copper strip with mica insulation between the turns, which construction will stand long-continued over-heating without deterioration.

The machine switchboard has three panels of white marble, one for the exciters and one for each of the generators now in place. The generator panels have no live contacts on the face of the board, and are each equipped with one voltmeter, a switch by which this instrument may be thrown on to either phase, two main ammeters, one for each phase, and one continuous-current ammeter in the field circuit. Switching is accomplished by two double-pole, double-throw slide switches, one for each phase, the double throw being from one set of 'bus bars to the other. Beside these instruments there are the usual field rheostats. There are no fuses on the generator board, a short circuit being considered less dangerous with



One of the Main Wheels with Governor, Fly-Wheel and Coupling.

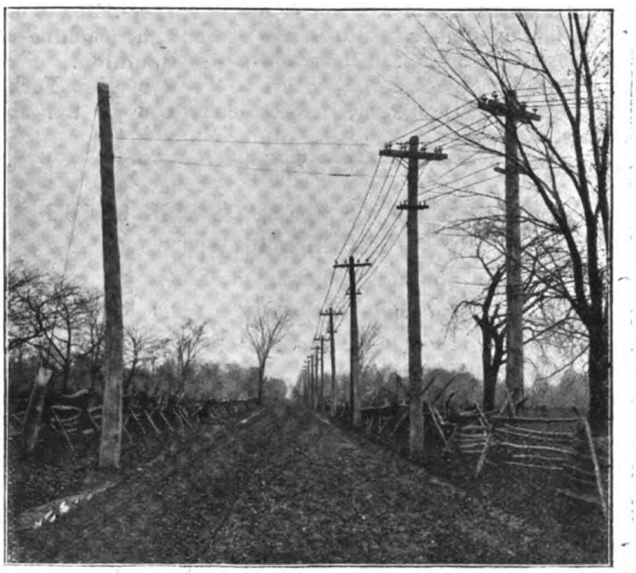
these machines than a sudden throwing off of the load by a fuse blowing with the turbine gate full open. The exciter panel coutains the usual instruments and switches for operating two continuous-current shunt machines in parallel on the exciter 'bus bars.

The exciters themselves consist of two 30-kilowatt, four-pole, 70-volt machines, built by the Crocker-Wheeler Company, driven at 1,000 revolutions per minute by individual turbines to which they are direct-coupled, each exciter unit being of sufficient capacity to excite the full equipment of four generators. These turbines are hand-governed.

One of the most interesting parts of the station is that devoted to the step-up transformers for obtaining the 20,000 to 24,000 volts delivered to the line. Two-phase currents being used on the line, a plain battery of single-phase transformers is connected on each phase. Each battery consists of five 200-kilowatt Stanley transformers, immersed in "mineral seal" oil in heavy boiler-iron cylindrical cases, about 4ft. in diameter and 6ft. in height. The transformers are cooled with water, which is taken from the penstock and circulated through pipes inside the transformer cases.

Each transformer is fitted with a marble switchboard supplied with switches on both the high and the low-tension sides; the latter are of the ordinary slide type, double-throw from one set of 'bus bars to the other, and mounted on the backs of the panels. The 20,000-volt switches are more interesting. They are of what is called the stick type, consisting of a wooden pole about 4ft. long, carrying at its upper end a receptacle or socket which may be pushed up around a downwardly projecting contact finger on the board. The socket on the pole is connected, by a heavily-insulated, flexible cable with a plug permanently screwed into its receptacle. The socket is provided with guides, which run under hard rubber slides when the socket is attached to or removed from the finger. The tips of both fingers and sockets are made of non-arcing metal. It is not intended that these switches shall be opened with the load on, but the load will first be removed by the low-tension switches. The others will then only open the magnetising current of the transformers and the capacity current of the line. Each high-tension stick may be attached to either one of two fingers, connecting to either one or the other of the duplicate lines which will eventually be established. Between the two poles of the switchboard for each transformer there is a heavy marble barrier. Non-arcing fuses are placed on both primary and secondary sides of each step-up transformer.

The Line.—The line, as noted above, is of a rather unusual type for such long transmissions, namely, two-phase. The 25 per cent. economy of copper, which could have been obtained by a three-phase line with the same potential differ-



The 20,000-volt Two-Phase Pole Line.

ence between wires, is sacrificed for the reduced interference of unbalanced loads which will be obtained by the arrangement adopted. The four No. 1 medium-drawn bare copper wires are supported on a single cross-arm, the two phases being respectively on the two sides of the poles, and the wires 18in. apart. The poles vary from 40ft. to 50ft. in length, have tops with a minimum diameter of 8in., and are spaced 90ft. apart.

Protection against lightning is obtained by a barbed wire the whole length of the line, stapled to the tops of the poles and earthed at each pole. At the terminals, banks of Stanley lightning arresters and choking coils are used, there being 30 gaps in series between each wire and earth. The insulators are triple-petticoat porcelain, tested in the ordinary way to 65,000 volts before use. The pins are of "locust," prepared in oil, and are fastened into the cross-arm with a wooden peg, the object being to avoid all unnecessary metal near the wires. A two-wire telephone line is mounted on a lower cross-arm, and is frequently transposed, the power wires not being transposed or spiralled. For a large part of the distance the line follows the route of the Grand Trunk Railway.

The Transformer Sub-Station.—At Hamilton the line runs into a specially constructed brick transformer station on Victoria-avenue. After passing through the arresters, each wire terminates in a panel of the line board provided with stick switches as at the other end. One-half of the room is occupied by two batteries of five 175 kilowatt transformers, similar to those at the power station, except that they are air-

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cooled instead of water-cooled. The boiler-iron cases are fitted with a ring of vertical tubes open at either end, and the transformers set over a duct into which air is blown by a Sturtevant blower coupled to a two-phase motor. The air rises through the tubes and discharges from the tops of the cases, cooling the oil, which in turn cools the copper and iron of the transformer. Each transformer is fitted, as are those at the power station, with switchboard panels having high-tension and low-tension switches. The high-tension side is also fused at this point with enclosed 20,000-volt, 18-ampere fuses, 15in. in length.

The Company is now supplying power to the incandescent service of the Hamilton Electric Light and Power Co., and still another switchboard is in use at the transformer sub-station, for the out-going 2,000-volt feeders. These feeders are provided with two independent wires on each phase, except those which will be devoted exclusively to power service, which will have three-wire two-phase lines. The lighting loads are balanced and boosted at the Electric Light Company's station. The old house-to-house 1,000 to 50 volt, 133⅓ ∼ transformers of the lighting company have been replaced by 2,000 to 100 volt 66⅔ ∼ transformers in larger units, with a better grouping of the secondary loads. The Company expects later to carry a considerable power load to drive the arc light machines and also several, if not all, of the tramways of Hamilton.

We are indebted to the *Electrical World* of New York for the illustrations and information contained in the above article.

IMPROVEMENTS IN MAGNETIC SPACE TELEGRAPHY.*

BY DR. OLIVER LODGE, F.R.S.

(Concluded from page 367.)

Magnifying Telephone.

Instead of using the vibrating coil to affect a soundboard direct, it was obvious that it might be used first to affect a microphonic contact in a local battery circuit, and thus cause

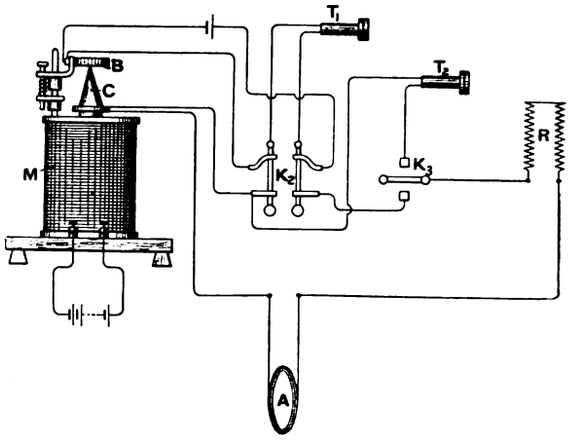

Fig. 6.

fluctuations in a stronger current than that induced from a distance, and so send on a more vigorous disturbance to another telephone, and thus cause a louder noise. For this purpose, after several microphonic transmitters had been tried, a Berliner was ultimately chosen, and arranged at B in Fig. 6. Here the ordinary telephones are arranged so that the disturbance can be heard either direct without magnification or after magnification, and then the received disturbance can be compared with the magnified disturbance. The telephone T_1 serves for both determinations, according to whether the keys are up or down. The telephone T_2 was a duplicate of the same make, and was switched into either circuit when T_1 was out of it, so as to keep everything similar. It was found during the experiments that T_2 was unimportant; the resistance and inductance of the rest of the circuit were great in comparison.

In these early trials the tripod merely pressed against the mica disc of the transmitter; but the mica was now removed and the tripod attached to the coil pressed against the carbon plate instead; but this was no improvement. Hitherto the coil was *pressed* up, resting on elastic pellets below, and was under considerable constraint; now, finally, the tripod was attached rigidly to the centre of the carbon plate of the Berliner transmitter, and the coil

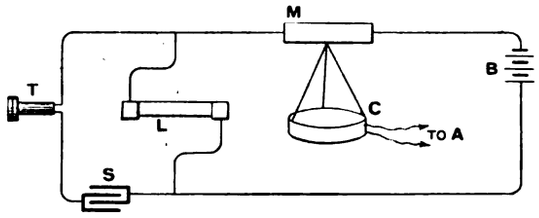

Fig. 7.

was allowed to hang freely in the magnetic air gap. This was much the best plan; but a spiral spring pressing upwards is still generally used to support the weight of the coil and to regulate the dominant pitch appropriate to the disc and coil as a vibrating system.

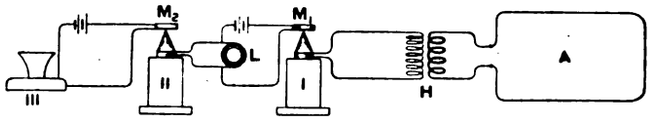

Fig. 8.

The method of connecting the magnifier to the telephone listened to was also modified, and was frequently as in Fig. 7, where T is any telephone, diagrammatically indicated, M is the Berliner microphonic transmitter, with receiving coil hanging on a tripod

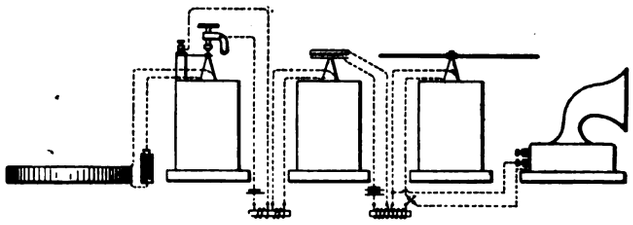

Fig. C.—Arrangement of Two Magnifying Telephones and One Soundboard Telephone in series; all of the vibrating coil pattern. Compare Fig. 8.

from its carbon plate, B is a battery of three storage cells; and L is a self-induction coil, without iron, which carries most of the steady current which is necessary to the good action of a microphone, but

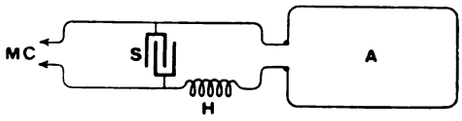

Fig. 9.

diverts the jerks and fluctuations mostly through the telephone, even though this be of high resistance.

Sometimes a condenser, S, was inserted in its circuit too, with the object of assisting through the telephone fluctuations of a

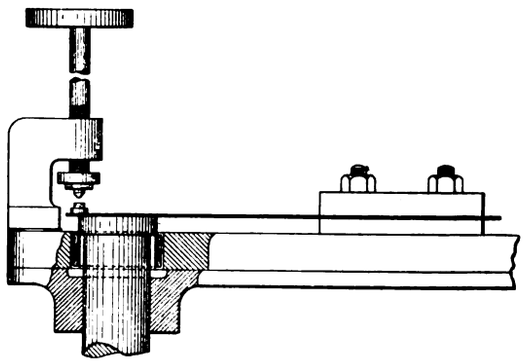

Fig. 10.—Details of Magnifying Telephone with vibrating coil suspended on reed and supporting a microphonic contact.

definite pitch, and of other pitches not too far removed from that. A transformer could be used instead of the self-induction shunt, but the advantage of a transformer is more felt on long lines; for

* Paper read at the Institution of Electrical Engineers, Dec. 8, 1898.

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a compact apparatus it serves too, but it wastes more power than the L shunt.

The arrangement shown in Fig. 8 was tried as receiver at my

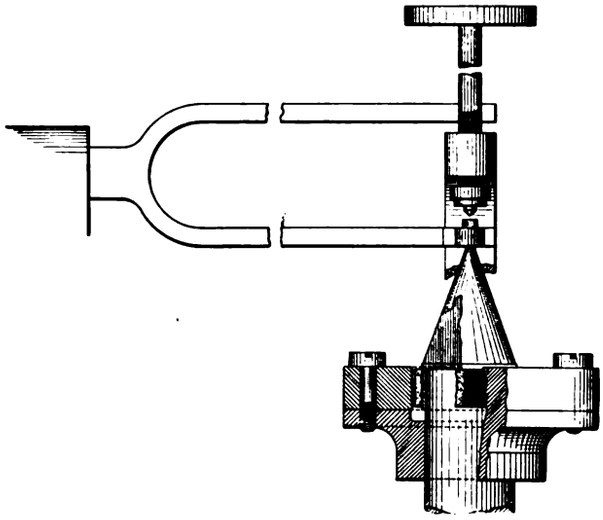

FIG. D.—Arrangement of Coil on Tuning Fork for first Magnifier, with single microphonic contact and adjusting screw. Compare Fig. 10.

house of the signals sent from college, two miles away. A is the cable once round the garden, connected to the thick winding of a hedgehog transformer, H. Its thin winding is connected to the

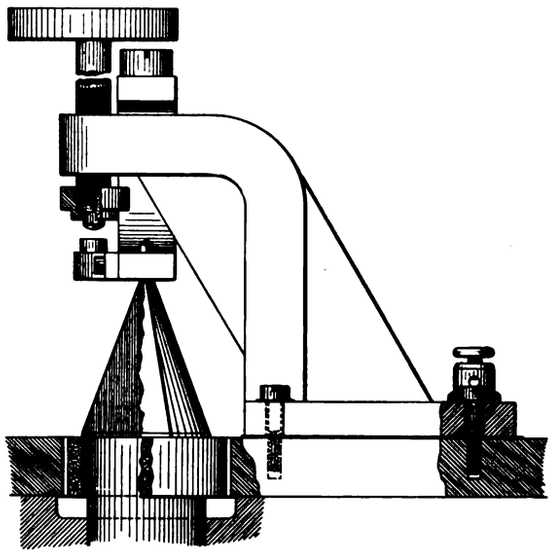

FIG. E.—Details of the Microphonic Contact of the first Magnifying Telephone, with coil suspended from tuning fork seen endways. Compare Fig. 10.

fine-wire suspended coil of the first magnifying telephone I. The currents from its transmitter, M_1, are taken to the fine-wire coil of the next magnifier, II., shunted by the low-resistance self-induction

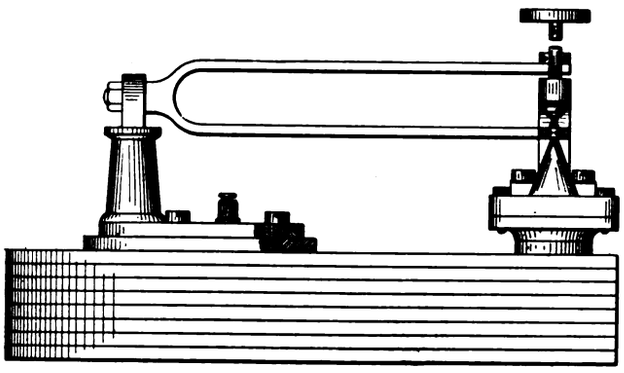

FIG. F.—Syntonic Magnifying Telephone, with tuning fork; suspended coil working a microphone. Compare Fig. 10.

coil L. III. is the final telephone of the series, viz., an ordinary Western Electric loud speaker (2 ohms), in series with the transmitter M_3. Under these circumstances the signals could be heard with the ear 2in. from the funnel of III.

But the hedgehog wasted a lot of power; its volume of iron being considerable, and the hysteresis and eddy losses at high frequency being very marked. An improved arrangement consisted in interposing a 20-microfarad condenser (the largest then available, kindly lent by Dr. Alex. Muirhead). This was not enough to tune up the circuit, except when the thin-wire circuit of the hedgehog was unclosed. So the plan shown in Fig. 9 was adopted, and was a decided improvement. M C is the magnifying arrangement, as before. H is the thick wire of the hedgehog, inserted merely as extra self-induction. S is a condenser having a capacity of 20 or 21, or sometimes as much as 24, microfarads (a

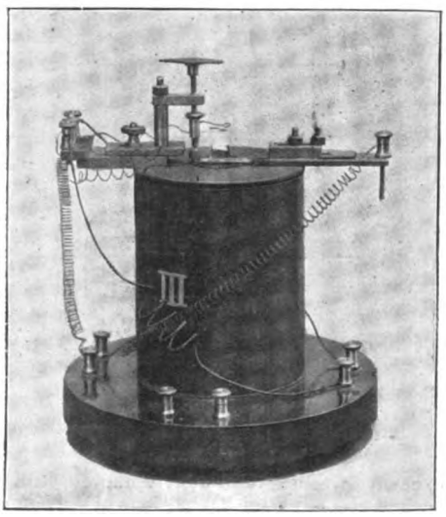

FIG. G.—Photo raph of the Telephone Magnifier with coil suspended by a tuned reed. Compare Fig. 10.

small plug condenser being added in parallel to vary and improve the tuning).

Thus the note was enhanced by resonance, and the signals became almost loud. (The tuning-reinforcement at the College end happened, however, on this particular occasion to be rather poor.)

This must serve as a sample of a great number of experiments, made with all manner of condensers and different notes; an especial amount of variation being practised at the sending end. It is to be remarked that fine-wire coils to the telephones are by no

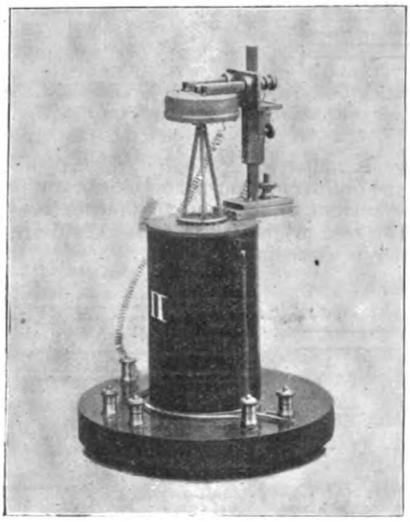

FIG. 11.—Photograph of Single-pole Magnifying Telephone with vibrating coil operating a Berliner transmitter.

means the best for this particular purpose, and afterwards ribbon coils of thin aluminium strip were used instead. Transformers and L shunts could then be dispensed with; but small telephonic transformers are still usually employed, to prevent the constraint exerted on the hanging coil by a steady current passing through it. Small transformers don't waste much, and a little waste of power matters nothing where there is a local battery.

The Berliner or such-like granular transmitters, though serving well to magnify an already audible current, do not always pick up and magnify an inaudible one, and, moreover, they do not discriminate between an intended and accidental vibration. For this

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purpose a better and more precise apparatus has to be constructed —viz., the reed or the tuning-fork magnifying telephone, with only a single pair of carbon contacts. This is shown in Fig. 10, and its essence is that the coil is hung to a reed or fork or vibrator of definite pitch, and carries also a pellet of carbon which presses lightly upward on another fixed pellet, thereby constituting a single-contact microphone. Such an arrangement, as is well

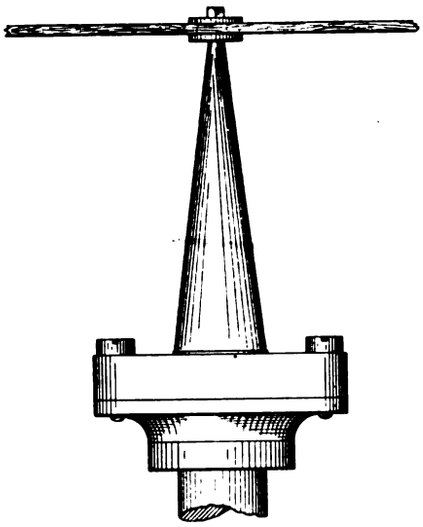

FIG. 12.—Mounting of Coil and Pole-piece of Sound-board Telephone.

known, is excessively sensitive to utterly imperceptible mechanical disturbances, and the minutest fluctuations of current now passing through the hanging coil give ultra-microscopic tremors sufficient to vary the resistance of the light carbon contact perceptibly; the energy of a single-cell local battery being thus brought into action,

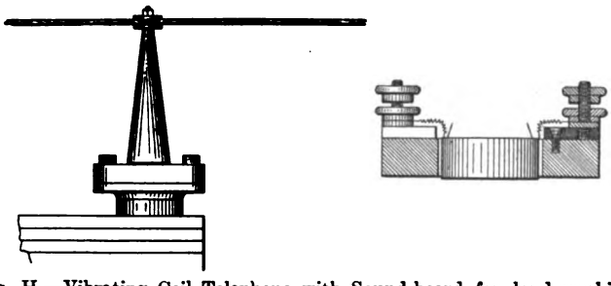

FIG. H.—Vibrating Coil Telephone with Sound-board, for loud-speaking or other signalling. Compare Fig. 12.

enough energy is imparted to disturb (through another hanging coil) one of the ordinary granular transmitters, which then passes on a stronger current to the loud speaker, or the "call." Or it may be that two reed magnifiers in series are desirable, when the received current is exceedingly faint.

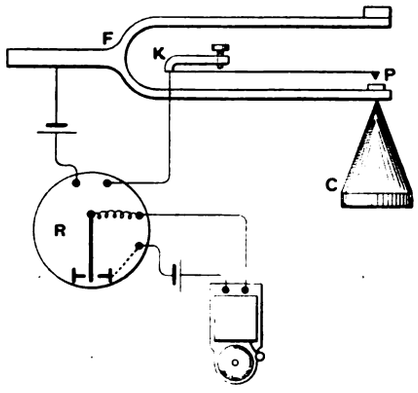

FIG. 13.

The single-point magnifiers do not carry big currents, and they require delicate, though easy, adjustment; but when properly made and adjusted they work extremely well with pure tones. The multiple-contact microphones work better for articulate speech, as is well known. The magnifying transmitter is shown in Fig. 11. I find graphite carbon the best for these single contacts, and I am indebted to Mr. Swan, to Le Carbone, and to Mr. Acheson for several specimens of soft carbon, which answer much better than the harder arc lamp variety.

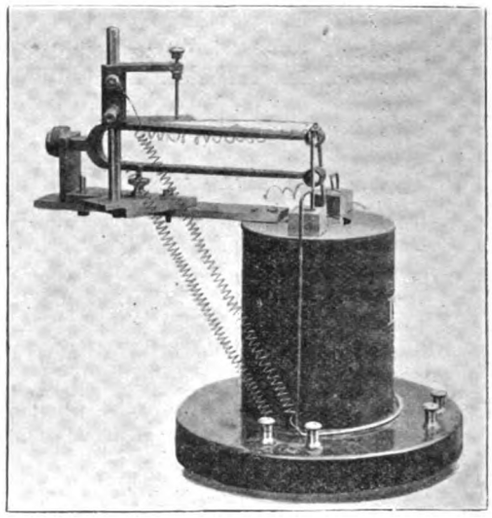

FIG. J.—Photograph of the Electromagnetic Syntonic Call Telephone, which breaks the circuit of a relay and so rings an electric bell when it receives the current of right frequency from the magnifiers. Compare Fig. 13.

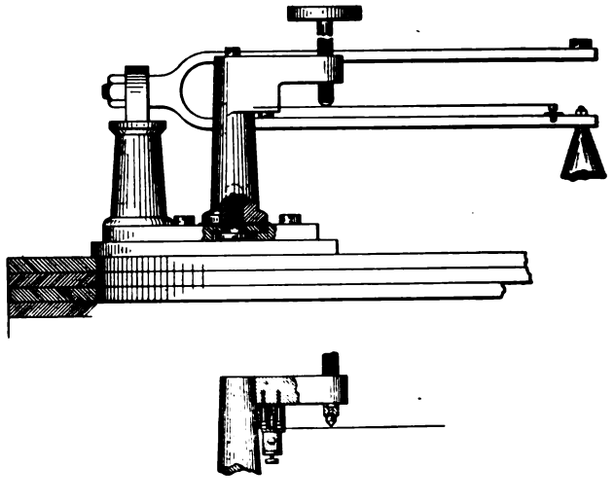

FIG. K.—Details of Syntonic Call Telephone, showing the dancing contact on one of the prongs. Compare Fig. 13.

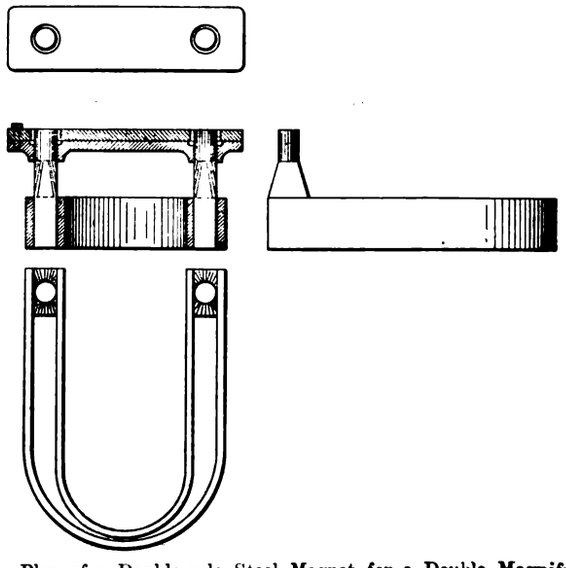

FIG. L.—Plan of a Double-pole Steel Magnet for a Double Magnifying Telephone.

The last telephone of the series has been so far represented as one of ordinary pattern, but it is obvious that the vibrating coil attached to a wooden sound-board may be employed, like Fig. 12;

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and, further, that a combination of such sound-board telephone may have an important application to the human voice and the acoustics of buildings—a different subject, into which I will not now further go.

It is also manifest that when the vibrations are magnified they may be used to work a relay and ring a bell, or actuate a Morse instrument, or anything else; just as in the phonophoric receiver, for instance. I am indebted to Mr. Langdon Davies for the loan of one of his phonoporic receivers.

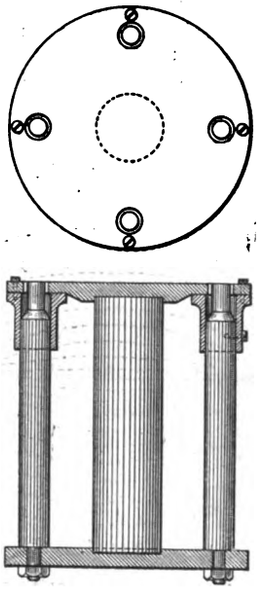

FIG. M.—Permanent Magnet with four annular pole-spaces adapted to receive the four coils of a quadruple magnifying telephone.

The bell-ringing arrangement that we at present prefer is a coil telephone of the tuning-fork pattern, so that (if protected from mechanical shaking) it shall only respond to a definite note, and not to casual currents in the line. The light coil hangs to the limb of a large tuning-fork, and on this or on the other limb is a light metallic contact which dances when the limb vibrates, thereby practically breaking a local relay circuit and letting its tongue fly

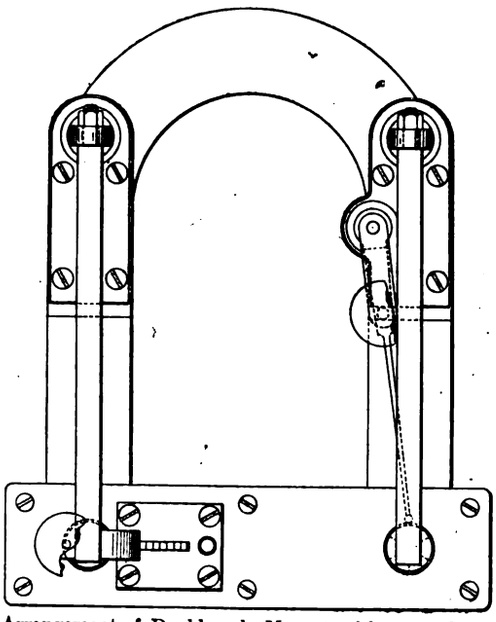

FIG. N.—Arrangement of Double-pole Maguet with one pole magnifying and the other pole "calling."

over, so as to close a bell circuit. A diagram is hardly necessary, but one is given in Fig. 13.

C is the last of the series of the suspended magnifying telephone coils.

F is a tuning-fork on firm stand.

K is also rigidly supported, and carries a thumb-screw for adjustment of spring.

P is a platinum stud contact carried by a very light spring; and this forms part of the local polarised relay circuit,

R, which rings a bell in the very ordinary way in any office where calling up is desired.

It may be thought that a light coil is hardly competent to shake appreciably the massive steel limbs of a tuning-fork; but when it is isochronously attuned to the pulsations of the received disturbance, a tuning-fork is wonderfully sensitive (even to aerial vibrations, as is well known in an ordinary resonance experiment); and the fact that it is not sensitive to disturbances of accidental frequency is wholly advantageous. The light trembling spring is, however, readily disturbed by any sort of shaking, and if the relay is too delicately adjusted it may give spurious calls due to mechanical tremors. From these it must be guarded.

Continuous working at the subject for over a year on the part of Mr. Benjamin Davies and myself, with occasional aid from instrument makers, has naturally resulted in a mass of observations and experiments. What is now published is but a fragmentary selection, but the Paper is quite long enough.

ÆTHERIC TELEGRAPHY.*

BY W. H. PREECE, C.B., F.R.S.

I have never submitted to the Institution of Electrical Engineers any record of my long and continuous researches on signalling through space. My reports have been made from year to year to Section A of the British Association. Some of them not having been printed, it is not to be wondered at that all my work is not known, and so much of it is occasionally reproduced by others. I will confine my remarks in this paper to ætheric telegraphy, and to its electro-magnetic form alone.

In 1884† disturbances—that is, stray currents producing extraneous noises on the telephone—were detected on the circuits erected over the house-tops, produced by currents in telegraph wires buried in iron pipes in the streets. Messages sent on the telegraph wire were actually read on the telephone circuit, though the wires were nowhere in contact. Exhaustive experiments were made to prove that these results were due to induction and not conduction. This was done by making the circuits metallic. They were separated from each other by a span of 80ft.

Many preliminary laboratory experiments were made with coils of many turns, but in 1885 square coils of insulated single wire, each side being of 440 yards length, were laid horizontally on the ground in the neighbourhood of Newcastle, and conversation by telephone was effected from one to the other through a space of one-quarter of a mile. Disturbances between these squares were appreciable at 3,000ft., and even at a distance of 10¼ miles between parallel lines of telegraph connecting Durham and Darlington. In 1886‡ experiments were carried out across the Severn for a length of 14 miles between Bristol and Gloucester, the parallel wires being separated by a mean distance of 4·5 miles. Primary currents of 0·449 ampere were rapidly made and broken by mechanical means, producing on the telephone a continuous note which could be conveniently broken up by a Morse key into dots and dashes, as in Cardew's vibrator. Disturbances were observed in the secondary circuit. The circuits were metallic and of many miles in length, that on the Gloucester side being completed through Stroud, and that on the Welsh side through Monmouth. Here we had just reached the limit of disturbance with the means at our disposal. It afforded a convenient measure of the range of audibility. The unexpected fact was shown that, whether the circuits were metallic or earthed at the ends of the parallels, the results were the same. This was confirmed subsequently by innumerable experiments, especially by some results obtained between Arran and Kintyre in 1894.§ All our experience since has shown that a coil of one single turn of thick copper wire, and of the largest possible diameter, gives the best result, and signals to the greatest distance. Moreover, it will be shown that the greater portion of this coil may be made up by the earth. In a single turn thus formed we have the full beneficial effect of electro-magnetic as well as of electrostatic induction, we have the advantage of earth conduction, and we reduce capacity and inductance to their minimum. In closed coils of many turns we have only electro-magnetic induction, and we make inductance a maximum. In the autumn of the same year (1886) the vast expanse of sand at Porthcawl, in South Wales, was used to further develop the law determining these effects.‡ Two horizontal squares of 300 yards per side were placed 300 yards apart, and subsequently one of them was suspended on scaffold poles 15ft. above the other, which was covered with water at high tide. No difference was detected in the strength of signals, whether the space were air or water, or a combination of air and water. Subsequent experiment

* Paper read before the Institution of Electrical Engineers, Dec. 22, 1898.

† "Induction between Wires and Wires," B.A. Report, Birmingham, 1886. [*The Electrician*, Vol. XVII., p. 410.—ED. *E.*]

‡ Note "On Induction between Wires and Wires," B.A., Manchester, 1887. [*The Electrician*, Vol. XIX., p. 461.—ED. *E.*]

§ [Described in Mr. Preece's 1894 B.A. Paper. See *The Electrician*, Vol. XXXIII., p. 460.—ED. *E.*]

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(1893) showed that through 15ft. the effect in air was distinctly better than through water.

The conclusion then arrived at was that the magnetic field extends uninterruptedly through the earth, as it does through the air, and that if the secondary circuit had been in a coal-pit it would have been equally evident. In fact, Mr. Arthur Heaviside succeeded in 1887 in communicating between the surface and the galleries of Broomhill Colliery, 350ft. deep. But subsequent experiments showed that the conclusion arrived at was not true for water, for, though we have spoken in Dover Harbour telephonically through 36ft., at 400ft. off the Goodwin Sands, no practical signals could be detected. Hence, the effect must diminish in water with some high power of the distance. A new telegraph line of copper wires running parallel to the Great Western Railway in 1886 offered convenient opportunities to experiment further.* The fact that parallel wires followed the same law as metallic coils facilitated such experiments. Horizontal coils of large diameter lying on the ground are impractical things, and I was glad to get rid of them. It was determined that with two parallel wires of 1 mile length, the primary wire being excited by 1 ampere, the limit of audibility was reached at 1·9016 miles, and that

$$x = 1{\cdot}9016\sqrt{\frac{C_1 l}{r_2}}$$

gave a fairly accurate empirical formula to determine the maximum distance, x, which should separate any two wires of length, l, C_1 being the primary current and r_2 the resistance of the secondary wire. This was amply confirmed by experiments repeated in the Severn Valley in the same year,* and it established the fact that it was advisable to use copper conductors of the largest gauge that could be obtained. It was also determined that a very important element of success was the rate at which the currents rise and fall, and that every cause of retardation, such as capacity and self-induction, should be eliminated from the circuits.

A great many experiments were made in Lisvane, in Glamorganshire (1887), Loch Ness (1892), the Conway estuary (1893), Frodsham, on the estuary of the Dee (1894), Wimbledon (1894).† But the most satisfactory results were obtained in the Bristol Channel (1892), between Lavernock and Flat Holm, 3·3 miles apart, between which places messages passed freely.‡ In fact, at the present time this line has been re-erected and made permanent. It is in actual practical daily use, and has never failed ever since it was established. The Pyke and Harris alternator, which was used in 1892, has been replaced by dry cells. The frequency has been raised to 400. The rate of rising and falling of the current has been immensely improved. The resistance of the circuit has been made as low as possible. There is no measurable capacity, and self-induction is eliminated. Hence the signals are simply splendid, and their rate of working dependent only on the skill of the operator.

The conception of the function of the earth as the completion of the circuit of a single coil has been thoroughly formulated. The earth acts simply as a conductor, and *per se* it is a very poor conductor, deriving its conducting property principally, and often solely, from the moisture it contains. On the other hand, the resistance of the "earth" between the two earth-plates of a good circuit is practically nothing. Hence it follows that the mass of earth which forms the return portion of the circuit must be very great, for we know by Ohm's law that the resistance of a circuit increases with its specific resistance and length, and diminishes with its sectional area. Now, if the material forming the "earth" portion of the circuit were, like the sea, homogeneous, the current-flow between the earth plates would follow innumerable but definite stream lines, which, if traced and plotted out, would form a hemispheroid. These lines of current have been traced and measured. A horizontal plan on the surface of the earth is of the form illustrated in Fig. 1, while a vertical section through the earth is of the form shown in Fig. 2. With earth plates 1,200 yards apart these currents have been found on the surface at a distance of half a mile behind each plate; and, in a line joining the two transversely, they are evident at a similar distance at right angles to this line.

Now, this hemispheroidal mass could be replaced electrically by a resultant conductor (R, Fig. 2) of a definite form and position; and, in considering the inductive action between two circuits having earth returns, it is necessary to estimate the position of this imaginary conductor. This was the object of the experiments at Frodsham. If the material of the earth be variable and dry the hemispheroid must become very much deformed and the section very irregular, the lines of current-flow must spread out further, but the principle is the same, and there must be a resultant return. The general result of the experiments at Frodsham indicate that the depth of the resultant earth was 300ft., while those at Conway are comparable with a depth of 350ft. In the case of Frodsham the primary coil had a length of 300ft., while at Conway the length was 1,320ft. At Loch Ness and between Arran and Kintyre, where the parallel lines varied from two to four miles, the calculated depth was found to be about 900ft. The depth of this resultant must, therefore, increase with the distance separating the earth-plates, and this renders it possible to communicate by induction from parallel wires over much longer distances than would otherwise be possible.

In establishing communication by means of induction there are three dispositions of circuit available, viz.: (*a*) single parallel wires to earth at each extremity; (*b*) parallel coils of one or more turns; (*c*) coils of one or more turns placed horizontally and in the same plane. The best practical results are obtained with the first arrangement, more especially if the conformation of the earth admits of the wires being carried to a considerable height above the sea, whilst the earth-plates are at the sea level. By adopting this course the size of the coil is practically enlarged, and even if it be necessary to

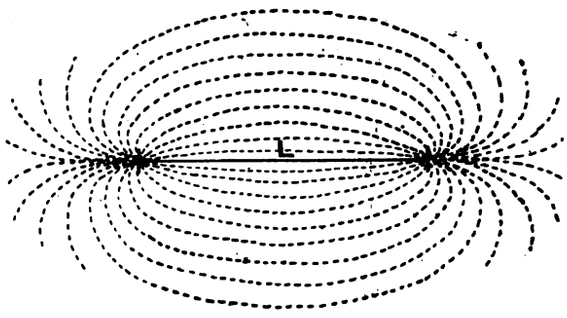

FIG. 1.

increase the distance between the parallel wires to effect this object the result is still more beneficial. Two wires of a definite length were first made up into two coils forming metallic circuits, then uncoiled and joined up as straight lines opposed to each other, with the circuit completed by earth. The inductive effects, and the distance between which they were observable, was very many times greater with the latter than with the former arrangement.

One very interesting fact observed in Loch Ness in 1894 was that there was one particular frequency in the primary circuit that gave a decided maximum effect upon the telephone on the secondary circuit. It was a case of tuning. It was so effective as to secure the transmission of speech across a space of 1¼ miles.

Effects of resonance were observed during the experiments in Arran in 1894.* A metallic circuit was formed, partly of insulated wire 500ft. above the sea level, and partly of ordinary line wire, the rectangle being two miles long and 500ft. high. Wires on neighbouring poles at right angles to the shorter side of the rectangle, although disconnected at both ends, took up the vibra-

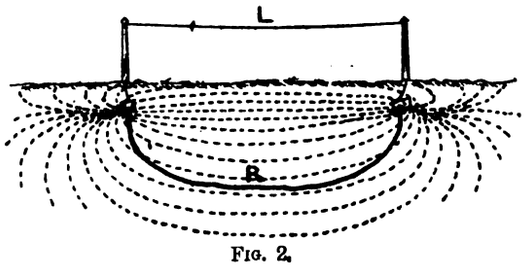

FIG. 2.

tions, and it was possible to read all that was signalled on a telephone placed midway in the disconnected circuit by the "surgings" thus set up.

In March, 1895, the cable connecting Oban with the island of Mull broke down. A gutta-percha-covered wire, 1½ miles long, was laid along the ground from Morven, on the Argyllshire coast, while on Mull the ordinary overhead iron wire connecting Craignure with Aros was used. The mean distance separating the two wires was about two miles. There was no difficulty in communicating. Public messages were sent for a week until the cable was repaired.†

Perhaps the most important experiment attempted was that to communicate between England and Ireland. A circuit was made up from Carlisle to Haverfordwest, and another in Ireland from Belfast to Wexford.‡ The whole telephonic system of the

* [See *The Electrician*, Vol. XIX., p. 461.—ED. *E.*]

† [The majority of these experiments are described in Mr. Preece's 1894 B.A. Paper, above referred to. See *The Electrician.*, Vol. XXXIII., p. 460.—ED. *E.*]

‡ [*Loc. cit.* See also *The Electrician*, Vol. XXX., p. 81, and Vol. XXXI., p. 520.—ED. *E.*]

* "Signalling through Space," B.A., Oxford, 1894. [*The Electrician*, Vol. XXXIII., p. 460.—ED. *E.*]

[† See *The Electrician*, Vol. XXXIX., p. 216.—ED. *E.*]

[‡ See *The Electrician*, Vol. XL., p. 780.—ED. *E.*]

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country was stopped from midnight to two a.m. one Sunday morning in June, 1895. Attempts were made to signal, but it was impossible to distinguish a signal through the wonderful, incessant, and strange, sounds that filled the telephone and overpowered everything else. No telegraph was at work anywhere. The hum of two or three electric light installations working on the alternate-current system was evident, but there was a weird, strange babel of noises that was mysterious and disappointing. I am strongly of opinion that these sounds were due to disturbances excited by primary electrical effects outside our globe. I have not thought the experiment worth repeating. It can have no practical value, but I had arranged in the event of its success to communicate between England and Europe, and then between Europe and America.

BOOKS RECEIVED.

"*Proceedings* of the Municipal Electrical Association." 1898. Published under the supervision of the Editing Committee. (Huddersfield: Alfred Jubb and Son.) Price 3s. 6d.

"Terrestrial Magnetism," No. 4, Vol. III., December, 1898. Edited and published by L. A. Bauer and Thomas French, jun. (London: William Wesley.)

"The Official Gazette of the United States Patent Office," No. 13, Vol. LXXXV. Published by authority of Congress. (Washington: Government Printing Office.)

"Navigation en Temps de Brouillard." By Emile Lacoine Effendi. (Constantinople: Imp. Française.)

ELECTRICITY WORKS ACCOUNTS.

The Woolwich District Electric Light Co. (Limited).

Electricity supply in Woolwich was commenced in September, 1893, therefore the accounts which are dealt with in our table are those of the third and fourth completed years of working.

The total received capital of £16,000 has been raised, £10,000 by the issue of 10,000 £1 shares, and £6,000 on Four per Cent. Debentures. Of this total amount £15,745, representing £42·6 per kilowatt of plant capacity, has been expended on capital account, no less than £30 of the £42·6 total per kilowatt being on plant.

Corresponding with an increase in the number of the consumers of from 69 to 76 during 1897 the equivalent 8 c.p. lamp connection had risen from 3,878 to 5,023, an increase of about 30 per cent., while the output for 1897 was 77,150 units sold as compared with 75,929 in 1896, a rise of but 1·6 per cent. It is evident, therefore, that the majority of the lamps added to the circuit in 1897 were connected near the end of the year, and had little influence in increasing the output. In consequence of this and the failure of the condensing plant the accounts show a disappointing state of affairs for 1897. The already high costs of 4·88d. per unit in 1896 are shown by the accounts to have risen in the succeeding year to 5·69d. *All* the items of cost are responsible in some degree for this result, as they all without exception show increases.

The ultimate results are that although the tariff remained unchanged the ratio of costs to revenue had risen from 86·5 to 96 per cent., and instead of a working profit of £240 as in 1896, the figure for 1897 was only £77. Nothing has been written off for depreciation or reserve, but £204 was paid in interest, leaving a deficit of £105.

Contracts had been entered into by the company for the provision of new condensing plant, extension of mains and plant, and for the conversion of the system from high pressure alternating to low pressure continuous current, and it was anticipated that these extensions would have been ready for this winter's load.

	WOOLWICH.	
Undertaking Worked by	The Woolwich District Electric Light Co., Ltd.	
Date of Commencement of Supply	September, 1893.	
System of Supply	Alternate-current transformer sub-stations.	
Chief Engineer	F. Barnes Spencer.	
YEAR ENDED	DEC. 31, **1896.**	DEC. 31, **1897.**
QUANTITIES—		
Units generated	—	—
„ **SOLD (TOTAL)**	75,929	77,150
„ sold to consumers	75,929	77,150
„ sold for public lighting, &c.	—	—
„ used on works	—	—
UNITS SOLD per 8 c.p. LAMP CAPACITY	5·40	6·67
Maximum supply demanded	92 kilowatts	107 kilowatts
Number of public lamps	—	—
Number of consumers	69	76
Connections to mains in 8-c.p. lamps	3,878	5,023
CAPACITY OF PLANT IN 8-c.p. LAMPS	14,060	11,560
CAPACITY OF PLANT IN KILOWATTS	450	370
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	— / —	— / —
Share	£10,000 / £22·2	£10,000 / £27·0
Loan (including Debenture charges)	— / —	— / —
RECEIVED (TOTAL)	14,250 / 31·7	16,000 / 43·2
Share	9,250 / 20·6	10,000 / 27·0
Loan (including Debenture charges)	5,000 / 11·1	6,000 / 16·2
AUTHORISED, NOT RECEIVED (TOTAL)	— / —	— / —
Share (unissued)	750 / 1·67	— / —
Share (uncalled)		
Loan (including Debentures)	— / —	— / —
REPAID (TOTAL)	— / —	— / —
RESERVE OR SINKING FUND	— / —	— / —
DEPRECIATION FUND	— / —	— / —
EXPENDED (TOTAL)	14,237 / 31·7	15,745 / 42·6
Lands and buildings	2,012 / 4·47	2,085 / 5·64
Plant	9,927 / 22·1	11,094 / 30·0
Mains	1,853 / 4·12	2,121 / 5·73
Miscellaneous	445 / 0·99	445 / 1·20
BALANCE OF CAPITAL ACCOUNT	13 / 0·029	255 / 0·690
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£1,782 / 5·640d.	£1,904 / 5·928d.
Revenue from supply	1,587 / 5·020d.	1,710 / 5·322d.
„ meters, &c.	47 / 0·149d.	53 / 0·165d.
„ public lighting	— / —	— / —
„ sale of lamps, &c.	66[a] / 0·209d.	85[a] / 0·265d.
„ miscellaneous sources	83 / 0·263d.	56 / 0·174d.
EXPENDITURE—		
TOTAL COSTS	£1,542 / 4·880d.	£1,827 / 5·685d.
WORKS COSTS	1,039 / 3·286d.	1,273 / 3·963d.
Generation of Electricity	*1,028 / 3·250d.*	*1,258 / 3·915d.*
Fuel (including cartage, &c.)	554 / 1·752d.	685 / 2·130d.
Oil, waste, water, stores	92 / 0·291d.	117 / 0·364d.
Wages at station	245 / 0·775d.	309 / 0·962d.
Repairs & maintenance at Station	136 / 0·430d.	147 / 0·458d.
Distribution of Electricity	*11 / 0·035d.*	*15 / 0·047d.*
Wages, &c.	7 / 0·022d.	8 / 0·025d.
Repairs, renewals of mains, &c.	3 / 0·010d.	7 / 0·022d.
Public Lighting	— / —	— / —
Attendance	— / —	— / —
Renewals	— / —	— / —
MANAGEMENT CHARGES, &c.	503 / 1·591d.	554 / 1·724d.
Royalties	— / —	— / —
Rent, rates, taxes	*307 / 0·971d.*	*333 / 1·036d.*
Management	*196 / 0·620d.*	*221 / 0·688d.*
Salaries	128 / 0·405d.	142 / 0·442d.
Stationery, &c.	10 / 0·032d.	11 / 0·034d.
Establishment charges	21 / 0·067d.	28 / 0·087d.
Law charges, &c.	37[b] / 0·117d.	40[c] / 0·125d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£240 / 1·93%	£77 / 0·51%
Carried to Depreciation Fund	— / —	— / —
Carried to Res. or Sinking Fund	— / —	— / —
Net int. on loans (incl. Deb. charges)	102 / 0·82%	204 / 1·36%
BALANCE FROM LAST ACCOUNT	67 / 0·54%	22 / 0·15%
Do. AVAILABLE for DISTRIBUTION, &c	205 / 1·65%	— / —
Deficit	— / —	*105 / 0·70%*
ORDINARY DIVIDEND PAID	2% / —	— / —
% of TOTAL COSTS to GROSS REVENUE	86·5%	96%
Expenditure per kilowatt capacity	£3. 8s. 6d.	£4. 18s. 10d.
REVENUE PER KILOWATT CAPACITY	£3. 19s. 2d.	£5. 3s. 0d.
Expenditure per 8-c.p. lamp capacity	2s. 2¼d.	3s. 2d.
REVENUE PER 8-C.P. CAPACITY	2s. 6½d.	3s. 3½d.
REVENUE PER 8-C.P. CONNECTED	9s. 2¼d.	7s. 7d.
Price charged for lighting, per unit	6d.	6d.
„ for power, per unit	—	—
„ for public lighting	—	—

REMARKS—*a* Profit on installing work, &c. *b* Includes insurance £28, and auditing £7. *c* Includes £33 to insurance and £6 to auditing.

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MUNICIPAL JACKS-OF-ALL-TRADES.

We commend to the careful consideration of everyone who is in any way interested in electrical manufactures and trading, in the United Kingdom, the following extract, which, with but trifling variation, is to be found in no less than *seventy* recent notices from local authorities intending to apply for statutory powers for electricity supply:—

To authorise the Council to manufacture, purchase, hire, sell, and to let all necessary lamps, accumulators, meters, dynamos, fittings, plant, machinery, apparatus and other matters or things required for the purposes of the Order, and to acquire, work and use patent rights for the generating, storing, collecting, distributing and measuring, or otherwise relating to the supply of electricity.

Could the full purport of this clause, and its broad issue if ever it is carried into operation, be realised by the electrical profession and industry of this country, we have little fear that they would supinely tolerate any such iniquitous encroachment on their just rights; but there is danger that the mischievous tendency of legislation in this direction may not be perceived, or, if perceived, its full influence may not be understood until it is too late to avert a catastrophe. Nor need we draw the line at the electrical profession and industry, for there is no indication that the mania for municipal trading in the future is to be confined to business of an electrical nature or anything of the character of public works. Whose turn it will be next we do not venture to predict; but the thin end of the wedge having been inserted, the entire bulk of that disruptive weapon can easily be driven in; the cloven hoof once revealed, the entire personality associated with that limb is likely enough soon to become apparent. Municipal tramways, lighting works, dynamo factories, wiring, fittings, heating and cooking departments, *et hoc genus omne*, may, indeed, be followed by a long series, including municipal bakeries, boot shops, newspaper offices, and all the odds and ends of trade by which mankind earns its daily bread. Such things, in fact, are even now claimed as the legitimate ground for municipal activity by many of the more advanced of the responsible representatives of this "progressive" school of socialism. In all respects,

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therefore, in which the present tendency is prejudicial to the electrical profession, will that profession enlist the sympathy and claim the co-operation of every individual interested in any private industry or trading enterprise. Beyond that patent fact we ourselves are not concerned with the movement except in so far as it bears directly upon electrical affairs.

There are two principal aspects of municipal trading, as represented by the foregoing clause, from which it should be viewed with distrust, if not with alarm. The first is, that Municipalisation spells Monopoly. It has ever done so in the past, when the local authorities have succeeded in getting the upper hand; and from what it has revealed in the past we may infer its character in the future. For, the so-called principle which is held to justify the claim to monopoly is as applicable to every new form of municipal trading as it is to those to which it has been already held to apply. This principle is, that the ratepayers' capital and assets in municipal works must be protected from competition. If this is true of an electricity supply works, it is equally true of a municipal retail shop for the sale of any household commodity whatever. In support of this assertion, we may refer to a conference of the municipal authorities of Lancashire and Cheshire, held at the Manchester Town Hall on Tuesday last, for the purpose of organising opposition to two projected company undertakings which would create competition with local municipal electricity works. The Lord Mayor of Manchester said that the proposed schemes "trespassed" on the position of the various town authorities, and he thought it their duty to do their best "in the interest of the ratepayers" to secure their rejection in the House of Commons. But this intolerant attitude was capped by the position assumed by the Town Clerk of Liverpool, who argued that "municipalities ought to join and fight the matter out, not as a question of detail but of principle, and get it settled once for all that *when a Corporation had been authorised to spend money in any public undertaking it should be freed from all outside competition.*" And this enlightened pronunciamiento, breathing forth, as it does, the spirit of the middle ages, was received with acclamation. We may, therefore, regard it as an accepted canon of municipalisation, that all rate-aided undertakings are to be protected from outside rivalry and competition. Hence, local authorities having secured to themselves the right to "manufacture, purchase, hire, sell and to let" electrical plant, will next proceed to protect their business by enforcing their precious "monopoly"; or, in other words, independent company and private undertakings will have to come to an end. Surely it requires but little imagination to picture the disastrous results of this condition of affairs? Were it to operate throughout the land, in any considerable section of British industry, it would be nothing short of a national catastrophe.

The other chief aspect of municipal trading that calls for special notice is the financial basis upon which it is conducted. Municipal enterprise of this description is always in the nature of a subsidised undertaking, even where it is not a monopoly rigidly enforced by protective measures. Hence, where competition is not completely swept out of the sphere of influence of the little local demigods, their competitors must find themselves hopelessly handicapped through the special facilities the municipal traders possess for cheaper production and underselling. The security for capital offered by the majority of local government bodies is such that ample capital for municipal works can be attracted at a very low rate of interest, while the individual trader or joint-stock trading concern has to allocate a considerably larger percentage of the returns to this account. Financiers, by the way, will doubtless view with dismay the serious depreciating effect of extensive municipal trading upon the price of money, no less than the insecurity to capital itself, created by this unscrupulous competition. The normal rate of interest has steadily fallen for some time past; an era of municipal jacks-of-all-trades would probably lower the average rate to one half of its present value. Again, to revert to the main question, a local authority would always have the rates to draw upon in the event of its business showing a balance on the wrong side, whereas the ordinary trader might be ruined by such a contingency—an inequality of contest that would enable the rate-aided combatant absolutely to exterminate all rivalry by a short period of artificially depressed prices. And, in defence of the sacred rights of their municipal trading enterprises, local authorities would find ready excuse for killing off their rivals with such a weapon as this. The prospect wears no rosy hue, either for the independent trader or for the capitalist—or, *ipso facto*, for British labour.

Another new phase of municipalisation which has made its appearance recently in certain quarters, calls for notice on this occasion, as it bears upon the question of municipal trading. It used to be believed, and acted upon, that each local authority held sway over a well defined area and possessed no authority beyond that area. Even when the practice of municipalising works of various kinds came into vogue, local authorities were only permitted to conduct these undertakings within their own territories, and were debarred from encroaching upon the areas controlled by neighbouring authorities. An effort is now being made to have this barrier removed. A local authority is no longer to be a well-defined body, but is to become a nebulous thing capable of indefinite expansion and intermixture with similar nebulæ; at least, this will be the condition of affairs if Parliament should sanction the application for removal of existing restrictions to carrying on works beyond the normal area. Thus a town tramway system may reach out beyond the municipal boundaries and become a network of interurban lines, and, growing still more important, may ultimately assume the dimensions of an extensive system of railways, having no sort of natural relationship with the local authority controlling it. Endless complications must inevitably arise from the exercise of such powers. For example, Bradford may construct a municipal light railway to Leeds, and Leeds may want it extended to Harrogate, and Harrogate to Hull; and thus a through line from, say, Liverpool to Hull may eventually arise, with a through service of electric cars, similar to the interurban system of American traction companies. Whether this entire system be worked entirely by the Bradford Corporation, or whether each section be worked by separate authorities, the situation would be anomalous and absolutely "impossible." The same criticism applies to local authorities acquiring power to supply electric current, or to sell their municipal-made binding screws in the districts of other authorities. The movement would be confusion growing ever worse confounded.

In view of the extensive action of local authorities in this matter, as indicated by the great number of new notices embodying the clause set out at the commencement of this article, the Electrical Section of the London Chamber of Commerce, at a meeting presided over by Mr. Sidney Morse, recently decided to recommend joint action on the part of all similar organisations throughout the United Kingdom. We profoundly trust that, whether by this means, or in some other effective manner, the representatives of British trade and industry will succeed in stemming the destructive flood of socialism of which the above clause is but one of many indications.

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REVIEWS.

Algebra Made Easy. Being a clear explanation of the Mathematical Formulæ found in Prof. Thompson's "Dynamo-Electric Machinery" and "Polyphase Electric Currents." By EDWIN J. HOUSTON and ARTHUR E. KENNELLY. (London: Swan Sonnenschein and Co. 1898.

The title appearing on the cover of this 100-page book is certainly misleading, and it is necessary to refer to the subtitle on the front page to ascertain the scope of the publication. An attempt is made to explain within these narrow limits, to a student who has not had the advantage of a school training in algebra, the meaning of the mathematical formulæ in Prof. Thompson's two books. "To handle and manipulate algebraic expressions, to solve equations and reduce them to their simplest forms, is," we are told in the introductory chapter, "an art attained only by study and practice, and with which the following pages do not deal. It has no essential part in the understanding of mathematical expressions." If any class of student attaches value to "understanding" mathematical expressions in this way, he will find the means to acquire this "Algebra Made Easy" in the book before us. Commencing on p. 5 with a definition of the common algebraical symbols, in 38 small pages of large type, he is brought to the end of a chapter on "Equations and Their Solutions." After a chapter on logarithms, "Trigonometry" is dealt with from pp. 56 to 71, and in 24 more pages differential and integral calculus is disposed of. It is hard to imagine that any reader could be benefited by a book of this sort, and it would be interesting to know whether Prof Thompson would not think it an "unnecessary or superfluous appendage" to his books. The last words in commas are quoted from the following passage in the introductory chapter, a passage hardly, we think, suited to the comprehension of a reader whose education has not been pushed far enough to include the simplest laws of algebra :—

> This symbolic language, which so largely pervades scientific technology, is the natural and beautiful language of exact quantitative expression. It is essentially a simple language, shorn, by long and wearisome evolution, of almost every vestige of unnecessary or superfluous appendage, and which, when properly enunciated, carries a meaning to the student as clear and perspicuous as its expression is brief and direct.

The Interpretation of Mathematical Formulæ.—By EDWIN J. HOUSTON and ARTHUR E. KENNELLY. (London: Swan Sonnenschein and Co. 1898.)

This book has a similar object to the above, but, not confining itself to those mathematical formulæ only which are used in Prof. Thompson's books, it has assumed about twice the size of "Algebra Made Easy." It does not stop short at integral calculus, but also deals with hyperbolic functions and determinants. The authors ingenuously remark in their preface :—"The authors, of course, do not claim, however, that those who have read this book thereby become expert mathematicians."

Specification. A Quarterly, No. 2, 1898. (London: The Proprietors of *The Builders' Journal and Architectural Record.*)

The chief characteristics distinguishing the second number of this quarterly from the first are a stiffer binding and substantial additions of matter bringing the book up to nearly double its former thickness. The section "Electrician" has been added to by the inclusion of short subsections on telephones, electric lifts and lightning conductors. Though there is much useful information to be gleaned out of this section by those already experienced, it is on the whole somewhat loosely and inaccurately written, and the hope we expressed in our notice of the first number has certainly not yet been adequately fulfilled as regards the revision of the electrical sections and the "Glossary of Terms." This latter still contains some highly interesting definitions. Under "Electric Bells" we learn that fuses are used in bell systems and "should be replaced once a year if not 'blown' (burnt by excess of current)." It is only fair to state that in spite of inaccuracies there is a mass of information regarding precedents and practice, which should prove of great assistance to engineers and architects capable of exercising due discrimination with their use of the suggestions and information given.

The Telephone System of the British Post Office. A Practical Handbook. By T. E. HERBERT. (London: Page and Pratt, Limited) 1898.)

This is a good and accurate technical description of the telephone systems employed by the Post Office in this country, preceded by a few chapters on first principles and on apparatus generally, and followed by a brief sketch of the methods of switching used by the National Telephone Co. The part descriptive of the Post Office system appears to have been brought completely up to date, and possibly we have no right to be disappointed that a forecast is not included in the shape of a detailed description of the methods of junction-transfer switching which are being introduced at the central trunk exchange in London. The volume will no doubt be found useful to the engineering staff both of the Post Office and of the National Telephone Co., and can be confidently recommended to them, although we do not expect the latter, or any of the London telephoning public, to credit the statement on p. 18, to the effect that the Ader receiver is but little used in England. The diagrams are not up to the usual standard of those in technical treatises, but probably an improvement in this respect and in the printing and paper would have considerably increased the cost of the publication. An alphabetical index would have been of use, and should not have been omitted.

ELECTROMAGNETIC THEORY.—CXI.*

BY OLIVER HEAVISIDE.

(Concluded from page 185.)

§ 447. So far O. P. M., Part 3. I regret that the condensation should tend to reduce it to the dry bones of mere formulæ. The original will not be published in Another Place before it is wanted. In the meantime I have only space left here for a few notes in connection with the preceding. They may be useful to investigators, as there are plenty of nuts to crack.

The formula (219) may be written

$$\frac{\pi}{\sin r\pi} = \sum \pm \frac{x^r}{r} = u. \tag{253}$$

The companion formula is

$$\pi \cot r\pi \pm \lambda = \sum \frac{x^r}{r} = v, \tag{254}$$

and possesses several points of interest. Just as u comes from the generalised ϵ^z, so does v come from the generalised ϵ^{-z}. Thus,

$$\epsilon^{\Delta}1 = \sum \frac{\Delta^r}{\lfloor r}1 = \sum \frac{x^{-r}}{\lfloor r \lfloor -r} = \sum \frac{x^r}{r}\frac{\sin r\pi}{\pi}, \tag{255}$$

$$\epsilon^{-\Delta}1 \,||\, \sum \frac{\Delta^r}{\lfloor r}\frac{1}{\cos r\pi} \,||\, \sum \frac{x^r}{r}\frac{\tan r\pi}{\pi}. \tag{256}$$

Now (254) is exact when $x=1$, without λ. But when x is not 1, the functions u and v differ in behaviour. The first is continuous through $x=1$, the second is discontinuous. That is, there is a jump up through the amount λ when x is just above 1, and a jump down to the same extent when x is just below 1, λ being about 1·895, as found below. Why there should be a discontinuity in v, though not in u, at $x=1$, may be understood by considering that $\epsilon^{\Delta}\Delta 1$ is an impulse at $x=-1$, and $\epsilon^{-\Delta}\Delta 1$ an impulse at $x=+1$. So in the latter case integration produces a jump.

Or we may differentiate v to x. We get $0=\sum x^r$. This means that $\sum x^r$ is an impulsive function. It is ∞ at $x=1$. Note also that in the theory of convergent functions the expression $\sum z^r$, z being complex, plays the part of an impulsive function at the point $z=1$, although, of course, function-theorists would not, I think, admit that it had, by itself, any particular meaning.

By differentiation to r, the v formula makes

$$-\frac{\pi^2}{\sin^2 r\pi} = (\pi \cot r\pi \pm \lambda)\log x - \sum \frac{x^r}{r^2}, \tag{257}$$

* This series of Articles is a portion of Vol. II. Mr. Heaviside's work on "Electromagnetic Theory." All rights of reproduction are reserved.

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and other formulæ may be derived. Perhaps the most interesting particular case of v is when $r=0$. Then there is an infinite term $x^s/0$ on the right side of (254). Deduct it from the left side. The result is

$$-\log x \pm \lambda = x + \tfrac{1}{2}x^2 + \tfrac{1}{3}x^3 + \ldots - x^{-1} - \tfrac{1}{2}x^{-2} - \ldots. \quad (258)$$

Remembering the potency of λ, this leads to

$$w = x + \tfrac{1}{2}x^2 + \tfrac{1}{3}x^{-3} + \ldots = \lambda - \log(x-1), \quad (x>1), \quad (259)$$

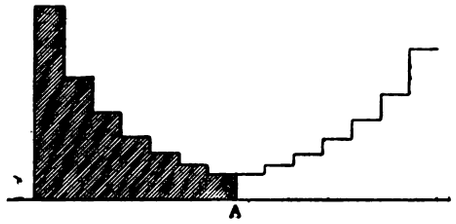
$$\text{or} = -\log(1-x), \quad (x<1). \quad (260)$$

This w function is infinite at $x=1$; beyond that it changes from $-\log(1-x)$ to $\log \mu(x-1)$, $^{-1}$ where μ is a constant (about 6·653). It is then continuously divergent. When x is <-1 it is alternatingly divergent.

To show λ by itself, we have

$$\pm\lambda = 2(x + \tfrac{1}{3}x^3 + \tfrac{1}{5}x^5 + \ldots - x^{-1} - \tfrac{1}{3}x^{-3} - \tfrac{1}{5}x^{-5} - \ldots). \quad (261)$$

Numerical examination of various cases of the cot and log formula all lead to about the same value of λ when done roughly, usually from 1·8 to 2. But to find it more closely, special care must be taken. Some of the derived formulæ are much more convergent than the primitive; but this does not help as regards close estimation of λ, because the error becomes multiplied in another way. To find λ pretty closely, I used the w formula (259), with x between 1 and 2. The results are very regular when attention is paid to certain points. The error, if estimated by the size of the l.c.t., would be large unless a value of x so little greater than 1 were used that the labour became prohibitive. But there are certain considerations allowing of closer work with less labour. Thus, in the series $w = x + \frac{1}{2}x^2 + \ldots$, give x a value between 1 and 2, say 1·1, such that there are two equal bottom terms. Representing the series diagrammatically thus, we have to find the



lowest point, when regarded as a continuous curve. If quite symmetrical, the lowest point would be at A, and the shaded area would represent the value of the series. But there never is symmetry, so A is not quite, though nearly, right. In this way, choosing values of x producing two equal bottom terms, excellent results are obtainable by stopping at the end of the first of the two.

But if x is such that there is but one l.c.t., the results will be staggery if we always count the full l.c.t., or always one-half of it, &c. We should plainly count a portion only of the l.c.t. of such size as harmonises with the case of two equal bottom terms. Now to get the nth term to equal the $(n+1)^{\text{th}}$ when $x = 1 + m^{-1}$, requires $n = m$. Use this rule whether m be integral or fractional. For example, if $x = 1{\cdot}8$, $n = 3\frac{1}{3}$, count three terms and $\frac{1}{3}$ of the next. Then regular results arise, as may be seen by the following:—

x	n	λ	l.c.t.
2	1	2	
1·5	2	1·932	
1·4	2·5	1·921	0·916
1·3	3·33	1·9114	0·714
1·2	5	1·9026	0·4976
1·1	10	1·8974	0·2596
1·05	20	1·8953	0·1362
1·025	40	1·89520	0·0671
1·01	100	1·89518	0·0270

Observe that very large variation in the size of the l.c.t. makes little difference in the calculated value of λ, and that the last three results agree to four figures. It would seem that 1·895 is correct as far as written. But what it means (in terms of π or other constants) I do not know.

In the algebraical theory λ would not be a real constant, but an indeterminate imaginary. Thus

$$\text{if} \quad y = x - \tfrac{1}{2}x^2 + \tfrac{1}{3}x^3 - \ldots, \quad \text{then} \quad \epsilon^y = 1 + x \quad (262)$$

is an identity, or $y = \log(1+x)$. This can be interpreted for any value of x, by using $\epsilon^{in\pi} = -1$, n being an odd number; or $\log(-1) = in\pi$. In accordance with this, $w = -\log(1-x)$ for any value of x, which makes the superinfinite w (when $x>1$) be complex to suit the algebra, whereas the divergent series w is real.

There is a similar conflict in the cot formula. By squaring the series u and v, it can be shown that

$$u^2_r = \pi \cot r\pi (v_r - v_{r+\frac{1}{2}}), \quad (263)$$

$$v^2_r = \pi \cot r\pi (v_r + v_{r+\frac{1}{2}}). \quad (264)$$

The formula for u is satisfied, but that for v, containing λ, will not do. If, however, we put $\lambda = \pm i\pi$, then we harmonise the algebra at the expense of making the series v be complex when x is real.

The generalised ϵ^x and ϵ^{-x} formulæ show a conflict also. Thus, by squaring,

$$\left(\Sigma \frac{x^r}{\lfloor r}\right)^2 = \Sigma x^{2r}\left(\frac{1}{\lfloor r \lfloor r} + \frac{2}{\lfloor r+1 \lfloor r-1} + \frac{2}{\lfloor r+2 \lfloor r-2} + \ldots\right)$$
$$+ \Sigma x^{2r+1}\left(\frac{2}{\lfloor r \lfloor r+1} + \frac{2}{\lfloor r-1 \lfloor r+2} + \ldots\right)$$
$$= \Sigma \frac{x^{2r}2^{2r}}{\lfloor 2r} + \Sigma \frac{x^{2r+1}2^{2r+1}}{\lfloor 2r+1} = \Sigma \frac{(2x)^r}{\lfloor r}; \quad (265)$$

i.e., $(\epsilon^x)^2 = \epsilon^{2x}$, with the generalised series. In a similar manner, we can show that

$$\left(\Sigma \pm \frac{x^r}{\lfloor r}\right)^2 = \Sigma \pm \frac{(2x)^r}{\lfloor r}. \quad (266)$$

This would be satisfied by $\epsilon^{-x} = \Sigma \pm x^r g(r)$. But it is not true, save when x is integral. The effective meaning of the series is not ϵ^{-x}, but $\epsilon^{-x}\cos r\pi$. I do not explain, but take things as I find them.

The w series above runs up to ∞ at $x=1$, and then runs down again on the other side, with a constant multiplier introduced. But there is not necessarily a change of this kind in passing through infinity. For instance,

$$U = 1 + \tfrac{1}{2}x(1 + \tfrac{3}{4}x(1 + \tfrac{5}{6}x(1 + \tfrac{7}{8}x(\ldots \quad (267)$$

represents $(1-x)^{-\frac{1}{2}}$ when $x<1$. It is convergent down to $x=-1$, and then alternatingly divergent and calculable. At $x=1$ it is infinite. But it is directly divergent and calculable when $x>1$, and seems to represent $(x-1)^{-\frac{1}{2}}$. Here there is conflict with the algebra of i.

But the series

$$V = 1 - \tfrac{1}{2}x(1 + \tfrac{1}{4}x(1 + \tfrac{3}{6}x(1 + \tfrac{5}{8}x(\ldots, \quad (268)$$

which represents $(1-x)^{\frac{1}{2}}$, and is alternatingly divergent when $x<-1$, passes through zero when $x=1$, and then becomes directly divergent. Considered as a function satisfying a differential equation, we should say it then represents $c(x-1)^{\frac{1}{2}}$ where c is a real constant. But c is not 1, as in the last case, but is $-\frac{1}{2}$, by rough calculation. The negativity can be easily explained, for $V = (1-x)U$ by algebra, and when U is $(x-1)^{-\frac{1}{2}}$, V is negative. A reason can also be given why the algebraical relation $V = (1-x)U$ is numerically violated. For though U and xU have the same point of convergence when $x>1$, yet when they are united to make the V series, the point of convergence is shifted to quite another place. But I do not see why the factor should be $\frac{1}{2}$, if that be the true value. It is remarkable that the divergent Bessel functions should be more understandable, both algebraically and numerically, than elementary cases of Newton's binomial theorem.

§ 448. The following electrical method of constructing formulæ for comparison is worthy of attention. If two electrical combinations whose resistance operators are Z_1 and Z_2 be put in sequence, and an impressed voltage e act at their junction, the current there is $C = e(Z_1 + Z_2)^{-1}$, and the voltage on the Z_2 side is

$$V = Z_2 C = \frac{e}{1 + Z_1/Z_2}. \quad (269)$$

Taking various forms of Z_1 and Z_2 we may obtain interesting results by different ways of algebrisation. For instance, there are two ways of expansion of the operator $(1 + Z_1/Z_2)^{-1}$ by division. That either of the series of operations should give V correctly is remarkable. It will do so if the result is

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convergent. That the other way should give an equivalent result is much more remarkable. This occurs sometimes. But it usually happens that the divergent result is not the full equivalent of the convergent result. Interesting generalised series connect them.

Say $Z_1/Z_2 = ap^{\frac{1}{2}}$, and $e=1$, starting at $t=0$. Denote the convergent result by u, and the divergent by v. Then

$$u = a^{-1}p^{-\frac{1}{2}} - a^{-2}p^{-1} + a^{-3}p^{-1\frac{1}{2}} - a^{-4}p^{-2} + \ldots$$
$$= \left(\frac{t^{\frac{1}{2}}}{a\lfloor\frac{1}{2}} + \frac{t^{\frac{3}{2}}}{a^3\lfloor\frac{3}{2}} + \ldots\right) - \left(\frac{t}{a^2\lfloor 1} + \frac{t^2}{a^4\lfloor 2} + \ldots\right). \quad (270)$$

This satisfies (269), and is right initially, and is convergent. It is not immediately evident what V rises to finally, though we know it should be 1. The other way makes

$$v = 1 - ap^{\frac{1}{2}} + a^2p - a^3p^{1\frac{1}{2}} + a^4p^2 - \ldots$$
$$= 1 - \left(\frac{at^{-\frac{1}{2}}}{\lfloor -\frac{1}{2}} + \frac{a^3t^{-1\frac{1}{2}}}{\lfloor -1\frac{1}{2}} + \ldots\right). \quad (271)$$

This also satisfies (269); it is not evident what it means initially, but it is 1 when $t=\infty$. Here u and v are equivalent when a is +. Equating them, we obtain the generalised ϵ^{t/a^2}. But u and v are not equivalent when a is −. $V=u$ is the solution then, but not $V=v$. To see this put $a=-b$ and let b be +. Then use the generalised ϵ^{t/b^2} to the first part of u. Let u become w. It is

$$w = 1 - 2\epsilon^{t/b^2} + \left(\frac{bt^{-\frac{1}{2}}}{\lfloor -\frac{1}{2}} + \frac{b^3t^{-1\frac{1}{2}}}{\lfloor -1\frac{1}{2}} + \ldots\right). \quad (272)$$

This is the solution when a is negative. Comparing with v, we see that in passing from positive to negative a, the extra term $-2\epsilon^{t/a^2}$ is added.

The electrical interpretation is interesting. *See* § 242. Let a cable (having resistance and permittance only) of infinite length be earthed at $x=0$ through a resistance, and e be inserted there. Then u or v show the rise of V at the beginning of the cable from 0 to 1, when the terminal resistance is positive, and u or w show the rise of V from 0 to $-\infty$ when the resistance is negative. When a is reduced to zero, the rise from 0 to 1 takes place instantly. When b positive is reduced to zero, the rise from 0 to $-\infty$ takes place instantly. That is, if we had a negative resistance, even of infinitesimal amount, the finite voltage e would generate an infinite voltage instantly under the circumstances stated.

As a second case, let $Z_1/Z_2 = ap^{-\frac{1}{2}}$. Then

$$u = 1 - ap^{-\frac{1}{2}} + a^2p^{-1} - a^3p^{-1\frac{1}{2}} + \ldots$$
$$= \epsilon^{a^2t} - \left(\frac{at^{\frac{1}{2}}}{\lfloor\frac{1}{2}} + \frac{a^3t^{1\frac{1}{2}}}{\lfloor 1\frac{1}{2}} + \ldots\right), \quad (273)$$

$$v = a^{-1}p^{\frac{1}{2}} - a^{-2}p + a^{-3}p^{1\frac{1}{2}} - a^{-4}p^2 + \ldots$$
$$= \frac{1}{at^{\frac{1}{2}}\lfloor -\frac{1}{2}} + \frac{1}{a^3t^{1\frac{1}{2}}\lfloor -1\frac{1}{2}} + \ldots. \quad (274)$$

Here u and v are equivalent again when a is +, as we see by equating them. V falls from 1 to 0. But when a is $-b$, and b is +, the result is

$$w = 2\epsilon^{b^2t} - \left(\frac{1}{bt^{\frac{1}{2}}\lfloor -\frac{1}{2}} + \ldots\right). \quad (275)$$

This comes from u by the generalised exponential. V now rises from 1 to ∞. It is a terminal condenser, instead of a resistance, that is concerned. *See* § 248.

Thirdly, let $Z_1/Z_2 = ap^{1\frac{1}{2}}$. Then

$$u = a^{-1}p^{-1\frac{1}{2}} - a^{-2}p^{-3} + a^{-3}p^{-4\frac{1}{2}} - a^{-4}p^{-6} + \ldots \quad (276)$$

is the convergent solution, true whether a is + or −. But the other result dividing the other way, viz.,

$$v = 1 - ap^{1\frac{1}{2}} + a^2p^3 - a^3p^{4\frac{1}{2}} + a^4p^6 - \ldots, \quad (277)$$

is not equivalent to u whether a be + or −. The reason is this. Let

$$X = \ldots + 1 + bp^{1\frac{1}{2}} + b^2p^3 + b^3p^{4\frac{1}{2}} + \ldots, \quad (278)$$

the series being complete both ways. What is its value? Now

$$2\epsilon^t = \ldots + 1 + p^{\frac{1}{2}} + p + p^{1\frac{1}{2}} + \ldots, \quad (279)$$

and I find that the sum of every third term beginning anywhere equals $\frac{1}{3}$ of the total. Therefore $X = \frac{2}{3}\epsilon^{t/c}$, if $c = b^{\frac{1}{2}}$, and b is +, and the equivalent solutions are

$$u = -(b^{-1}p^{-1\frac{1}{2}} + b^{-2}p^{-3} + b^{-3}p^{-4\frac{1}{2}} + \ldots), \quad (280)$$

$$w = -\tfrac{2}{3}\epsilon^{t/c} + 1 + bp^{1\frac{1}{2}} + b^2p^{4\frac{1}{2}} + \ldots, \quad (281)$$

when b is +. Here by p^{-n} is to be understood $t^n/\lfloor n$, to save useless work.

But when a is +,

$$u = (a^{-1}p^{-1\frac{1}{2}} + a^{-3}p^{-4\frac{1}{2}} + \ldots) - (a^{-2}p^{-3} + a^{-4}p^{-6} + \ldots) \quad (282)$$
$$= \tfrac{2}{3}\epsilon^{t/c} - (1 + ap^{1\frac{1}{2}} + a^3p^{4\frac{1}{2}} + \ldots) - 2(a^{-2}p^{-3} + a^{-4}p^{-6} + \ldots). \quad (283)$$

Here

$$1 + a^{-2}p^{-3} + a^{-4}p^{-6} + \ldots = \tfrac{1}{3}\{\epsilon^{t/c} + 2\epsilon^{-t/2c}\cos(t/c)(\tfrac{3}{4})^{\frac{1}{2}}\}, \quad (284)$$

so u is transformed to

$$u = w = 1 - (ap^{1\frac{1}{2}} + a^3p^{4\frac{1}{2}} + \ldots) - \tfrac{4}{3}\epsilon^{-t/2c}\cos(t/c)(\tfrac{3}{4})^{\frac{1}{2}}, \quad (285)$$

when a is +. This explains the result (86), § 244, relating to a terminal inductance.

§ 449. The above three cases illustrate the general theory, which may be just sketched here. Let

$$U = \frac{1}{1-bp^r} = -(b^{-1}p^{-r} + b^{-2}p^{-2r} + b^{-3}p^{-3r} + \ldots). \quad (286)$$

This is the convergent solution when r is +. It is not necessary to consider r to be −, because the theory is quite similar. To transform U to the equivalent W when b is +, let

$$X = \ldots + 1 + bp^r + b^2p^{2r} + b^3p^{3r} + \ldots, \quad (287)$$

the series to be complete. Then

$$W = -X + 1 + bp^r + b^2p^{2r} + b^3p^{3r} + \ldots \quad (288)$$

is the required result.

When r is the reciprocal of any integer, say n^{-1},

$$X = \frac{1}{r}\epsilon^{t/c}, \quad (289)$$

where $c = b^{1/r}$, because of the generalised ϵ^t formula. But when b is negative, $X=0$. For when n is even, $\frac{1}{2}n$ generalised ϵ^t expressions are cancelled by the other $\frac{1}{2}n$. And when n is odd, the generalised ϵ^{-t} expression occurring n times equally annihilates the result. Thus, $n=5$, omitting the constant,

$$X = \epsilon^{-t}(1 - \cos\tfrac{1}{5}\pi + \cos\tfrac{2}{5}\pi - \cos\tfrac{3}{5}\pi + \cos\tfrac{4}{5}\pi) = 0. \quad (290)$$

It follows that in the physical case, when a is +, both the solutions, convergent and divergent, are obtained by division, as in the cases $r=\frac{1}{2}$ and $-\frac{1}{2}$ given above, whilst when a is −, there is an extra term, − X. In any case the matter is resolved into the evaluation of X. Putting $c=1$ for ease,

$$X = \ldots + 1 + p^r + p^{2r} + \ldots = r^{-1}\epsilon^t \quad (291)$$

is not only true for $r=1$, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, &c.; but also for their doubles, except when it makes $r=2$. The generalised ϵ^{-t} formula shows the validity of this doubling. But when r is an integer, then

$$X = 1 + p^{-n} + p^{-2n} + \ldots = n^{-1}(\epsilon^t + \epsilon^{ct} + \epsilon^{c^2t} + \ldots), \quad (292)$$

where 1, c, c^2, &c., are the $n\,n^{th}$ roots of 1. So $X = r^{-1}\epsilon^t$ is not true for r integral, save 1, and there may be special peculiarities when $r>1$ and fractional, though it is true when $r=1\frac{1}{2}$. But continuity would seem to show that it is true from $r=0$ to $r=1$ generally. The following refers to $r=m/n$, m being a smaller integer than n. A special case will be easier to follow. Say $r=\frac{4}{5}$, then

$$X = (1 + p^{\frac{1}{5}} + p^{\frac{2}{5}} + p^{\frac{3}{5}} + p^{\frac{4}{5}})\ (\ldots + 1 + p^4 + p^8 + \ldots)$$
$$= (1 + p^{\frac{1}{5}} + p^{\frac{2}{5}} + p^{\frac{3}{5}} + p^{\frac{4}{5}})\tfrac{1}{4}(\epsilon^t + \epsilon^{it} + \epsilon^{-t} + \epsilon^{-it}). \quad (293)$$

Here $p^r\epsilon^t = \epsilon^t$; $p^r\epsilon^{-t} = \epsilon^{-t}\cos r\pi$, $p^r\cos t = \cos(t + \frac{1}{2}r\pi)$, (294)

so we get X = sum of five correct real formulæ, and this sum comes to $\frac{5}{4}\epsilon^t$, as required.

If imaginary parts cancel one another at the end, the imaginary may be employed throughout. Thus, $r=\frac{3}{4}$.

$$X = (1 + p^{\frac{1}{4}} + p^{\frac{2}{4}} + p^{\frac{3}{4}})\,(\ldots + 1 + p^3 + p^6 + \ldots)$$
$$= (1 + p^{\frac{3}{4}} + p^{\frac{2}{4}} + p^{\frac{1}{4}})\,\tfrac{1}{3}\,(\epsilon^t + \epsilon^{ct} + \epsilon^{c^2t}), \quad (295)$$

where $c = i^{1\frac{1}{2}}$. Now take $p^r\epsilon^{ct} = c^r\epsilon^{ct}$. Then

$$X = \tfrac{4}{3}\epsilon^t + \tfrac{1}{3}(1 + i + i^2 + i^3)\epsilon^{ct} + \tfrac{1}{3}(1 + i^2 + i^4 + i^6)\epsilon^{c^2t}, \quad (296)$$

which is $\frac{4}{3}\epsilon^t$, as required. Numerical results are good. This process goes when $r=m/n$. But the individual results, when complex, are not true. *E.g.*, $p^r\epsilon^{i^2t}$ is not $i^{2r}\epsilon^{-t}$, but only the real part thereof. There is more to be said on this subject, and I have no doubt a good deal more will be said when proper mathematicians will thoroughly explore divergent series for physical purposes. But this volume is now full up.

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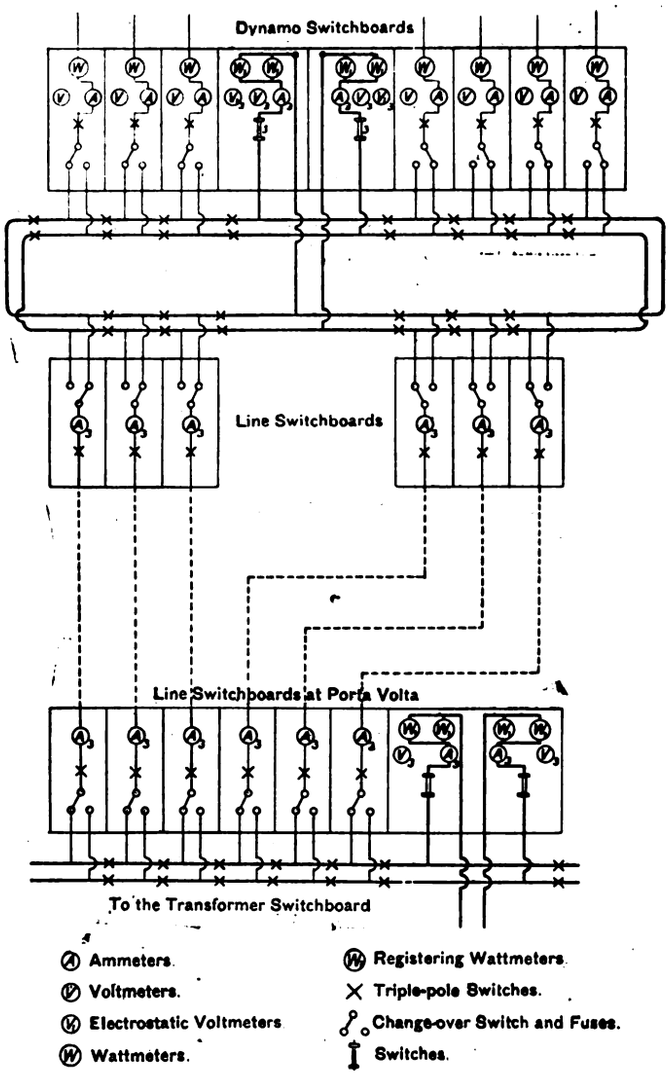
THE WATER-POWER INSTALLATION AT PADERNO.*

BY G. SEMENZA.

(TRANSLATED BY JOHN R. DICK, B.SC.)

(*Concluded from page 365.*)

One of the most remarkable parts of the plant is the switchboards. The great importance given to switchboards is of quite recent date, and arises from the latest experience in materials. In the first stations where large currents at high pressure were used, no greater importance was given to the switchboards than to those for ordinary lighting stations. But the numerous difficulties that arose gradually proved that in such installations the switchboards represent one of the most delicate parts of the whole plant. Consequently they ought



Arrangements of the Switchboards for the Electrical Transmission from Paderno to Milan.

to be designed very carefully, without sparing expense, and provided with plenty of room. The switchboard at Paderno, built on these lines, has an area of about 17 sq. ft., and is fixed in a large opening in the middle of the wall of the dynamo room. The dynamo instruments are placed on a gallery 9ft. 6in. above the floor, while those for the line are placed on the other side of the switchboard room. The dynamo switchboard is divided into nine panels, of which seven belong to the seven alternators, while the other two are used for the 'bus bars and are fixed in the centre of the board.

Each of the panels of the dynamo board carries the following apparatus and instruments:—one double-pole high-tension switch, three fuses, one change-over switch, one regulator for the exciting current, one regular for the exciter field, one switchboard transformer, one volt meter, one ammeter, one watt meter for the alternating current, one ammeter for the exciting current, one voltmeter and synchronising lamp.

These are more or less the apparatus and instruments which are found on all the panels; some, however, merit special notice. With regard to the switch, it may be remarked that all currents at a low voltage can be broken without difficulty because the pressure is not sufficient to maintain an arc when the two contacts of the switch are at a little distance from each other. Small currents at very high voltages can also be broken without special apparatus, because up to a certain limit they lack the necessary energy to overcome the resistance of the air. But when both pressure and current are large the case is different. With 8,500 volts and 150 amperes one gets an arc which may exceed 8ft. in length, and with 8,000 volts and 80 amperes an arc which exceeds 5ft. When those enormous arcs are developed between two parts of a switchboard, they are carried upwards by the action of the hot air, and pass through any conductors they may encounter, melting metals, smashing insulators and burning wood and rubber.

The length an arc may assume depends, first of all, on the nature of the dielectric in which it occurs. It depends, in the second place, on the material of which the electrodes are composed; thus, if the electrodes are of copper we get a much longer arc than if they are of carbon, because the copper vapour, which volatilises and burns, forms a path of higher conductivity than that formed from particles of carbon. And here we find an explanation of the efficacy of quick break switches. With a quick break switch of the type of the General Electric Co. a current of 70 amperes at 3,600 volts is easily broken, but if it is done slowly with the same switch the arc cannot be extinguished, because, with the increase in rapidity of movement, the formation of copper vapour is rendered much less. The principle of a quick break in oil is employed in the construction of the high-pressure switches at Paderno.

Safety fuses present an analogous problem, but, fortunately, the solution is very safe and simple. The fuses made by the firm of Brown-Boveri and Co. have given such a perfect action at 5,000 volts as to justify considerable confidence in their action at higher pressures. The fuse wire is stretched out in an open tube of composition or of porcelain. When the fuse goes the arc thus formed instantaneously expands the air contained in the tube, and causes a kind of explosion which extinguishes the arc. On the left of the board there is a change-over switch, whose object we will now describe. The whole of the installation, commencing with the switchboards of Paderno going step by step to Porta Volta and Santa Radegonda, has been designed so that there may always be the possibility of splitting up the supply into two distinct parts. The 'bus bars are are in duplicate, and each dynamo may be connected up to either of the two.

Thus the lines, as well as the transformers at Milan, the dynamos at Porta Volta, &c., can be separated from each other. This has been designed so as to keep the two supplies distinct, should one supply have special requirements, or be a source of disturbance to the other. Our own experience and that of others on the supplying in parallel of motors, lighting and traction leads us to believe that such separation would be unnecessary. In any case, however, the measure is prudent and will render the supply more secure.

The wattmeter on the switchboard of each dynamo was introduced more with the idea of giving a true relative indication of the load of each alternator than to give an absolute reading, because when several alternators are running in parallel, the ammeters give very little indication of the true load on the machines, this being affected by the difference of phase. The electrostatic voltmeters placed on the main switchboard measure the pressure at Milan. Three pilot wires are fixed on the posts under the principal conductors, and connect the voltmeters directly with the secondary circuit at 150 volts placed in the station of Porta Volta. These are of very great importance because it is according to their readings that the pressure at the station is regulated.

* Lecture given before the Milan section of the Associazione Elettrotecnica Italiana

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Behind the row of dynamo switchboards are fixed the line switchboards. The lines are six in number, and each one has its own switchboard with change over switch, fuses and ammeters. All the switchboards are in general accessible where possible; each section may be completely separated from the others which are live, so that a man can work on them or clean them with perfect safety. They are all made of iron, porcelain and marble, and no combustible material is employed. The connections are all made of rigid bars and the *tout ensemble* is symmetrical, simple and mechanical.

The lines run from the switchboards into a room above where the lightning arresters are placed; from thence they pass through suitable openings placed in the back wall of the room to the first post. As we have already said, the number of wires in the line will be 18. A high-tension line of this description intended for an important public supply, like that of Milan, had to be designed with special care and precautions to avoid breakdowns; it was not only necessary to have the line well made, but to have a line which could be repaired without interrupting the supply. From the station of Paderno and that of Porto Volta runs a double row of posts; each row carries nine wires, and is at a distance of 6ft. 6in. from the other. When it is necessary, from any reason whatsoever, to work on one of the lines, the whole of the section to which it belongs can be cut out of circuit, and the supply carried by the other half alone. At times of heavy load in such cases there will be a greater drop of pressure, but this has been provided for by the possibility of increasing the pressure of the alternators to 15,000 volts.

In the early alternate-current installations the line was one of the chief sources of failure, and that because not even a remote idea was entertained of the importance of the effects of mutual and self-induction. It is curious that although academically the case had been worked out some time before, yet among the lines proposed by the different manufacturing firms there were solutions perfectly diverse and contradictory. Now all this part is well enough known, so that it is possible to proceed with perfect safety. It is recognised that, in order to have a weak, small inductance, the wires must be of small diameter and far apart, necessitating, in the case of heavy currents, a considerable number of wires. Then there is another very important point, and that is, when the wires are numerous they must be arranged in such a manner that the effects of induction are equal on all. If not, there will be a tendency to produce idle currents between the wires belonging to the same branch of the system.

The theoretically perfect arrangement of a number of conductors carrying three-phase currents would be that in which each conductor was placed in the same condition of induction with respect to the others. A cross-section of the arrangement would show all the wires placed at equal distances on a circle. This form of grouping the conductors, although possible to realise, is not very practical, especially if the number of wires is great. The form which, after the circle, gives the smallest mutual induction between the different wires of the same branch is that represented in the figure, in which the wires are arranged in the form of a triangle. This is the arrangement actually adopted on the Paderno line. The wires are 0·354in. diameter, and the distance between the nearest is 2ft. They are of electrolytic copper of 98 per cent. conductivity, and are fixed up in such a way as to have, with a span of 197ft., a dip which varies from 2ft. in the hardest winter to 4ft. in the hottest summer.

In lines for alternating current it is necessary to consider the loss of energy as well as the drop of pressure. The loss of energy is the product of the resistance by the square of the current, and will be about 9 per cent. at full load when the power factor is 80 per cent. The expression for the drop of pressure is somewhat more complex. The special case was studied by the late Prof. Ferraris, and the resulting calculation is of the highest interest. In this calculation the branch of the three-phase system to which each wire belongs must be taken into account, because the effect of mutual induction is a function of the positions of all the nine wires, the relative distances, and the currents which flow through them. The drop of pressure is a function of this coefficient of mutual induction, the ohmic resistance of the wire, the current, and lastly the difference of phase caused by an inductive load. All these quantities properly combined give as a result the drop of pressure which in our case is about 12·5 per cent., while the loss of energy is only 9 per cent.

This is one of the first lines in which entirely metallic masts are used. Although the fall of one wire or the breaking of an insulator may cause a dead earth, their mechanical superiority is undoubtedly of great value. Besides, it is not at all easy to find wooden posts of sufficient length, and the construction of mixed posts is not a satisfactory solution; hence, it was preferable to take greater care in the design of the insulators, and to employ posts entirely of iron. The post is made of light lattice work. Each post weighs about 9cwt., and is embedded in a mass of concrete. Where there are curves along the route two posts are joined together to form a St. Andrew's cross. The insulator carrier is very strong, and has a light steel spindle in order to prevent the accumulation of snow. Under the conditions to which our line is subject, the insulator is a detail of the highest importance, and is of special design. There are two types which seem to meet the requirements of the case—the one the American bell type, which has an internal core of glass or hard porcelain; the other the multiple umbrella type, made entirely of porcelain.

The idea of the American type is, by means of the glass or hard porcelain part, to offer a high resistance to perforation by electrical discharges, while the external portion of enamelled porcelain presents a long path for surface leakage and for direct discharges through the air. In the multiple umbrella type the first object is accomplished by increasing the thickness of the porcelain in proximity to the head, the second by the large development of the leakage surface. The available experience in materials not being very extensive, it was decided to use one of the types on one line and the other on the other, Both are constructed by the Societa Ceramica Richard-Ginori. The line does not follow the same route as the roads, but crosses the country in a direction very nearly that of a straight line, and the angles which it makes, either to avoid houses or other obstacles, do not in any case exceed 8deg. or 4deg. Larger angles are used for crossing the railway lines and water courses, and also where it enters Milan. If it had followed the roads the work of inspection would have been easier, but it would have increased the angles and lengthened the route.

The Edison Company pays the proprietor a price per yard of route which covers the wayleave for wires and posts, the repairs of damages during erection in a strip of land 10ft. wide, and the damages incurred in inspecting and repairing the line during a period of 30 years. The Edison Company, in return, possesses the right to pass along this strip of land with vehicles and carts as often as may be necessary. The work of inspection is thus quite an easy matter.

One of the most delicate points in connection with high-tension lines is the protection against atmospheric discharges. I shall endeavour now to give a *résumé* of the points on which common knowledge is agreed with regard to this question, premising that it deals rather with hypothesis and assumptions than with ascertained facts, and that, accordingly, I shall use language which is empirical rather than scientific.

It appears that the lightning discharges affect the line chiefly in the three following ways:—(1) The discharge between a cloud and the earth may pass through a greater or less length of the wires; (2) A discharge between two clouds may induce a disturbance in the wires; (3) A cloud overhanging the wires may induce a charge at a high potential in them.

In the first case the charge may or may not be oscillatory. In the second and third, the general opinion is that it is always oscillatory. Whether it is so or not is of the very highest importance, because its nature and effects are completely different in the two cases. Any discharge, whether oscillatory or not, always encounters an impedance in the conductors of a greater amount than the mere ohmic resistance, but if the discharge has the form of a single flow of energy it will encounter a diminishing impedance in the con-

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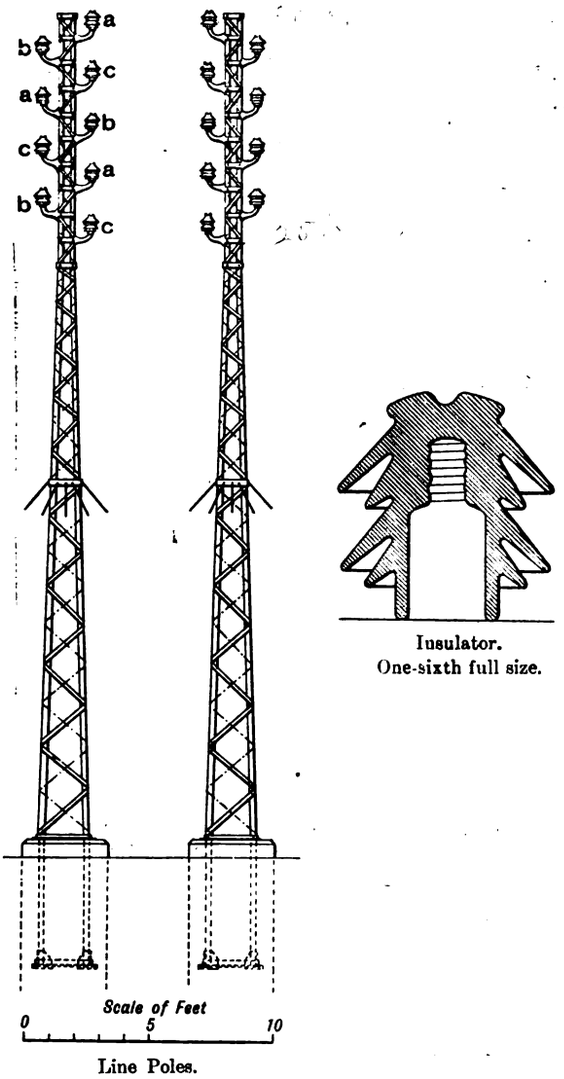
ductor, and after a few instants it will flow like an ordinary current. In the case, however, where it is oscillatory, with a frequency of, perhaps, millions of cycles per second, the ohmic resistance becomes a negligible quantity in comparison with the enormous inductance which the circuit presents. The result is that an oscillating discharge, rather than flow along a single turn of copper wire, will jump across an air-gap of several inches, because the impedance of one turn of wire is such that the difference of potential at its extremities may reach very high values. It is obvious at once that the effects of the two kinds of discharge will be distinctly different. A discharge striking the wire, and which is not oscillatory, will tend to follow the line until it comes to a point where the insulation to earth is weak. If this point is an air space there will be a spark; if it is an insulator the latter will be perforated. An oscillatory discharge, on the other hand, will seek the least inductive path to earth, and will jump over



Line Poles.

Insulator.
One-sixth full size.

large air spaces rather than pass through a long wire or a coil.

Sometimes, during thunderstorms, lightning discharges will jump directly to earth through strata of air four or five yards in thickness rather than follow the wires to their extremities, where air spaces of only a few inches will be found.

Generally speaking, then, it is not difficult to prevent the discharge from reaching the machines and transformers, especially if it is oscillatory. The chief trouble arises afterwards. It nearly always happens that the different wires of the line are struck simultaneously, and the two sparks, the lightning conductors and the earth form a shunt between the two wires of very low resistance. Then a short circuit takes place on the whole of the plant, which even if it lasts only a short time, may damage the machinery very seriously. It is clear that a short-circuit to earth through the lightning arresters is produced much more easily the higher the working pressure and power of the plant.

Telegraphic and telephonic lines are sufficiently protected by simple comb arresters, because the 100 or 200 volts, to which the pressure may possibly rise, is incapable of producing an arc across an air-gap of a few millimetres. The protection of a high-pressure line is a very difficult matter, and that explains how certain safety devices have succeeded in some cases and have completely failed in others.

A complete system of protection should fulfil the following requirements:—(1) To protect the line from direct discharges; (2) to prevent oscillatory discharges from jumping directly from the wires to the poles or to earth; (3) to prevent the discharges from reaching the machines; (4) to prevent the lightning arresters from forming a short circuit on the installation.

The protection of the line from direct discharges can be done with pointed rods, or better, with a group of pointed rods fixed on the poles and well connected with earth. In many cases the method was carried out of placing above the conductors a barbed wire which runs the whole length of the line and is put to earth at different points. It appears to give a negative result, however, so that now it is no longer used, at least in Europe. It may be said that while it protects against direct discharges, it does not protect from secondary effects, and hence it was discarded.

Electrical oscillations, like the harmonic vibrations of a stretched string, assume the form of nodes and ventral segments, and in order that a lightning conductor may act, it must be fixed on the line near one of the nodes, but where these may occur from time to time is a question of the greatest uncertainty. A great number of lightning conductors must then be placed along the line, a number which experience alone can decide in special cases.

The third requisite does not present much difficulty in satisfying. It is only necessary to place a lightning arrester on the machine to be protected, and to have the two alternative paths as different as possible, making that to the dynamo or transformer of a very high inductance, and that to earth of the smallest possible inductance. The discharge will then choose the second, even if it has to jump over a considerable air space in order to do so.

The inductance of the line to the dynamo or transformer is augmented by inserting a coil composed of a dozen fairly large turns which do not contain oil. Such a coil presents a very high impedance to oscillatory discharges, and a very small impedance with the ordinary working frequency. Referring to the phenomenon of nodes and ventral segments, M. Wurtz is not content with a single coil, but inserts numerous lightning arresters in the hope that he may obtain a coincidence with one of these. How he determines the number of the apparatus is not quite clear, and he has not indicated his theory. The earth conductor ought to be as straight as possible in order to present a minimum impedance. Oscillatory discharges do not lend themselves readily to sudden change of direction, and a sharp bend offers a high impedance; hence the necessity for short and good earth connections. Moist earth is very good, but water by itself is bad. The surface of the earth plate should be as large as possible.

The last point, *i.e.*, to prevent the discharge forming a short circuit on the plant, brings us to the discussion of the lightning arrester itself. A very good thing, generally speaking, is to place in the lightning conductor a high ohmic resistance, whose co-efficient of self-induction is small—for example, a carbon rod. This limits the flow of current and reduces the damage arising from a short circuit. Another arrangement, absolutely necessary, is that of making each lightning arrester have a separate earth. To join all the earths into a single one is very dangerous, because it makes the ultimate resistance of the short circuit practically nil. Apparatus have been invented by the hundred. Those which have given the best results up till now are the Wurtz type and the Siemens type.

The Wurtz apparatus made by the Westinghouse Company is composed of a series of small cylinders of a special kind of

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brass containing a large amount of zinc, arranged in line with an air space of about ½mm. between each. In consequence of a discharge an arc is not usually formed, and though this is a known fact, the reason is not very well established. In America, the General Electric Co. makes a lightning arrester called the Wirt, which does not differ from that of Wurtz, except in theory. Wurtz attributes the power of extinguishing the arc to the action of oxide of zinc, while Wirt says it is due to the cooling action of the metallic masses.

In the Siemens lightning arrester the arc formed is broken by electro-dynamical means. The apparatus is made of two pieces of copper wire brought close together at the base and separated above so that it has the appearance of two horns. The line is attached to one of the wires, the earth to the other. When a discharge jumps across the air space between the two wires, the arc which is formed is, by a well-known electro-dynamical effect, driven towards the ends, where it becomes elongated, and the action of the hot air makes it curve upwards until it is broken. All this lasts in general only a few seconds, and there are no dangerous results. Sometimes, however, the duration is greater, and then the short circuit which ensues may produce a considerable drop of pressure, but this is better than injury to the plant. In the present state of the question, we have thought it wise to test both of these systems on the line of Paderno, and experience will decide which is the better.

The line reaches Milan at the station of Porta Volta, where it is received on a suitable switchboard. From the switchboard the currents are conveyed to the transformer chamber. The transformers are supplied by the firm of Ganz and Co., are of the three-phase type and have a ratio of 12,000 to 3,600 volts. Their construction is quite simple. They consist of three columns of laminated iron disposed in one plane. On each column are wound a number of coils belonging alternately to the primary and the secondary circuit. This type is criticised by some from the point of view that not having the three magnetic circuits equally long it may give rise to a dissymmetry of the system. But the objection appears unfounded, and it is always possible in our case, where the transformers are numerous, to connect them in such a way as to compensate for the dissymmetry. The output of each transformer is 350 kilowatts, and its dimensions are:—height 6·9ft., length 6·56ft., width 3·28ft., and weight 7·75 tons. The secondaries of these transformers are carried to a switchboard which forms part of the general switchboard of the station at Porta Volta.

[*Note by the Translator.*—Since translating the above description of the central station of Paderno, I have received the following interesting information from Signor Semenza:—The works were commenced in February, 1896. Water was admitted into the canal in August, 1898, and the current was put on the line on September 28th. Public supply was given in Milan from Paderno on October 15th for the three-phase distribution and Edison network, and on October 29th for the traction service. The experience of a month or two is not enough to judge of the ultimate success of such a scheme, but it is highly satisfactory to know that the high-tension worked perfectly, the dynamos gave their guaranteed efficiency, and the line losses were exactly as calculated.—J. R. D.]

MODIFIED BRIDGE METHOD OF MEASURING RESISTANCES CONTAINING EARTH CURRENTS.

BY R. R. BLACK, ELECTRICIAN TO THE EASTERN EXTENSION TELEGRAPH COMPANY.

The following is a simple method of measuring the resistance of a cable by reversals when earth currents are strong and variable. It is a more sensitive method than the false zero unless the latter can be taken without a shunt on the galvanometer; it saves the lengthy calculation for correcting reversals taken by the ordinary Wheatstone bridge method, and the resistance of the battery is not required to be known. Three arms of the bridge a, b and d are fixed, and an adjustable resistance, R, is inserted between the bridge and cable R is then adjusted until balance is obtained to instrumental zero. The current to line is then reversed, and balance is obtained again to instrumental zero by altering R to R_1. Then

$$x = d\frac{a}{b} - \frac{R + R_1}{2}.$$

That is the fixed resistance d multiplied by the ratio $\frac{a}{b}$, minus the arithmetical mean of the two readings, R and R_1, give the true resistance of x. With even bridge

$$x = d - \frac{R + R_1}{2}.$$

The formula is found as follows:—

C and C_1 = currents flowing along d and x respectively.
e the E.M.F. of earth current in the line.
a and b = bridge ratios.
x = resistance of line.
d = the fixed resistance.
R = The variable resistance between bridge and line, with zinc current to line.
R_1 = The variable resistance between bridge and line with c to line.
E = E.M.F. of battery.

When balance is obtained to instrumental zero the potential at A is equal to the potential at B;

$$\therefore\ ac_1 = cb, \qquad \therefore\ c = c_1\frac{a}{b};$$

also $$Rc_1 + xc_1 \pm e = dc.$$

Substitute value of c we get

$$Rc_1 + xc_1 \pm e = d\frac{a}{b}c_1. \tag{1}$$

Reverse the testing battery and readjust R to R_1.

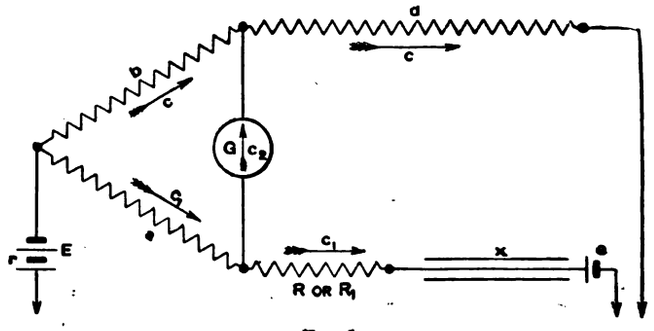

FIG. 1.

As the ratio arms and d are fixed, when balance is again obtained with E reversed, the values of the currents in the figure are the same as before, but in the opposite direction.

Therefore $$-R_1c_1 - xc_1 \pm e = -dc$$

substitute value of c

$$-R_1c_1 - xc_1 \pm e = -d\frac{a}{b}c_1. \tag{2}$$

Substract (1) and (2)

$$Rc_1 + xc_1 + e + R_1c_1 + xc_1 - e = 2d\frac{a}{b}c_1,$$

$$R + R_1 + 2x = 2d\frac{a}{b};$$

$$\therefore\ \frac{R + R_1}{2} + x = d\frac{a}{b},$$

$$\therefore\ x = d\frac{a}{b} - \frac{R + R_1}{2}. \tag{3}$$

If ratio equal $$x = d - \frac{R + R_1}{2}. \tag{4}$$

When the earth current opposes the line current it is equivalent to a resistance in effect (*see* "Student's Guide to Submarine Cable Testing," p. 40). Consequently d must allow for this. As a rule, if d is made about 25 per cent. higher than the estimated value of $x\frac{b}{a}$, before beginning the test, it will not be necessary to make any alteration in it.

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For example :—

With this plan of connections the resistance usually employed for the ordinary test can be varied, and the extra resistance box d can be fixed.

a and b were 1,000 ohms each and the number of cells 10. The approximate resistance of x was 4,000 ohms. Adding 25 per cent. to $4{,}000\frac{1{,}000}{1{,}000}$, to allow for the resistance effect due to the EC, d was made 5,000 ohms.

Zinc was then put to line, and balance was obtained to instrumental zero, when 556 ohms were unplugged in R.

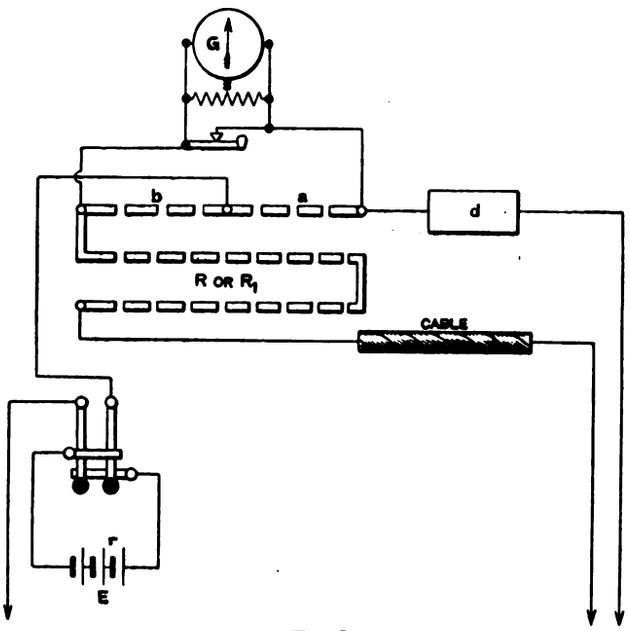

FIG. 2.

The line current was then reversed, and balance R_1 was obtained to instrumental zero with 1,676 ohms unplugged.

Therefore by formula

$$x = 5{,}000 \times \frac{1{,}000}{1{,}000} - \frac{556 + 1{,}676}{2} = 3{,}884 \text{ ohms.}$$

The following are actual examples :—

Example I.

Ratio 1,000/1,000 20 cells. Fixed resistance $d = 6{,}000$ ohms.

R 543	R_1 773	Mean 658 ohms.
548	774	,, 661 ,,
548	776	,, 662 ,,
548	775	,, 661 ,,
549	775	,, 662 ,,
		,, 661 ,,

6,000 - 661 = 5,339 ohms.

Example II.—*Reading by False Zero = 5,335 ohms.*

Ratio 1,000/1,000 20 cells. Fixed resistance = 8,000 ohms.

R 858	R_1 978	Mean 918 ohms.
858	971	,, 914 ,,
853	973	,, 913 ,,
853	974	,, 913 ,,
858	971	,, 914 ,,
		,, 914 ,,

8,000 - 914 = 7,086 ohms.

Example III.—*Reading by False Zero = 7,090 ohms.*

Ratio 10,000/10,000. Fixed resistance 17,040 ohms.

R 7,655	R_1 1,470	Mean 4,562 ohms.
7,660	1,495	,, 4,577 ,,
7,415	1,690	,, 4,552 ,,
		,, 4,563 ,,

17,040 - 4,563 = 12,477 ohms.
Reading by False Zero 12,500 ohms.

In the last case, the fixed resistance had to be 50 per cent. higher than the actual resistance of x owing to the strong earth currents.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *December 30, 1898.*

Obituary.—Mr. R. T. McDonald, president of the Fort Wayne Electric Corporation, Fort Wayne, Ind., one of the most widely known men in the electrical manufacturing business in this country, died suddenly of pneumonia in Dallas, Texas, on the morning of December 24. Mr. McDonald was 49 years of age. He was of Scotch descent but of American parentage. He was a man of marked ability and was connected in various business and financial enterprises in many places throughout the United States.

Dr. Welling Adams, of St. Louis, Mo., who was a prominent figure in the electrical world a few years ago mainly through his scheme about six years ago to build a high-speed electric railroad between St. Louis and Chicago, died at his home in St. Louis on December 19 of pneumonia, at the age of 42 years. Of late years, Dr. Adams's personality has almost been forgotten in the electrical field. He, within a year or so, made the claim that he was the original inventor of the method of applying electric power directly to the axles of cars, but he received no support whatever in the courts.

Automobile Stages on Fifth Avenue.—For many years a line of horse omnibuses has been running along Fifth Avenue in this city and the antiquated system of travel has been the subject of a great deal of comment in the public Press at different times. Several officers of the Third Avenue Railroad Co., which is now equipping its lines with electric power, have purchased the old omnibus line for the purpose of introducing motor 'buses and retiring the horses. It has not yet been decided what method of propulsion will be adopted on the new vehicles, but there is a strong likelihood that it will be electricity. The fact that Dr. Louis Duncan, a well known electrical authority, is consulting engineer of this enterprise, would seem to indicate that he would naturally favour electricity, if in his judgment it will meet all the requirements of the service. Fifth Avenue is the fashionable residence street of the city, and the possibility of ever getting car tracks down on the thoroughfare is so remote that no one has ever attempted to secure a franchise.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London :—

NOW READY.

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. The Author hopes that, besides Telegraph and Telephone Engineers, it may, perhaps, also prove of service to those in charge of cables for the transmission of light and power. The localisation of faults has been very fully investigated, including the different degrees in which the various methods are affected by the presence of a second fault or of general leakage.—*Extract from Preface.* Demy 8vo, fully illustrated. 10s. 6d., post free; abroad 11s.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition now ready.*

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"WIRELESS TELEGRAPHY: SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES."—By Dr. O. J. Lodge, with many original illustrations. *Enlarged Edition*, 2s. 6d. net, 2s. 9d. post free.

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"ELECTRIC MOTIVE POWER," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

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"'THE ELECTRICIAN' WIREMAN'S POCKET-BOOK."

"The Electrician" Electrical Trades' Directory and Handbook.—An important announcement in connection with the 1899 issue of the "Big Blue Book" will be found in an advertisement on another page of the present issue, to which our readers will please refer.

Electricity Supply Data and Statistics.—In the large sheet tables of electricity supply statistics issued with *The Electrician* for Jan. 6 there were some omissions which we hope to remedy in the final issue of the tables the first week in February, when the tables will form part of "The Electrician" Electrical Trades' Directory and Handbook for 1899. and will also be obtainable on rollers and in cloth cases. The Editor will be obliged if station engineers and others who can assist in completing the table will send in particulars as to: (1) The total capital expenditure to Dec. 31, 1898 (actual or approximate); (2) The total units generated for year to Dec. 31, 1897 (actual); (3) Units generated for year to Dec. 31, 1898 (actual or approximate); (4) Any other particulars which will help to make the table fully complete to Dec. 31, 1898. It is hoped that the information sought will reach *The Electrician* office by Jan. 23.

TENDERS INVITED.

The *Metropolitan Asylums Board* invite tenders for the supply and erection of the following electric lighting plant at the Northern Hospital, Winchmore Hill, N. :—(1) Switchboards, booster and connections; (2) battery; (3) electric mains; (4) steam exhaust, feed and drain pipes; and (5) wiring and fittings. Further particulars are given in an advertisement, and copies of specifications and drawings (by Messrs. Burstall and Monkhouse) may be obtained at the office of the Board, Norfolk House, Norfolk-street, Strand, London, W.C. Tenders must be lodged by 10 a.m. of 25th inst.

The Commissioners of *Govan* invite tenders for the supply and erection of (1) water tube boilers and feed heater; (2) engines and dynamos, equalising transformer, boosters, &c.; (3) lead-covered armoured cables; (4) storage batteries; (5) arc lamps; and (6) arc lamp pillars. Specifications may be obtained from Mr. Arnot, C.E., 79, West Regent-street, Glasgow, and tenders must be delivered to the town clerk (Mr. A. Macdonald), Hillock House, 752, Govan-road, Govan, by 23rd inst. Further particulars are given in an advertisement on another page.

The Corporation of *Lowestoft* invite tenders for the supply and erection of the following plant:—(*a*) boilers and fittings, economisers, feed pumps, &c.; (*b*) pipe work, &c., for engine and boiler house; (*c*) steam dynamos and motor boosters; (*d*) storage batteries; (*e*) main switchboard and connections; (*f*) overhead travelling crane; (*g*) underground mains and conduits, road work, &c.; (*h*) arc lamps and posts; (*i*) station lighting. Plan, &c., may be obtained at the offices of Mr. W. C. C. Hawtayne, consulting engineer, 9, Queen-street-place, London, E.C., after 16th inst. Further particulars are set out in an advertisement elsewhere, and tenders must be addressed to the Town Clerk, at the offices, 115, High-street, Lowestoft, by noon of Feb. 6.

As announced in an advertisement, the Electricity committee of the *Belfast* Corporation invite tenders for the supply of the following:—Cast iron pipes, cast iron frames and covers, earthenware conduits, insulated cable, and Lancashire boilers. Specifications and conditions of contract may be obtained from Mr. Victor A. H. M'Cowen, city electrical engineer. Tenders must be lodged with the town clerk (Sir Samuel Black), City Hall, Belfast, by Thursday, Feb. 2.

The Commissioners of the Burgh of *Stirling* invite tenders for the supply of mains. Specifications can be obtained from the clerk to the commissioners (Mr. Thomas L. Galbraith), and specifications and drawings may be seen at, but not obtained from, the office of Prof. Alex. B. W. Kennedy, 17, Victoria-street, London, S.W. An advertisement contains further particulars, and tenders must be delivered at the Town Clerk's Office, Stirling, not later than 30th inst.

The *Sunderland* Corporation require tenders for road work with stoneware casings, and supplying and laying cables. Specifications, &c., can be obtained from the borough electrical engineer (Mr. J. F. C. Snell), and tenders, addressed to the chairman of the Lighting committee, Town Hall, Sunderland, must be delivered at the office of the town clerk (Mr. Fras. M. Bowey), by Friday, 27th inst. Further particulars are given in an advertisement on another page.

The *Ealing* (London) Council require tenders for two 500 H.P. steam alternators, and one 150 H P. steam dynamo alternator. Tenders to the clerk, Public Buildings, Ealing, W., by 30th inst.

The *Southampton* Corporation invite tenders for the supply of transformers and fittings. Tenders to the town clerk (Mr. George B. Nalder), Municipal Offices, Southampton, by 2 p.m., 16th inst.

The *Glasgow* Corporation invite tenders for providing and erecting generating plant at one or other of their new electricity works. Tenders to Sir J. D. Marwick, City Chambers, Glasgow, by *Saturday, Jan. 21.*

The *London* County Council invite tenders for four continuous-current dynamos, one motor generator, two switch-boards with switches, measuring instruments and other work required for the proposed Victoria Embankment electric generating station. Tenders to Mr. C. J. Stewart, County Hall, Spring-gardens, S.W., by 10 a.m., Jan. 31.

The *London* County Council also require tenders for the erection of four gas engines at the proposed Victoria Embankment electric generating station. Tenders to the clerk by 10 a.m., Jan. 31.

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The *Shanghai* Council invite tenders for a concession, for a period of thirty years, for the exclusive right of establishing and working a telephone system in Shanghai.

The *Shanghai* Council also invite tenders for a concession for constructing and working about 23 miles of electric tramways on the trolley system. Particulars of both contracts from Messrs. John Pook and Co., 8, Jeffrey's-square, London, E.C. Tenders to Mr. J. O. P. Bland by noon of March 31 and 15, 1899, respectively.

The Compagnie Generale de Traction, of *Brussels*, invite tenders until the 25th inst., for the supply of 9,000 porcelain insulators and 10 tons of galvanised iron wire, &c.

TENDERS RECEIVED AND ACCEPTED.

The Accrington Town Council have let tenders for the supply of electric lighting plant as follows :—

Steam dynamos, Johnson and Phillips	£2,991	10
Storage battery, Chloride Electrical Storage Syndicate	910	0
Instruments, Crompton and Co.	641	0
Cables and street boxes, W. T. Glover and Co.	4,550	0

APPOINTMENTS VACANT AND FILLED.

The Wigan Corporation require an electrical engineer competent to draw up and carry out an electric lighting scheme (with or without tramways). An advertisement elsewhere gives further particulars, and applications must be sent to the town clerk (Mr. J. J. Charnock), Wigan, by 16th inst.

The Lighting committee of the Canterbury Town Council require an assistant electrical engineer (salary £104 per annum), two junior electricians (£52 per annum each), one stoker, one lamp trimmer and cleaner, a jointer and an assistant jointer. Additional particulars are given in an advertisement, and applications must be sent to the town clerk (Mr. Henry Fielding), 15, Burgate-street, Canterbury, by 10 a.m., 17th inst.

The Oldham Corporation require an assistant engineer for their electricity works. Further particulars are given in an advertisement. Applications to the chief electrical engineer, Electric Supply Station, Oldham, by the 16th inst.

As will be seen from an advertisement elsewhere applications are invited for two shift engineers for the Cropper's Hill power station of the St. Helens Corporation. Applications on or before Monday, 23rd inst.

The Worcester Corporation require two improvers as switchboard attendants. There are also vacancies for two pupils at the electricity works. Applications to city electrical engineer (Mr. C. J. Sutherland). See advertisement.

The Electric Lighting Committee of the Portsmouth Corporation are prepared to take pupils with a mechanical training. Particulars from the superintendent (Mr. E. Price), Corporation electricity works, Portsmouth. See advertisement.

The Professorship of Physics at the University of Sydney is vacant. Salary £900 per annum. Particulars from the acting Agent-General for New South Wales, 9, Victoria-street, London, S.W.

The Metropolitan Asylums Board require an assistant engineer with experience in electric lighting. Salary £300 per annum. Applications to Norfolk House, Norfolk-street, W.C., by 23rd inst.

Mr. N. Staniland has been appointed electrical engineer by the Canterbury Town Council at a commencing salary of £200 per annum.

BUSINESS NOTICE.

Owing to the increasing trade in the Midlands, the Birmingham offices of the Edison and Swan Company have been removed to larger and more convenient premises, International Exchange Buildings, Edmund-street, where an extensive show-room is being fitted up for the display of electroliers and brass fittings generally.

The British Thomson-Houston Co. (Limited) announce that they have opened branch offices at 21, Lincoln-place, Dublin. Telegraphic address, "Asteroidal Dublin," telephone 320. Mr. Arthur Jacob is resident engineer.

Messrs. W. J. Crampton and Co. have removed their offices and showroms from 3, Theatre-buildings, Regent-road, to 25, Regent-street, Great Yarmouth.

Messrs. E. J. Mather and A. A. Mather, trading as Mather Bros., electrical engineers, 278, Caledonian-road, N., and 73, Farringdon-street, E.C., London, have dissolved partnership. Debts by Mr. A. A. Mather.

Messrs. C. C. Wardrop and C. A. V. Whitaker, electrical and civil engineers, 1, Army and Navy Mansions, Victoria-street, London, S.W., have dissolved partnership. Debts by Mr. Wardrop. Mr. C. F. Monckton, late engineer and manager of Messrs. Bousted Bros.' electrical department, Ceylon, has joined Mr. Wardrop, and the new firm will practice as civil and electrical consulting engineers under the style of Wardrop and Monckton, at the above address.

Mr. H. T. Boothroyd (late of Messrs. Laird Bros., Birkenhead) is commencing business under the title of H. T. Boothroyd and Co., mechanical and electrical engineers, Miller's Bridge, Bootle. He has acquired the business of Messrs. W. and J. Robinson (Limited), and the new firm make a speciality of dynamos, motors, ship lighting and general electrical work. Mr. W. Robinson acts as manager.

BANKRUPTCIES, LIQUIDATIONS, &c.

Official notice is given that Mr. G. Franklin, Broomfield, and Mr. J. Gamble, Southborne, Sheffield, have been appointed liquidators in the voluntary liquidation of the Sheffield Electric Light and Power Co. (Limited), whose undertaking has been acquired by the Corporation.

It has been resolved to wind up voluntarily the Improved Incandescent Electric Lamp (Foreign Patents) Syndicate (Limited), and Mr. R. Ballard, 20, Jewry-street, E.C., has been appointed liquidator.

At a meeting of the London and Hampstead Battery Co. (Limited) it was resolved to wind up the company voluntarily, and to appoint Mr. R. J. S. Beeton, 23, West-hill, Sydenham, S.E., and Mr. S. T. Turtle, 141, St. John's-hill, Wandsworth, S.W., liquidators.

At a recent meeting of the Northern Counties Electric and Motor Co. (Limited) it was resolved to wind up the company voluntarily, and to appoint Mr. J. Robinson, Lightcliffe, Yorks., liquidator.

A first meeting of the creditors of John Evelyn Lairdet, inventor and patentee, was held in London last week. Debtor failed in 1888, but has received his discharge. Proofs of debts to the amount of £8,458 were lodged. The assets include debtor's interest in electric accumulators, electric motor cars, water motors, &c., and he claims that if these are properly worked and perfected they will will realise more than 20s. in the £. He attributes his failure to expenditure in completing his inventions. It was pointed out on debtor's behalf that the receiving order had been obtained by accident, and that steps were being taken to set it aside, debtor being desirous of submitting a proposal to his creditors. The meeting was adjourned to Feb. 3.

Last week at the London Bankruptcy Court the adjourned meeting of creditors of E. B. Pym, electrical engineer, late of Scarborough, was held. No statement of affairs has been filed. Debtor will undergo preliminary examination at Taunton. It was stated that debtor is entitled to an income which is alienable upon bankruptcy. The meeting was further adjourned to 30th inst.

Claims against John Dewhurst, electrician, &c., 52, North End-road, West Kensington, London, W., must be sent to the trustee, Mr. Hough, Bankruptcy-buildings, London, W.C., by 21st inst.

In the Chancery Division, Mr. Justice Wright made an order continuing the voluntary winding-up of the Mannesman Tube Co., under the supervision of the Court.

Mr. Thomas King, electrical engineer, recently carrying on business at Invicta Works, St. Peter-street, Maidstone, and at Brighton, was publicly examined at Maidstone last week. Debtor stated that he commenced business on his own account in Brighton in 1891 with a capital of nearly £600. He had managed Mr. Robert Dann's business at Maidstone for several years. Examination adjourned for explanations from the debtor.

Prism Globes.—The Prism Globe Syndicate (Limited) have now ready a new price list of prism globes, including "oval," "spherical," "acorn" and "pine" shapes. The prices of these globes, for which great economy is claimed, have been recently considerably reduced.

Crossley Gas Engines.—Messrs. Crossley Brothers have secured an order from the London County Council for what is claimed to be the largest installation of gas engines ever put down in any part of the world. Eight double cylinder horizontal engines, four of a maximum I.H.P. of 260 each, and four of 210 I.H.P. each, are to be supplied, as well as four of 5 I.H.P., combined with air compressors and hydraulic pumps. The large engines are to be built on the "tandem" principle and all are to work with coal gas. The engines will be used for driving centrifugal pumps at the Lots'-road pumping station. This is the second order Messrs. Crossley have received from the Council for pumping engines.

E.P.S. Cells.—There has recently been an alteration in the price of the Electrical Power Storage Co.'s K.W.S. type of cell, and new lists showing the alterations can now be obtained of the company.

"Neptune" Copper Rail Bonds.—Messrs. W. F. Dennis and Co., of 23, Billiter-street, London, E.C., forward a new list of "Neptune" copper rail bonds, manufactured by Messrs. Felten and Guilleaume, for whom Messrs. Dennis and Co. are the sole agents for the United Kingdom. The list is illustrated, and shows on page 2 a multiple bond for heavy rails carrying large currents.

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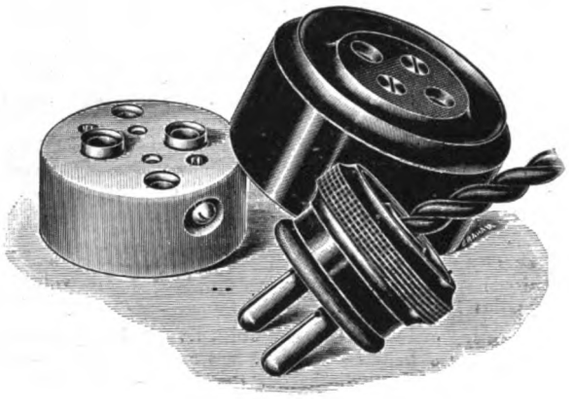
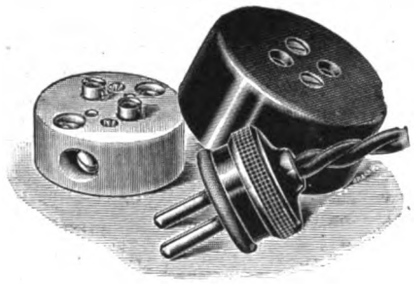
A large number of these bonds have been supplied for use on the Glasgow tramways to the corporation officials' own designs. It is claimed for these bonds that they possess the advantage that the steel pins are driven from the same side that the bonds are put through the web of the rails, an important point where conversion from existing horse or steam tramways is to be adopted, as by the use of this method the road need only be opened on one side. The list also illustrates patent screw bonds, &c.

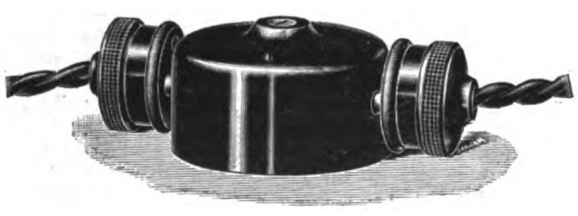
"Lundberg" Accessories.—The mention of Mr. Lundberg's name seems naturally to suggest improvements in switches, plugs, &c., for with clockwork regularity we seem to receive samples of



Mr. Lundberg's excellent work in this department. We are not surprised to learn that the demand for the various types of these accessories, manufactured at the Bradbury-street works, is an increasing one, for the work in the specimens we have received from time to time has been excellent. A sample of a new "Universal" high voltage wall connection without fuse terminals and fitted with the "Ridge" type of cover is here illustrated, the principle of construction being, Mr. Lundberg claims, quite novel. All the metal parts are thoroughly protected against possible leakage of current



To provide a proper insulating bridge between the ends of the contact tubes when the circuit is broken by withdrawal of the plug, holes are countersunk in the roof of the cover to admit the ends of the contact tubes. Long experience convinces Mr. Lundberg that this is the simplest and most satisfactory method, as the length of contact pins is kept down to reasonable limits. The plugs and sockets are of similar gauge, and consequently interchangeable with those supplied by the firm since 1884, and with each other.



The contact tubes are of extra stout metal and are pierced at their base by horizontal holes; through these pass studs screwing into the pillar terminals and clamping them solidly into contact with the tubes. We also illustrate the "Dot" wall connection similarly arranged for high insulation, and in which the diameter has been somewhat reduced owing to improved construction and absence of fuse terminals. The third figure shows the "Dot" twin wall connection. Mr. Lundberg was the original introducer of twin socket plugs. In the present case he has adopted side-entering plugs, so that the fitting stands only a minimum distance from the wall when fixed. At present this article is only made to suit the "Dot" gauge.

Catalogue.—The British Thomson-Houston Co. send us a copy of their recently-issued catalogue, No. 1,005, which consists practically of a well-gotten-up album of illustrations of motor work of every description undertaken by these contractors. The execution of this publication is artistic, and the range of subjects in the 25 illustrations shows to what a great variety of purposes electric motors are now put. Unlike most books printed in English, this one commences (with page 825) on what is usually the last page, and ends on page 854, where a Western naturally looks for the beginning of the story. However, as an album can generally be glanced through with equal pleasure in any order, Oriental or Western, users of this catalogue will suffer no inconvenience from the adoption of the Japanese plan. Perhaps this elasticity of arrangement is intended to indicate the fact that the electric motor is as triumphant in the East as in the West.

Calendars.—We have to acknowledge the receipt of a useful hanging pad calendar from the Commercial Cable Co.

———From the Cape Asbestos Co. (Limited) we have received a handy desk blotting pad and calendar, which is built to last the year through.

"Automotor" Pocket Book.—We have received the 1899 issue of the "Automotor and Horseless Vehicle Pocket Book," published by Messrs. F. King and Co. The book contains a large amount of useful information regarding horseless vehicles, and, in addition to much matter usually to be found in annual publications of this character, gives tables and technical data which will be of service to the automotor engineer and constructor. The book is price 1s.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Jan. 4 to Jan. 10, with the ports of destination:—

Argentina—Buenos Ayres £825 (including £750 telegraph material). *Australasia*—Adelaide, £1,440 (including £907 telegraph material); Brisbane, £371; Fremantle, £2,575; Melbourne, £270 (telegraph material); Perth, £36; Sydney, £414; Wellington, £295. *Belgium*—Ostend, £51. *Denmark*—Copenhagen, £50. *Egypt*—Alexandria, £20,000 (telegraph cable). *Germany*—Cologne, £20; Hamburg, £63. *Gibraltar*—£780. *Holland*—Amsterdam, £30. *India*—Madras, £300. *Japan*—Yokohama, £1,317. *North Atlantic*—26 knots telegraph cable. *Norway*—Christiania, £112. *South Africa*—Cape Town, £680; Chinde, £75; Durban, £2,334 (including £2,314 telegraph material); Port Elizabeth, £58. *Spain*—Barcelona, £75 (telegraph cable). *Sweden*—Gothenberg, £22; Stockholm, £915 (including £885 telegraph material). *United States*—New York, £8. *West Indies*—Trinidad, £55. Total £293,171, against £18,683 in the corresponding week last year (Jan. 5to Jan. 11).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Adelaide (S. Australia).—We recently referred to the acceptance by the Town Council of Adelaide of a tender of the South Australian Electric Light Co. "for the electric lighting of the town." We are informed by Messrs. J. C. Lanyon and Sons, of Gresham House, Old Broad-street, London, E.C., that this statement is "incorrect and misleading." The following particulars, in support of this contention, are supplied by Messrs. Lanyon:—

"The gas company's contract for lighting the whole of the city of Adelaide (about 900 lamps) does not expire till September, 1902.

"The Adelaide Corporation have power under an Act of Parliament to supply electricity.

"The South Australian Electric Company's Act of 1897, clause 39, is as follows:—

'Except as to the Municipality of Port Adelaide, this Act shall only 'apply within the limits of such municipalities and districts, the Councils 'of which shall by public notice notify that, as the result of a poll, the rate-'payers have affirmed a resolution that it is desirable that this Act shall 'so apply.'

"The Adelaide Corporation wish to erect electric works and supply electricity, but a poll of the citizens in 1894 decided against the scheme.

"In August, 1898, the Corporation called for offers from persons willing to do *private electric* lighting in the city, such persons to state what they were willing to give for the privilege.

"The South Australian Electric Company agreed with the Corporation that a poll of the ratepayers should be taken, the Corporation to support the Electric Company in its endeavour to get ratepayers to affirm a resolution that it was desirable that the Electric Company's Act shall apply within the limits of the municipality; that the Corporation should not for ten years exercise its power of supplying electricity, nor transfer its powers to any other person or company; that the Electric Company would provide, erect, light and maintain 30 arc lamps (2,000 c.p.) for five years for one shilling per lamp per annum; that the Electric Company would deposit with the Corporation £2,000 and with the treasurer of the province £5,000; that a fine of 10s. per lamp per night for each lamp not lit and kept alight should be paid by the company; and that the contract did not in any way interfere with the existing contract with the gas company, which contract does not expire till September, 1902,

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"On Sept. 17, 1898, a poll of the citizens of Adelaide was taken, when 2,761 (about one-fourth) of the ratepayers voted—1,775 for and 959 against."

Therefore (Messrs. Lanyon continue), for the privilege of doing private electric lighting in Adelaide for ten years, the Electric Company have agreed to provide, erect, light and maintain for the Corporation 30 arc lamps of 2,000 nominal c.p. each at 1s. per lamp per annum, which will mean a loss of £4,000 to the Electric Company.

The following particulars relating to the South Australian Electric Company were (we are informed) filed in the Supreme Court, Adelaide, in April, 1898:—Capital, £20,000 in 1,000 shares of £20 each; capital paid up, £13,655; number of shareholders, 16; number resident in Adelaide, 12. It will be interesting to have the views of the Electric Company. Meanwhile, as Messrs. Lanyon and Sons, presumably for the Gas Company, feel aggrieved at the statement in *The Electrician* of Oct. 21 last, we give the above statement on their authority.

Bradford.—The revenue account of the electricity department shows a total income of £20,059, and an expenditure of £8,736, leaving a trading profit of £11,323. After deducting interest and sinking fund (£7,060) the net profit is £4,263. The total profits made since the works were opened have been £19,045, and from this there has been written off for depreciation of plant £7,308, leaving unappropriated £11,737.

Brighton.—The Local Government Board having only allowed a period of 12 years for repayment of the loan of £56,300, recently sanctioned, the Corporation are asking to have this period extended to 25 years, as previously.

Burton-on-Trent.—After allowing for interest and sinking fund there was a deficiency of £992 in the accounts of the electric lighting department for the past year.

Chesterfield.—A special committee has been appointed to consider and report upon the advisability of establishing electricity supply works.

Dover.—The subject of acquiring the undertaking of the Dover Electricity Supply Co. was discussed at Tuesday's meeting of the Town Council, and was adjourned.

Edmonton.—The Local Government Board have sanctioned the Guardian's scheme for the electric lighting of the workhouse.

Electric Traction in Spain.—A company, entitled the Compagnie Generale des Tramways Electriques, has been formed at Brussels, with a capital of 10,000,000fr. (about £400,000), and is being financed by the Banque de Paris et des Pays Bas and the Banque de Bruxelles, to acquire the Madrid Eastern Tramways and the lines at Barcelona and Soria.

Garston.—At a special meeting of the District Council on Monday it was decided to transfer the provisional order to the British Insulated Wire Co.

Glasgow.—At a meeting of the Corporation, on Thursday last, it was decided to adopt the recommendation of the Tramways committee to equip the whole of the tramways on the overhead trolley system.

The city engineer (Mr. A. B. M'Donald) has been authorised to obtain estimates for carrying out the electric ventilating arrangements at the City Chambers set out in our last issue.

Great Yarmouth.—The report of the electricity department for the past quarter states that there are at present 314 customers, representing an equivalent of 14,839 8 c.p. lamps connected. The total income was £1,697. 15s. 2d., and the generation, &c., expenses, £758. 0s. 5d. Of the balance (£939. 14s. 9d.), repayments of capital, interest, &c., absorb £570, leaving a profit on the quarter's working of £369. 14s. 9d.

Hammersmith (London).—The Vestry are applying to the London County Council for a further loan of £56,000 for extensions of the electric light, plant and mains.

Hampton Wick.—Although some of the ratepayers in this district are anxious to obtain a supply of electric current the District Council has done, and apparently proposes to do, nothing to meet the demand. A ratepayer recently applied to the neighbouring (Kingston) Town Council for a supply of current, but the application was refused as the permission of the Hampton District Council could not be obtained. The matter was discussed at the last meeting of the Hampton Council, when one of the members said that the subject had been considered by them before, and the cost of a provisional order prevented them from moving in the matter.

Hartford (Cheshire).—The Parish Council have decided to adopt electric lighting, and an agreement has been entered into with the Northwich Electric Supply Co. for supply of current.

Hospital Lighting.—The Queen's Hospital, Birmingham, has been provided with an electric light installation of 350 16 c-p. incandescents.

Leamington.—The Corporation have decided not to sanction an application of the Midland Electric Light and Power Co. for a provisional order, as the Council is itself applying for an order.

Marylebone (London).—Last week the Vestry further considered the question of applying to Parliament for a special act to erect electricity works and to engage in the generation and sale of electric current for all purposes. After discussion it was decided to request the Electric Lighting committee to report to the Vestry as to the probable cost of the proposed scheme, and authorising the committee to engage the services of an expert adviser.

Merthyr.—The District Council have considered a report from Messrs. Handcock and Dykes on the application of the British Electric Traction Co. for a provisional order for the district, and will support the application.

Middleton.—The Town Council have decided to petition Parliament against the decision of the Board of Trade to confirm the order of the Light Railway Commissioners, empowering the British Electric Traction Co. to construct an electric railway through the town, and thus join up Oldham, Castleton and Manchester. They assert that powers have been exercised which Parliament never anticipated when it passed the Light Railways Act.

Municipalization Extraordinary.—On Tuesday a conference of the municipal authorities of Lancashire and Cheshire was held at Manchester to consider the advisability of organising concerted opposition to the Lancashire Electric Power Company's Bill and the South Lancashire and Cheshire Electric Power Bill next session. Councillor Vaudrey, Lord Mayor of Manchester, presided, and said the promoters of these Bills proposed to obtain power to go through towns in Lancashire and Cheshire, and to supply electric current for motive power and lighting purposes. These bills, therefore, trespassed upon the rights of the various towns, and he thought it was their duty to do their best, in the interests of the ratepayers, to secure the rejection of the bills on the second reading. The following resolution was then submitted to the meeting:—

"That this conference of municipal corporations of Lancashire and Cheshire, within the area comprised in these bills, protest against the same as violating the principle for which municipal corporations have in past years successfully contended, and which have been established by the Tramways Act of 1870, and the Electric Lighting Acts of 1882 and 1888, and determines to take united action in opposition to the bills."

Alderman Higginbottom, of Manchester, said the bills were really an attempt to deprive ratepayers of large towns like Manchester of the money which they had expended on their electricity undertakings, and if the bills were passed the recognised control of their streets would be done away with. It had already been claimed on behalf of the promoters that, for electric lighting purposes, the control was not in the hands of the municipal authority, and if they laid down electric mains and plant the Board of Trade could grant powers to a company for the same purpose. On the other hand, it was contended that competing powers were never given against a municipal authority, but the recent report of the Select Committee was to the effect that Parliament could sanction such bills which entered into competition with the schemes of municipal authorities, and that the Board of Trade should judge whether the bills should pass on their own merits. In Manchester they had arranged to supply electric current to a large number of towns. It was a mutual agreement, and no element of compulsion had entered into these arrangements, and he protested against such an extraneous body coming and opening out their streets and mains and putting down plant, whether they wanted it or not. If the companies had set out to do the work under an agreement with the corporations, many of them would perhaps not have objected, unless they had already spent large sums of money in putting down plant; but it was altogether against the principles of municipal government that such outside bodies should be allowed to interfere with their streets and thoroughfares. Mr. Charles Petrie, of Liverpool, said he could not agree with Ald. Higginbottom that companies might, perhaps, have been allowed to do the work under an agreement, as this was contrary to the best interests of the ratepayers, and ought not to be tolerated. He looked with very great dislike upon any interference by the Board of Trade with the rights of a municipality. Mr. Harcourt Clare, Town Clerk of Liverpool, said the main principle involved was that corporations which had undertaken to supply electric current should be subjected to competition by outside bodies. They had been induced and even encouraged by Parliament to borrow money in order to give an electrical supply, but at the present moment it was practically enjoyed by a very small percentage of the inhabitants in any borough. In Liverpool, out of a population of 700,000, only some 3,000 had the supply, and he would ask whether it was reasonable and right that any corporation should be allowed to pledge the credit of the whole body of ratepayers for the benefit of a small section, and that then outside companies should be permitted to compete with them. The municipalities ought to join and fight the matter out—not as a question of detail, but of principle—and get it settled once for all that, when a corporation had been authorised to spend money in any public undertaking, it should be freed from all outside competition. The resolution was carried unanimously, and an executive committee

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was appointed to apportion the expense of opposing the bills among the different corporations comprised in the conference.

Nottingham.—A Local Government Board inquiry was held here on Wednesday into the application of the City Council to borrow £150,000 for electric light extension purposes. The town clerk (Sir S. G. Johnson) said the money was required to extend the plant and mains. As the present station was quite inadequate to meet the demands for electric current, the Corporation had decided upon an extension, and the amount now asked for was the estimated cost. Technical details were given by the electrical engineer (Mr. H. Talbot). There was no opposition.

Oystermouth.—The District Council have decided to advertise for tenders for the electric lighting of the district.

Paisley.—A committee has been formed for the purpose of inquiring into the advisability of acquiring and extending the tramways in the district. The Council have also approved of the bill of the Glasgow Corporation for the construction of electric tramways to and in the burgh of Paisley.

Poplar (London).—The District Board of Works have approved the electric lighting scheme prepared by their electrical engineer (Mr. A. Blackman). The total capital expenditure entailed is £79,000.

Plymouth.—It has been decided to make a uniform charge of 4½d. per unit for electric current to private consumers for lighting and power purposes.

Private Bill Legislation.—The bill deposited by the Central London Railway seeks an extension of time until June, 1900, for the completion of the railway.

The Liverpool Overhead Railway bill seeks powers to acquire on lease certain tramways authorised to be constructed by the District Councils of Waterloo-with-Seaforth and Great Crosby. When completed these tramways will form a continuous line from Great Crosby to the company's railway at Seaforth Sands. Powers are also sought to enter into working agreements with the Corporations of Liverpool and Bootle and other authorities. The new capital sought to be created is £50,000, with power to borrow a further £16,500.

The London, Walthamstow and Epping Forest Railway bill seeks to cancel the agreement with the Great Eastern Railway Co., and in lieu thereof ordinary general powers are sought to enter into working and traffic agreements with that company.

The Lancashire Electric Power Co. have deposited a bill for incorporating a company for the purpose of erecting stations for the production, storage and distribution of electricity. It is proposed to construct four stations, viz, in the parishes of Aspull, Parr, Little Lever, and on the Trafford Park estate, in the parish of Barton-on-Irwell. At these generating stations the company propose to manufacture and sell everything necessary for distributing energy for lighting and other purposes, public and private, and for converting the same into motive power, heat, or otherwise. The capital of the company is to be £3,000,000, in 300,000 shares of £10 each, but with power to divide these shares into preferred and deferred half shares. Power is also sought to raise a further £1,000,000 by the creation of debenture stock, but the compulsory powers of the company are not to be exercised until not less than £100,000 of the capital shall have been subscribed under contract. The first Directors are to be Messrs. W. P. J. Fawcus, F. E. Gripper, W. B. Hopkins, N. Scott Russell, G. B. Samuelson, R. P. Sellon (all of whom are, of course, well known in electrical if not in financial circles) *and four other persons to be nominated by them.* It is provided that nothing in the bill shall confer exclusive rights to supply energy within the area of supply, or to hinder or restrict any other body or person from supplying or increasing their supply within the same area, nor shall the company hereafter be entitled to compensation by reason of any competitive supply. The profits of the company are proposed to be limited to 10 per cent. on the paid-up capital, subject to a sliding scale.

The South Lancashire and Cheshire Electricity Co. have lodged a bill for similar powers. Only one generating station is proposed. This is to be erected at St. Helens. The capital is to be £750,000, with power to borrow a further £250,000. The clauses in this bill are almost identical with those of the Lancashire Company's bill.

The Leicestershire and Warwickshire Electric Supply Company's bill seeks powers to acquire land at Hinckley, Leicestershire, to erect a generating station for the supply of electricity direct or in bulk to any corporation within the company's area of supply. The share and loan capital is to be £1,000,000, of which £250,000 may be raised on mortgage. The profits are to be a fixed 10 per cent., but subject to an increase of 5s. per cent. for every one-tenth of a penny per unit at which energy may be supplied below 2½d. per unit.

The St. James' and Pall Mall Electric Light Co. has lodged a bill for powers to acquire additional lands for the erection of generating and transforming stations, to enable the Company to meet the increasing demand for electric current within its area of supply.

The Corporation of Birmingham have deposited their bill seeking powers to purchase the undertaking of the Birmingham Electric Supply Co. (Limited) under agreement. The sum of £420,000 is to be paid on Dec. 31, 1899, in respect of the company's fully paid-up capital of £200,000, wholly or partially, at the option of the company, either in cash or in 2½ per cent. Corporation stock. The transfer is to date as from Jan. 1, 1898, from which time to Dec. 31, 1899, the Corporation will, in addition to the sum of £420,000, guarantee a dividend at the rate of 6 per cent. per annum. The Corporation seek powers to borrow £500,000, to be repaid in 42 years.

The promoters of the Waterloo to Baker-street electric railway have submitted plans to the Vestry of St. Martin's-in-the-Fields for the construction of a subway for passengers from the north-east corner of Spring-gardens and Charing-cross to a point opposite the Grand Hotel, and thence to the south-east corner of Trafalgar-square, to communicate with a railway station to be constructed at Charing-cross. The vestry opposes the bill *pro forma*.

The Brompton and Piccadilly Circus Railway Co. seek powers to extend the already authorised line to St. Martin's-lane and Long-acre in one direction, and to the South Kensington station of the Metropolitan District Railway in the other. For these extensions £533,000 additional share and loan capital will be required. The bill proposes to empower the Metropolitan District Railway Co. to subscribe £200,000 towards the undertaking, to guarantee interest, &c.

Queenstown (Cork).—The Board of Trade have sanctioned the transfer of the Queenstown provisional order to the Cork Tramways and Electric Lighting Co. The town will probably be lighted electrically by Jan. 1, 1900.

Reigate.—The Town Council have purchased a site for an electricity generating station. Application is to be made to the Light Railway Commissioners for power to construct an electric tramway between Redhill Junction railway station and Reigate.

Rome.—The electric lighting installation at the Vatican is practically complete, and it is anticipated that current will be available in a few days.

Salford.—The Town Council are recommended to appoint Messrs. Lacey, Clirehugh and Sillar consulting engineers, at a fee of £500 per annum, in connection with the proposed extension of the electric light undertaking.

Sheffield.—In presenting the minutes of the Electric Light committee at the City Council, on Wednesday, Ald. Styring said the committee had taken possession of the undertaking of the Sheffield Company, and were sorry to find things were not in so satisfactory a condition as they could wish. To meet the demand for current it was necessary to work all the machinery to its full capacity. There was no spare machinery, and the management was absolutely dependent day by day on all the machinery keeping in good order. The late company had ordered additional machinery, but owing to the engineering strike this was only available two or three months ago. The failure of the electric light on Monday night was due to a short-circuiting behind the switchboard, and was entirely beyond the control of anyone connected with the undertaking. The lamps wired during the last year were 17,865, compared with 13,561 in the previous year, an increase of about 22 per cent. That brought up the total number of lamps to 73,853. The current sold during the year was 978,086 units, compared with 738,499 in the previous year, an increase of 32 per cent. Although the accounts for the past year were not completed, he was in a position to say that the gross revenue was £17,104. 15s. 4d., against £14,823. 10s. in the previous year, notwithstanding that current was in March last reduced from 5d. to 4d. The accounts were in an advanced enough state to show that there would be a sum of not less than £3,000 clear profit on revenue account for the Corporation as a result of the year's working.

Whitby.—The Board of Trade have notified the District Council that they will defer for another twelve months the question of rescinding the Whitby provisional order obtained in 1891.

Wimbledon.—For the position of resident electrical engineer, four candidates have been selected, viz:—Messrs. Ballard, Foyster, Harper, and Spencer. The final selection has been left with the Roads and Bridges committee.

The new gable at the electricity supply station was blown down by the gale on the 28th ult. The accident will delay the delivery of the machinery, the greater portion of which is ready.

Yeadon.—A special meeting of the District Council will be held to discuss the electrical proposals contained in the bill which is being promoted by the Yeadon and Guiseley Gas Co.

Soiree.—The annual soiree of the employés of the Sunbeam Lamp Co. (Limited), Gateshead, was held last week, when about 200 were present. In the unavoidable absence of the managing-director (Mr. Edmundson), the gathering was presided over by Mr. T. Grainger, secretary, and a very enjoyable evening was spent.

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PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom all information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

December 13, 1898.

26,380. E. GIGLIO. Liverpool. Improvements in electric batteries.
26,381. J. J. BATE. Liverpool. Improvements in conduits for electric conductors.
26,397. C. JUNG, A. BRECHER, and A. KITTEL. London. An improved acid-proof or non-conducting material for electrical and other purposes, and methods of preparing the same.*
26,401. C. E. SCHNÉE. London. Improvements in bath apparatus for treatment with electricity and medicinal substances.*

December 14, 1898.

26,412. J. STODDART. Halifax. An improved terminal for electrical fittings and apparatus.
26,419. H. HUMPHREYS and W. HUMPHREYS. Manchester. Improvements in and relating to dynamo electric motors.
26,420. C. M. DORMAN and R. A. SMITH. Salford. Improvements in fusible cut-outs.*
26,423. W. SHINN. Liverpool. An improved electrical governor for steam engines and the like.
26,458. R. RAINSFORD. London. Improvements in collectors for electric tramways on the overhead conductor system. (J. Walsh, United States.)
26,476. C. E. BURROUGHS. United States. Improvements in batteries.*
26,479. G. HOOKHAM. London. Improvements in electricity meters.

December 15, 1898.

26,494. A. WATSON. Birmingham. Improvements in electrical switches.
26,526. E. J. CLARK. London. A new or improved crucible for casting lead or like metals under pressure, especially applicable to the formation of secondary electric battery grids or plates.
26,527. H. H. LAKE. London. Improvements in regulators for electric car motors. (H. S. Maxim, United States.)
26,566. F. H. W. HIGGINS. London. Improvements in telephone transmitters.

December 16, 1898.

26,610. R. E. B. CROMPTON and E. A. N. POCHIN. London. Improvements in electric arc lamps.
26,614. J. A. MAYS. London. Process and apparatus for treating ores by electrolysis.
26,619. W. P. THOMPSON. Liverpool. Improvements in telephone switchboards or switching apparatus for telephone stations. (T. F. Ahern, United States.)*
26,649. SIEMENS BROS. AND CO. (LIMITED). London. Apparatus for simultaneously actuating from one point the controlling switches of the several electrical motor cars of a train. (Siemens and and Halske Aktien Gesellschaft, Germany.)*
26,650. — ANDREAS. London. Improvements in or relating to electric lamps.

December 17, 1898.

26,695. W. PUTTKAMMER. London. Improvements in electric accumulators or secondary batteries.
26,700. F. H. SNYDER. London. Improvements relating to the coating of metals with metals by the aid of electricity and to apparatus therefor.
26,703. H. T. HARRISON. London. Improvements in primary batteries.
26,723. W. E. BURNAND. London. New or improved device for indicating the frequency of an electric current or currents derivatively applicable for signalling and indicating speeds and the like.

December 19, 1898.

26,738. T. TAYLOR. Birmingham. Improvements in conduit inspection fittings for electric wiring.
26,769. H. E. ANDERSON. London. Improvements in and relating to electrically-operated clocks.*
26,787. H. G. TICEHURST and B. T. MOORE. London. Improvements in electric fuses for use in blasting or other like purposes.
26,789. V. I. FEENY. London. Improvements in and relating to electrical incandescent lamps. (Allgemeine Elektricitäts-Gesellschaft, Germany.)*
26,790. V. I. FEENY. London. Current conducting connection between electrical conductors. (Allgemeine Elektricitäts-Gesellschaft, Germany.)*

December 20, 1898.

26,806. W. B. THOMPSON. Dundee. Improvements in steam or electric after steering gear for ships.
26,807. F. L. MONKHOUSE. Newcastle-on-Tyne. Improvements in electric switches.
26,858. R. H. DUNN. Somerset. The oxidised-carbon electric power process.
26,886. THE POROUS ACCUMULATOR CO. (LIMITED) and J. C. HOWELL. London. Improved means for manufacturing metallic ribbon especially applicable for battery electrodes.*
26,914. A. COLLAVET. Liverpool. Improvements in dynamo electric machines, electric motors and the like.

December 21, 1898.

26,947. P. GADOT. Glasgow. A new process of treatment and method of working electric accumulators.
26,948. J. P. HALL. Manchester. Improvements in or relating to the brushes of dynamo electro motors and the like.
26,984. J. E. SPAGNOLETTI, J. CROOKES and J. LAWRENCE. London. An improved change-over switchboard and light indicator for use in connection with electric lights on board ship.
27,009. W. L. WISE. London. Interchangeable electric display apparatus. (G. L. Mason, United States.)

December 22, 1898.

27,018. C. H. LOGAN. London. An electro-chemical method of disintegrating rocks carrying minerals.
27,040. D. REID. Glasgow. An improved electric bell.
27,053. F. FOY. Manchester. Improved overhead electrical wire holder.
27,074. W. E. IRISH. London. Improvements in electrodes for arc lamps.*

December 23, 1898.

27,113. G. W. LAYBOURN. Tunstall. An improved process of the application of metals by electrolysis to or on the surface of earthenware, either in the biscuit or glost state.
27,142. W. A. BURNS. London. Improvements in or relating to electrically-driven ventilating fans.
27,183. A. SMITH. London. A new material for electrical insulation.

December 24, 1898.

27,254. C. WOOD. Birmingham. Improvements in electric arc lamps.
27,269. H. G. KUNKELMANN, E. C. FRANÇOIS and C. R. LOUBERG. London. Improvements in and connected with apparatus for measuring electricity.

December 27, 1898.

27,276. J. H. DORION. London. Improvements in supporting and take-up devices for cable-suspended electric lamps.
27,320. S. Y. HEEBNER. London. Improvements in and relating to electric motors and method of controlling same.*
27,334. P. M. JUSTICE. London. Improvements in telephone receivers. (A. T. Nye, United States).
27,335. P. M. JUSTICE. London. Improvements in telephone transmitters. (A. T. Nye, United States).
27,336. P. M. JUSTICE. London. Improvements in apparatus for use in telephone exchanges. (A. T. Nye, United States).

December 28, 1898.

27,360. J. THOMPSON. Cardiff. An apparatus or improved manner of means for determining or ascertaining the velocity of air currents in coal mines and other situations, and for other purposes by novel electrical and other means.
27,390. C. D. ABEL. London. Improvements in coin freed apparatus for electric and fluid meters. (Société Anonyme Continentale Pour la Fabrication des Compteurs a Gaz et Autres Appareils, France).

December 29, 1898.

27,414. J. CLARK. Glasgow. Improvements in or relating to electric lamp bracket joints.
27,453. H. LEITNER. London. Improvements in electric motors.

December 30, 1898.

27,469. S. O. COWPER-COLES. London. A process for the electro-deposition of vanadium.
27,473. D. STEWART AND CO. (LIMITED) and T. D. SEATON. Glasgow. Improvements in graduated resistance apparatus for starting on reversing electro motors.
27,498. G. ZAHIKJANZ. London. Improvements in electric incandescent lamps.
27,526. J. MATTHIAS. London. Improvements in thermo-electrical building bricks or blocks.*

December 31, 1898.

27,556. R. BOTTELLI. Italy. Improvements in incandescent electric lamps.
27,564. J. S. STEVENS, C. G. MAJOR and E. C. STEVENS. London. Improvements of controlling apparatus for electric lifts and other machines.
27,577. W. A. CROWDUS. London. Improvements in motor-driven vehicles and in electric motors therefor.
27,583. F. S. WORSLEY. London. Improvements in electric arc lamps.
27,586. E. EGGER. London. Improved direct coupled driving arrangement for electric automotors.
27,592. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in controllers for electric motors. (W. B. Potter, United States.)*

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1897.

27,428. RIANT. Electric furnaces for the production of calcium carbide and other substances.
27,508. MARCH. Extraction of gold by electrolysis.
27,619. NORDMANN. Incandescent electric lamps.
28,157. HOPE-JONES. Relay applicable to pneumatic or electric organs, or to other apparatus.
28,259. DUNCAN STEWART and CO. (LIMITED) and LYON. Resistance and contact apparatus for electric currents.
28,457. HIGGINBOTTOM, HINDLE, and MANNOCK. Apparatus for regulating and controlling electric motors.
28,729. BOOTH. Electrical switches.
29,009. BASTICK and THORNTON. Electric furnaces for the production of calcium carbide and other substances.

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29,010. Bastick and Thornton. Means or apparatus for conveying the boxes to and from electric furnaces.
29,011. Bastick and Thornton. Electric furnaces for the production of calcium carbide and other substances.
29,116. Baynes. Distribution and regulation of electric energy, and conductors connected therewith.
29,251. Wade and The Electric Motive Power Co. (Limited). Connections for storage cells.
29,318. Wade and The Electric Motive Power Co. (Limited). Control and regulation of electrically-propelled vehicles.
29,361. Kerridge. Electric gas lighting and controlling devices.
30,001. Luyers. Railway aero-electric brakes.
30,037. Lacko. Electric arc lamps. (Date applied for under International Convention, July 21, 1897.)
30,470. Jones. Electricity meter, self fixing, or box and main connection board, or box combined.
30,572. Fowler and The Mutual Electric Trust (Limited). Joints for electricity conductors.

1898.

468. Rosling and Appleby. Enclosed motors or dynamos.
586. P. R. Jackson and Co. (Limited) and Lewis. Mounting of dynamo electric machines.
632. Walters. Electric lamps and switches.
698. De Szwantowski. Electric illumination of railway trains.
812. P. R. Jackson and Co. (Limited) and Lewis. Dynamo electric machinery.
1,021. Stearn. Manufacture of filaments for incandescence electric lamps.
1,628. Crowdus. Secondary batteries.
1,687. Thompson. Electric signalling apparatus.
1,826. Cutter. Electric switches and cut-outs.
2,167. Moores and Farrell. Electric generators for cycles and other vehicles.
2,427. R. Waygood and Co. (Limited) and Unwin. Variable electric resistances or rheostats.
2,479. Byng and Bevis. Terminals for electrical connections especially adapted to incandescence lamp holders.
2,684. Fisher, Round, Round and Round. Apparatus for the electro-deposition of metals.
3,204. Vigreux and Brillié. Electric arc lamps.
3,749. Rhodin. Method of oxidation and bleaching by means of electrolysis.
5,172. Collingwood. Telephone transmitters.
5,663. Middleton and Huggins. Metallic conductors for protecting electric wires and cables.
6,901A. Weston. Index needles or pointers for electrical and other indicating or measuring instruments. (Date claimed under Patents Rule 19, March 22, 1898.)
6,991. Weston. Electrical measuring instruments.
7,057. Proctor and Blaikie. Plug switches and plug connections for the control and distribution of electric currents.
10,608. Lake (Hoffmann). Electrically illuminated buoys.
15,040. The British Thomson-Houston Co. (Limited). (Hewlett). Automatic circuit breakers.
16,245. Buckley and Croffert. Electric sounding device.
16,716. The British Thomson-Houston Co. (Limited). (Rice). Systems of control for electrically-propelled trains.
17,592. Bugg and Darling. Portable electric lamps.
18,156. Vogt. Manufacture of electrical resistances.
18,231. Bachmann, Vogt, Weiner, König, Kirchner and Jörg. Electrical heating appliances formed of artificial stone.
18,232. Bachmann, Vogt, Weiner, König, Kirchner and Jörg. Electrical resistances of artificial stone composition.
18,740. Siemens Bros. and Co., Limited (Siemens and Halske Aktiengesellschaft). Safety fuse apparatus for electrical installations.
19,537. Burke. Dynamo electric machines.
19,938. The British Thomson-Houston Co. (Limited). (Hewlett.) Safety devices for dynamo-electric machines.
19,942. Mills (Whitfield and Cowan). Combined electric generator or motor and steam, air, or the like engine or compressor.
20,049. Wise (Actien-Gesellschaft Elektricitaetswerke, vorm. O. L. Kummer and Co.). Electric safety fuses.
20,202. Ducousse. Electrical apparatus for operating railway points and signals. (Date applied for under International Convention, Feb. 24, 1898.)
20,416. Johnson (Hutchins). Means for supplying current to electrically-propelled railway vehicles.
20,677. Bullock. Apparatus for starting electric motors.
20,989. Bickford-Smith. Compositition for electrically firing detonators.
21,046. The British Thomson-Houston Co. (Limited). (Davis). Electric meters for alternating current circuits.
21,047. The British Thomson-Houston Co. (Limited). (Emmet.) Electric fuses.
21,048. The British Thomson-Houston Co. (Limited). (Allo). Prepayment electric meters.
21,410. Hutchison. Controlling switches and apparatus for electric motors.
21,943. Haddan. (The Allegemeine Electricitäts Gesellschaft.) Electrical contact breakers.
21,947. Siemens Bros. and Co. (Limited) and Holmes. Electric winch suitable for ash hoists and such like appliances.
22,080. The British Thomson-Houston Co. (Limited). (Hewlett). Protecting static volt meters.
22,082. The British Thomson-Houston Co. (Limited). (Geisenhoener). Trolley cars for electric railways.
22,085. Myers. Conductors and collectors for electric railways,
22,153. Carter. Gauge for testing if stereo, electro, photo-process, and such like blocks are type-high and uniform in thickness and for other like purposes.
22,171. Graeber and Tobler. Insulating devices for the electrodes of accumulators.
22,461. Johnson (Dercum). Primary batteries.
22,600. The British Thomson-Houston Co. (Limited). (Painter.) Incandescent electric lamps.
22,601. The British Thomson-Houston Co. (Limited). (Spinney.) Electric arc lamps.
22,664. Munro, Brecknell and Rogers. Appliances for use in securing the copper bonds or conductors in electric tramway rails.
22,683. The British Thomson-Houston Co. (Limited). (Case.) Coupling for electric conductors.

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Co. (Limited).

The following report of the Directors for the half-year ended Sept. 30 last will be presented to the fifty-third half-yearly ordinary general meeting of proprietors, at Winchester House, London, E.C., on Jan. 19, at 1 o'clock:—

The revenue amounted to £444,011. 12s. 3d., from which are deducted £121,376. 13s. 11d. for ordinary expenses and £41,716. 16s. 6d. for expenditure relating to repairs and renewals of cables, &c., during the half-year. After providing £2,522. 17s. 2d. for depreciation of spare cable, £6,965. 8s. 2d. for income tax, there remains a balance of £271,429. 16s. 6d., to which is added £3,568. 7s. 11d. brought forward—total, £274,998. 4s. 5d. From this balance there has been paid—

Interest on Debentures and Debenture Stock.....	£29,855	10	9
Dividend on Preference shares	10,148	2	1
Dividend on Preference stock	14,547	11	0
Two interim dividends of 2s. 6d. per share each on the Ordinary	100,000	0	0
	£154,551	3	10

After carrying £10,000 to reserve for maintenance ships, £5,000 to reserve in connection with the removal of head offices, and £70,000 to general reserve, there remains £35,447. 0s. 7d., which is carried forward. The revenue includes £23,901. 13s. 3d. dividends for the half-year upon the company's shares in other telegraph companies.

The new issue of £500,000 3½ per cent. Preference stock was more than fully subscribed for by the shareholders. One section of the cable, for which this amount is principally required, has been laid from Porthcurnow to Gibraltar, and the expedition with the additional cables from Gibraltar to Malta and Alexandria left the Thames on the 27th ultimo.

The conversion of the Ordinary shares into Ordinary stock, authorised at the last general meeting, was effected on Nov. 1. Shareholders who have not yet exchanged their share certificates for the new stock certificates are requested to do so without delay. The Stock Exchange Committee has granted official quotations for the new stock and for the additional issue of 3½ per cent. Preference stock.

The Directors are arranging for the building of a new cable repairing steamer to replace the ss. "John Pender," recently sold.

NEW COMPANIES, STATUTORY RETURNS, &c.

JOSEPH BOOTH AND SONS (LIMITED).—This company was registered on Jan. 9, with a capital of £75,000, in £100 shares, to acquire the business now carried on under the style of Joseph Booth and Sons, and to carry on the business of engineers, crane manufacturers, machinists, founders, electricians, and suppliers of electricity for the purposes of light, heat, motive power and otherwise. The first Directors are:—John W. Booth, William Booth, Arthur Booth and John A. Booth.

ENGINEERING AND ELECTRIC WORKS CO. (LIMITED).—This company was registered on Jan. 9, with a capital of £5,000, in £1 shares, to carry on the business of general engineering contractors, electricians, mechanical and electrical engineers, suppliers of electricity, and manufacturers of and dealers in electrical apparatus, and to construct, lay down, fix and carry out all necessary cables, wires, lines, &c.

LEECOLL ELECTRIC BATTERY CO. (LIMITED).—This company was registered on Jan. 5, with a capital of £60,000, in £1 shares, to acquire and develop Patent No. 10,439, (1897), and any subsequent improvements therein, to manufacture, sell and deal in lamps, primary and secondary electric batteries, vehicles, carriages, motor cars, motors, &c.

NUNEATON AND DISTRICT LIGHT RAILWAY CO. (LIMITED).—This company was registered on Jan. 5, with a capital of £2,000, in £1 shares, to apply for Orders for the construction and working of a light railway in Nuneaton, Warwickshire, and its neighbourhood, and to construct, equip, maintain and work railways and tramways by electricity or other motive power

AFRICAN TRANSCONTINENTAL TELEGRAPH CO. (LIMITED).—The annual return to Dec. 28 has been filed. The capital is £300,000, in £1 shares, of which 154,980 have been taken up. The full amount has been called.

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HOWELL'S SIMPLEX ANTI-INDUCTIVE TELEPHONE SYNDICATE (LIMITED).—The statutory return to Dec. 13 has been filed. The capital is £12,000, in 11,950 Ordinary shares of £1 each, and 1,000 Deferred shares of 1s. each. 2,840 Ordinary and 176 Deferred shares have been taken up, and the full amount has been called.

RIVER PO ELECTRIC AND POWER SYNDICATE (LIMITED).—The statutory return to Nov. 12 gives the capital as £10,000, in £1 shares (of which 1,000 are Deferred). Seven shares have been taken up and paid for in full.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Oct. 13, 1898). Price of silver 27 5/16d. per oz. (Jan. 12). Consols (2¾ per cent.) 110 7/8—111 for money, 111—111 1/16 for account; 2½ per cent. 103½—104 (Jan. 12). Stock Exchange Settling Days: Stocks and Shares Continuation Days, Jan. 25 and Feb. 8; Ticket Days, Jan. 26 and Feb. 9; Pay Days, Jan. 13 and 27; Mining Share Carry over Days, Jan. 24 and Feb. 7.

BLACKPOOL AND FLEETWOOD TRAMWAY CO.—It has been decided to issue £30,000 new ordinary capital in shares of £10 each to rank *pari passu* with the existing shares. The new issue is rendered necessary, on account of the success of the line, and to allow of further developments. Although the line has only been open five months, the receipts for the half-year will, it is stated, permit the payment of 8 per cent., and leave a substantial balance.

DIRECT UNITED STATES CABLE CO. (LIMITED).—An interim dividend of 3s. per share, free of tax (being at the rate of 3 per cent. per annum), for the quarter ended Dec. 31, will be payable on and after the 31st inst. The Directors have set aside £12,000 to reserve, and carry forward about £5,920. The transfer books will be closed from 17th to 31st inst. inclusive.

ELECTRIC CONSTRUCTION CO. (LIMITED).—The transfer books of the Four per Cent. Perpetual First Mortgage Debenture stock of this company are closed to the 14th inst.

GENERAL ELECTRIC CO. (OF AMERICA).—This company has declared a dividend on the Preferred stock of $1 1/2, payable Jan. 31.

HAMPSTEAD ELECTRIC SUPPLY CO. (LIMITED).—The transfer books of the Preference shares of this company are closed to 27th inst.

NEW ITALIAN ELECTRIC CO.—The business of Messrs. Gadda and Co., electrical engineers, Milan, has been turned into a limited liability company, with a capital of 2,000,000 lire.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to 13,334 Ordinary £10 shares and 20,000 £10 Five per Cent. Cumulative Preference shares of the *Potteries Electric Traction Co. (Limited)*. The committee has also been requested to allow the further issue of £10 shares of the *Brazilian Submarine Telegraph Co. (Limited)*, and the further issue of 150,000 Four per Cent. Debenture stock of the *Edison and Swan United Electric Light Co. (Limited)* to be quoted in the Official List.

SVENSKA AKTIEBOLAG SIEMENS AND HALSKE.—This is the title of a company formed in Stockholm, with a capital of 300,000 kroner, to carry out electrical undertakings in Sweden.

TELEGRAPH MANUFACTURING CO. (LIMITED).—The shares of this Company have been granted an official quotation by both the London and Liverpool Stock Exchanges, and are now regularly quoted in the Official Lists.

WEST INDIA AND PANAMA TELEGRAPH CO. (LIMITED).—The estimated amount of the traffic receipts of this company for the half-month ended Dec. 31 is £2,367, against £2,205 in the corresponding period of 1897.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Jan. 7	3,852	+ 304	...	...	...
Blackpool Corporation...	,, 5	143	+ 31	40	16,470	+ 2,462
Blackpool and Fleetwood Co.	,, 7	166	...	1	166	...
*Bristol Trams & Carriage	,, 6	2,506	+ 43	1	2,506	+ 43
City & South London Ry.	,, 8	1,143	+ 19	2	2,179	+ 5
Dover Corporation	,, 7	154	+ 37	40	7,352	...
†Dublin United (Southern)	,, 6	510	+ 173	1	510	+ 173
Liverpool Overhead Rly.	,, 8	1,339	− 99	2	2,630	− 165
*Sheffield Tramways.....	,, 8	1,278	+ 265	1	1,278	+ 265
*†South Staffs. Trams ...	,, 6	458	− 83	1	458	− 83

* Partly electrical. † Six days' receipts.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Jan. 4.		Price Wednesday, Jan. 11.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Week Ending Jan. 11. Highest	Lowest
								£ s. d.			
			TELEGRAPHS.								
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	103	104	103	104	3 16 11	January and July	103½	..
25,000	10	..	Amazon Telegraph	3	4	3	4	..	..	..	..
£125,000	100	5%	Do. 5 per Cent. Debentures	91	94	91	94	5 6 5	..	..	..
£305,560	Stock	15/0	Anglo-American	63	68	63	63	4 9 3	Feb., May, Aug., Nov.	63½	..
£3,047,220	Stock	30/0	Do. Preferred	116	117	117	118	5 8 0	,, ,,	118	117
£3,047,220	Stock	5/0	Do. Deferred	16½	17½	17	17½	..	..	17⅝	17
180,000	10	3/0	Brazilian Submarine	15½	15⅝	15½	15⅝	4 8 11	Mar., June, Oct., Dec.	15⅝	15⅜
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	110	114	110	114	4 7 9	June and December	..	..
10,000,000	$100	$2½	Commercial Cable Capital Stock	189	190	189	190	4 4 8	Jan., Apr., July, Oct.	..	..
£1,332,522	Stock	4%	* Do. 4 per Cent. Debenture Stock	103	105	103	105	3 16 1	,, ,,	104½	104
16,000	10	8/0	Cuba Submarine Ordinary (Deferred)	10	11	10	11	6 7 3	February and August	..	..
6,000	16	10/0	Do. Preference 10 per Cent.	16½	17½	17	18	5 11 1	,, ,,	..	..
12,981	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October	..	..
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	,, ,,	..	..
£30,000	50	4½%	Do. 4½ per Cent. Debentures	104%	107%	104%	107%	4 4 1	January and July	..	..
60,710	20	3/0	Direct United States Cable	11½	12½	11½	12½	5 6 1	Jan., Apr., July, Oct.	12½	1 ⅜
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	102	105	102	105	4 5 9	..	..	..
£1,000,000	Stock	..	Eastern Ordinary	178	178	174	179	3 18 10	Jan., Apr., July, Oct.	177	176
£1,296,000	Stock	17/6	Do. 5½ per Cent. Pref. Stock	104	107	104	107	3 5 5	,, ,,	105½	10 ½
£1,482,268	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	121	128	121	123	3 2 6	May and November	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1899	101	104	101	104	4 17 0	February & August	..	..
£500,000	Stock	8/9	Do. Provisional Certificates 50% paid	54	57	54	57	..	..	..	..
250,000	10	2/6	Eastern Extension	17½	18	17½	18	3 17 9	Jan., Apr., July, Oct.	17 1/16	17 1/16
£120,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	129	125	129	3 2 4	February & August	..	..
£16,200	100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Deb. 1900 (reg.)	99	103	99	103	4 17 1	January and July	..	..
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	,, ,,	..	..
£35,100	100	5%	*Eastern and S. African 5 p.c. Mor. Deb., 1900 (reg.)	99	103	99	103	4 17 1	,, ,,	103	100
£46,500	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	,, ,,	103	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	104	107	104	107	3 15 8	February & August	..	..
£300,000	25	4%	* Do. 4% Mauritius Sub. Debs. (red.)	104%	107%	104%	107%	3 15 2	May and November	10 %	..
180,237	10	1/9	Globe Telegraph and Trust	12½	12⅝	12½	12⅝	4 0 9	Jan., Apr., July, Oct.	12 1/16	12 1/16
180,043	10	6%	Do. 6 per Cent. Preference	16⅝	17½	16⅝	17½	3 9 7	,, ,,	17⅛	16⅛
150,000	10	5/0	Great Northern of Copenhagen	28½	29½	28½	29½	3 7 10	January, April, July	28 7/16	28⅛
£150,000	100	5%	* Do. 5 per Cent. Debs., 1883 issue Series "B"	101	104	101	104	4 17 7	March & September	..	..
£97,800	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red)	100	103	100	103	4 7 5	June and December	..	..
17,000	25	12,6	Indo-European	56	59	56	53	4 4 9	May and November	57½	57
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	109	112	109	112	5 7 7	March & September	..	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red)	104	107	104	107	3 14 9	June and December	..	..
11,839	8	4/0	Reuter's	7	8	6½	7½	5 6 8	April and October	..	..
2,231	£100 Cert.	6%	Submarine Cables Trust	134	139	134	139	4 6 9	,, ,,	..	..
15,609	10	..	West African Telegraph	..	..	..	..	..	..	..	..
£100,000	100	5%	* Do. 5 per Cent. Debentures (red.)	101	103	100	103	4 18 6	March & September	102½	..
30,008	2½	..	West Coast of America	⅛	1	⅛	1	..	..	..	..
£150,000	100	4%	* Do. 4 per Cent. Debentures	102	105	102	105	3 16 2	June and December	..	..
88,231	10	1/6	West India and Panama	1⅜	2⅛	1⅜	2	..	May and November	2	1 1/16
24,563	10	6/0	Do. 6 per Cent. 1st Preference	10½	10⅝	10½	10⅝	5 11 7	,, ,,	10⅝	10½
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	8½	9⅛	9	10	6 0 0	,, ,,	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	104	107	4 13 6	January and July	..	..
64,259	15	5/0	Western and Brazilian Ordinary	12½	13⅛	12½	12⅝	4 13 2	May and November	..	..
28,129	7½	3/9	Do. 5 per Cent. Preferred Ordinary	8	8½	8	8½	4 8 2	,, ,,	..	..
28,129	7½	1/3	Do. Deferred Ordinary	4	4⅛	4	4⅛	..	,, ,,	..	..
£189,531	Stock	4%	* Do. 4 per Cent. Debenture Stock	105	108	105	108	3 14 1	June and December	..	..
1,168,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	—	—	—	—	6 7 10	Feb., May, Aug., Nov.	..	..
£158,100	100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	93	103	98	103	5 16 6	March & September	..	..

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share	Last Dividend	Name	Previous Week's Price Jan. 4		Price Wednesday, Jan. 11		Rate per Cent. Yielded £ s. d.	Dividend Due	Business Done During Week Ending Jan. 11: Highest	Lowest
			TELEPHONES.								
44,000	£5	4/6	Chili Telephone (fully paid)	2¾	3¼	2¾	3¼	6 8 1	August	—	—
224,850	10/0	1½d.	Consolidated Telephone Const. & Manufacturing	1/16	3/16	1/16	3/16	6 7 0	July	—	—
28,000	5	4/0	Monte Video Telephone 6 per Cent. Preference	—		..		—	October	—	—
484,597	5	3/0	National	5⅝	5⅞	5⅝	5⅞	5 2 2	February & August	5 11/16	5⅝
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	13	15	13	15	4 0 0	" "	—	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	13	15	13	15	4 0 0	" "	—	—
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	5⅜	5⅝	5⅜	5⅝	4 8 11	" "	5½	..
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	99	102	99	102	3 8 8	June and December	100	99½
171,504	1	0/4	Oriental	⅜	⅝	⅜	⅝	6 13 4	April and October	—	—
58,000	5	6/0	United River Plate	4½	5	4¾	5	6 0 0	July	4⅞	—
£151,778	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	102	105	103	105	4 15 2	June and December	..	..
			ELECTRICITY SUPPLY COMPANIES.								
6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	11	11½	11	11½	—	—	11 7/16	..
6,000	10	4/8 1/16	Do. 4½ per Cent. Cumulative Pref.	10¾	11¼	10¾	11¼	4 4 0	—	10¾	—
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	11½	12½	11½	12½	2 16 0	February & August	12¼	12½
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6¼	6	6¼	3 9 3	" "	—	—
£34,000	5	2/6	Chelsea Electricity Supply Ordinary	9	10	9	10	3 0 0	March	—	..
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	113	115	113	115	3 18 3	June and December	113	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red)	103	105	103	105	4 15 3	—	..	—
50,000	10	5/0	City of London Elec. Lighting Ord. 40,001 to 90,000	22	24	22	24	5 4 2	February & August	23	22¾
10,000	10	1/9	Do. Ordinary 90,001 to 100,000	21	23	21	23	..	—	23½	22¾
40,000	10	6%	Do. 6% Cumulative Pref.	15½	16½	15½	16½	3 11 9	January and July	15¾	—
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	125	110	125	110	3 16 11	June and December	128¾	..
30,000	10	—	County of London & Brush Prov. Ord. (1 to 30,000)	12½	13½	12	13	—	—	12¾	12½
10,000	10	..	Do. (30,001 to 40,000)	12	13	11½	12½	..	—	—	—
20,000	10	6/0	Do. 6% Cumulative Preference	14½	15½	14½	15½	4 0 0	March & September	15	14¾
15,660	5	2/6	House-to-House Electric Lighting Supply Ord.	9	10	9	10	2 0 0	—	9½	—
12,000	5	3/6	Do. 7 per Cent. Preference	9½	10½	9½	10½	3 6 8	March & September	—	—
15,000	5	10%	Kensington and Knightsbridge Ord.	13	14	13½	14½	3 15 10	..	—	—
10,000	5	6%	Do. 6% 1st Pref.	7¾	8¼	7¾	8¼	3 12 9	January and July	..	—
110,000	3	—	London Electric Supply Ordinary	3	3¼	3	3¼	—	—	3¼	—
48,050	5	—	Do. Preference	6	6¼	6	6¼	—	—	6 3/16	6¼
£100,000	Stock	..	Do. 4% 1st Mort. Deb.	102	104	102	104	3 16 11	Mch., June Sept., Dec.	103	—
62,500	10	5/0	Metropolitan Electric Supply Ordinary	17½	18½	18	19	3 3 2	April and October	18½	18
27,500	10	—	Do. (£4 paid)	10½	11½	10½	11½	..	—	11¼	—
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	115	119	115	119	3 15 8	June and December	..	..
6,452	10	6/0	Notting Hill Electric Ordinary	17	18	17	18	3 6 8	March	—	—
10,000	5	—	Oxford Electric Ordinary	6	6½	6	6½	—	—	—	..
275,000	1	—	Rand Electric	⅞	1⅛	⅞	1⅛	—	..	—	..
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb	86	91	88	91	5 9 1	—	—	—
110,000	$100	$2	Royal Electric Company of Montreal Shares	150	155	150	155	5 3 3	—	—	—
180,900	100	4½%	* Do. 4½% 1st Mort. Debs.	105	107	105	107	4 5 10	April and October	—	..
31,980	5	5/0	St. James and Pall Mall Electric Ordinary	16	17	17	18	4 9 0	February & August	17 11/16	16¾
20,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	" "	9½	9½
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.)	..		..		..	June and December	..	—
65,000	5	..	South London Electric Supply Ordinary (£3 paid)	2¾	3¼	3	3¼	..	..	2¾	3
79,900	5	5/0	Westminster Electric Supply Ordinary	15½	16½	15½	16½	3 18 9	March & September	16½	15
18,848	5	5%	Yorkshire House-to-House	7¾	8	7¾	8	3 2 6	February and July	—	—
18,626	5	5%	Do. (£4 paid)	5¾	6¼	5¾	6¼	3 13 5	February and July	—	—
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	2	1/2¾	Brush Electrical Engineering	1⅞	2	1⅞	2	3 0 0	—	—	—
90,000	2	1/2¾	Do. 6 per Cent. Pref. Non-Cumulative	2½	2⅝	2½	2⅝	5 1 1	—	—	—
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	111	115	111	115	3 19 0	February & August	—	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101	104	101	104	4 6 7	June and December	..	..
£30,000	5	5/0	Callender's Cable Construction	9½	10½	9½	10½	6 8 7	" "	10¼	—
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	110	113	110	113	3 19 8	November and May	..	—
300,000	1	9⅜	Castner-Kellner Alkali Co. (fully paid)	1½	1⅝	1½	1⅝	5 16 5	—	1 9/16	—
50,000	1	..	Chadburn's Ship Telegraph Ordinary	1⅛	1⅜	1⅛	1⅜	..	—	..	—
50,000	1	7½	Do. 6 per Cent. Cumulative Pref.	1	1¼	1	1¼	4 16 0	—	—	—
32,098	3	1/6	Crompton and Co. (Nos. 1 to 32,098)	1⅞	2¼	2½	2¾	..	..	..	—
£42,850	100	5%	* Do. 5% First Mort. Deb. (red.)	89	94	89	94	5 6 5	January and July	—	—
99,261	5	2/1½	Edison and Swan United ("A" Shares) (£3 paid)	2½	3¼	2½	3	6 11 9	February & August	—	—
17,139	5	3/1½	Do. (£5 paid)	4	5	4	5	6 0 0	" "	..	—
£194,023	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	95	97	96	98	4 1 8	June and December	98¾	—
17,400	5	5%	Edmundson's Electric Corporation Ord (fully paid)	5	5½	5	5½	4 10 11	Half-yearly	..	—
110,000	2	1/2¾	Electric Construction Co. (Limited)	2½	2¾	2½	2¾	4 12 0	February & August	2 7/16	2 5/16
25,000	2	2/9¾	Do. 7 per Cent. Cumulative Pref.	2¾	3¼	2¾	3¼	4 6 2	August	..	—
£111,100	Stock	4%	Do. 4% First Mortgage Deb. (red.)	105	107	105	107	3 16 2	—	..	—
91,196	1	—	Elmore's Patent Copper Depositing	⅛	⅜	⅛	⅜	..	—	—	—
12,500	10	8/0	Henley's Telegraph Works Ordinary	22	23	22½	23½	5 10 8	February & August	23	22½
8,000	10	7/0	Do. 7 per Cent. Preference	18	19	18	19	3 18 8	" "	19	—
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 8	" "	—	..
60,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	4 8 11	" "	21⅞	22¼
300,000	100	4%	* Do. 4% First Mortgage Debentures (red.)	102	106	102	106	3 15 6	March & September	—	..
37,850	12	12/0	Telegraph Construction and Maintenance	37	41	37	41	4 6 2	March and July	39¾	38½
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	103	105	..		..	January and July	..	..
12,490	5	—	Telegraph Manufacturing Ordinary	7	7½	8	8½	—	—	7⅞	..
13,4?0	5	..	Do. 5% Cum. Pref.	5½	6	5½	6	4 3 4	—	..	—
£?,000	5	4/0	Williams and Robinson Ordinary	7½	8½	8½	8½	4 11 5	April and October	8½	—
£30,000	5	3/0	Do. 6% Cumulative Preference	6¾	7½	6¾	7½	4 2 9	" "	7 3/16	—
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	106	108	105	108	3 18 8	May and November	108	107½
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	..	Blackpool and Fleetwood Tramways	19½	20½	20	21	..	—	20½	20
25,000	10	6%	Bristol Tramways and Carriage	21½	22	21½	22	2 4 7	—	—	—
25,000	10	6%	Do. (£7. 10s. paid)	18⅝	18⅞	18⅝	18⅞	1 14 1	—	—	—
£30,410	Stock	4%	Do. 4% Debenture	120	121	120	121	3 6 2	—	—	..
80,000	10	..	British Electric Traction Ordinary	15½	16½	16	17	..	—	16½	..
10,000	10	2/4 7/16	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm.pd.)	13	13½	13	13½	4 8 11	—	13⅛	13½
£100,000	Stock	6/2 8	Do. 5% Perp. Deb.	119	121	119	121	..	—	120½	120
40,000	5	..	Buenos Ayres & Belgrano 6% Cum. Pref. (£3 paid).	2½	3½	2½	3½	..	..	3	—
27,500	5	..	Do. do. do. (fully paid)	3½	3¾	3	3½	..	..	3½	3
£260,000	Stock	..	Do. do. 5% Deb.	103	105	103	105	4 15 3	..	109½	..
£35,250	10	3/0	Central London Ordinary	9½	10½	9½	10½	2 18 0	June and December	10⅛	9⅞
178,898	10	1/9¾	Do. (£6 paid)	5½	6½	5½	6½	2 16 6	" "	—	..
£540,000	Stock	2½%	City and South London Railway Con. Ordy.	67	69	67	69	2 18 0	January and July	69	68
22,500	10	..	Do. Ordinary (£4 paid)	3½	4	3½	4	..	..	—	—
9,251	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	3 4 6	January and July	—	—
£137,701	Stock	4%	Do. 4% Perpetual Debenture	131	133	133	135	2 9 7	May and November	133½	..
20,000	10	6%	Imperial Tramways Ordinary (old £6 shares)	17	17½	17½	17¾	3 7 7	March & September	18	17½
10,000	10	6%	Do. 6% Preference	15½	16½	15⅝	16⅛	3 16 10	" "	15⅝	15⅝
£70,000	Stock	4½%	Do. 4½% Debenture	117	118	117	118	3 16 3	..	118½	117½
37,890	10	3%	Liverpool Overhead Railway Ordinary	10	10½	9 15/16	10 1/16	3 4 9	February & August	—	—
10,000	10	5%	Do. 5% Preference	14¾	15¾	14¾	15¾	3 5 7	" "	—	—
135,000	Stock	4%	Do. 4% Debentures	106	108	106	108	3 14 1	January and July	—	—
20,000	5	3,3¾	New General Traction 6% Cumulative Pref	4¾	5¼	4¾	5¼	5 14 3	—	—	—
£540,000	Stock	3%	Waterloo and City Ordinary	111	114	111	114	2 13 4	June and December	—	—

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

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CONTENTS OF THE CURRENT NUMBER.

NOTES	427	Electricity Works Accounts	441
Meetings of Scientific Societies	429	A New Accumulator Switch. Illustrated	441
The Electric Lighting of Gibraltar. Illustrated	430	Induction Telegraphy.—*Discussion*	442
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe	437	Correspondence	446
COMPANY PROMOTION "IN BULK"	438	Legal Intelligence	446
Carbons for Electric Lighting and Other Purposes. By F. Jehl. Illustrated. Continued	439	Trade Notes and Notices	446
		Companies' Meetings & Reports	453
		New Companies, &c.	454
		City Notes	454
		Companies' Share List	456

NOTES.

THE new map of electric supply undertakings in the United Kingdom, which we publish as a Supplement this week, shows at a glance the distribution of these undertakings throughout the country. The circles and squares of red and blue, strangely intermingled, indicate by their shape the distribution of company and municipal undertakings, and by their colour that of alternating and continuous-current systems. In a former edition of this map we found it necessary to introduce a special inset map of the London stations, owing to the great and increasing density in this district. The Black Country, from a similar cause, threatened to belie its name and not only to become an incoherent chromatic effect, but to do violence to geography by overcrowding and displacement. We have therefore removed that sooty territory to a second inset map, which has found a convenient place in the, electrically speaking, uncultivated regions of north-west Scotland. We hope that the Supplement in its latest guise will prove of even greater utility than its predecessors.

THE prompt selection of a successor to Sir SPENCER WALPOLE as Secretary to the Post Office will have the good effect of silencing a good deal of irritating discussion which was springing up in respect of the various claimants to the vacant Secretaryship. The appointment of an outsider is quite in accordance with precedent. Sir ARTHUR BLACKWOOD left the Treasury to become Financial Secretary to the Post Office by way of preliminary to his succeeding Sir JOHN TILLEY, who was then approaching the eve of his retirement. Mr. WALPOLE's appointment was a still more conspicuous example of the same procedure, his previous position—that of Lieutenant-Governor of the Isle of Man—having no relation whatever with the postal service. This important appointment is practically in the gift of the Treasury, and we make no doubt that in selecting Mr. MURRAY his antecedents and progressive views have been duly considered by that autocratic body. The funny thing is, that the offer is reported as having been "accepted in deference to the special request of Her Majesty's Government."

PLYMOUTH, Devonport, and Stonehouse are three towns situated so near together as to form a sort of municipal galaxy. In the matter of electrical supply, Plymouth has been foremost, though its long-delayed municipal power station is still uncompleted. A municipal electric supply system is now projected at Devonport, but there are difficulties in the way, principally connected with the choice of a suitable site for the power station. It seems to us that these three towns afford an admirable arena for a trial of the capacity of local authorities to combine together and run a generating station for supply "in bulk." The area is not as yet coveted by any projected company, and evidence of genuine intention on the part of these local authorities might go far towards simplifying the present difficulty in connection with undertakings for wholesale supply. But if it is impossible for two large and closely related towns, like Plymouth and Devonport, to combine their electricity undertakings, what *locus standi* have municipalities in their opposition to companies who are willing to do this sort of thing in other parts of the country?

AT the monthly dinner of the London Chamber of Commerce on Tuesday evening the subject proposed for discussion was "The Progress of Electricity." The Chairman of the Council, Mr. T. F. BLACKWELL, who occupied the chair on this festive occasion, introduced the subject in general terms. He advocated the all-British cable scheme, nationalisation of the telephone system, and greater encouragement of electrical enterprise on the part of the legislature. Mr. SYDNEY MORSE, the chairman of the Electrical Trades' Section, followed up the protest against the excessive restrictions of legislation, and said that Parliamentary Committees had "scotched" electrical progress instead of encouraging it.

MAJOR-GEN. WEBBER was very unhappy because of the resolution of the Chamber in favour of the nationalisation of the telephone system. That resolution. he feared, "would

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be likely to kill the telephone industry in this country"—a compliment to the resolution, if a calamity to the industry. The MAJOR's theory is that the telephone business is purely local, and he alleges that to treat it on a national basis would be disastrous. We all remember his scheme of village telephony, in which the exchanges were to be placed near the Board schools, and the little boys and girls were to be sent out to hunt up an inhabitant whenever he might be "called." If it is such a system as this the MAJOR objects to regard as national, we agree with him; in fact, we hope its realisation in this country may never be even local. For the rest, we repeat our oft-made assertion that the one proper basis for an effective telephone system is that of Government control.

Cable Interruptions.—

	Date of Interruption.
Para—Maranham	Nov. 15. 1898

Energy in Radio-Active Bodies.—A Paper on this subject was read last Monday before the Académie des Sciences at Paris, by Sir William Crookes, F.R.S.

Royal Society.—Among the Papers down for reading yesterday was one by Prof. K. Pearson, F.R.S., and Miss Lee, "On the Vibrations in the Field round a Theoretical Hertzian Oscillator."

The Congo Telegraph.—The Brussels correspondent of the *Standard* learns from an official source that the telegraph line now being laid alongside the Congo River has reached Lukolela, nearly 500 miles from the starting point of the line at Boma.

Municipal Corporations and the National Telephone Co.—At a meeting of the Municipal Corporations Association, held at the Westminster Palace Hotel on Thursday last week, the National Telephone Co.'s three bills were discussed. It was said that if these bills were passed by Parliament they would have an injurious effect on municipalities, and that it was preposterous to allow to be passed a scheme which was designed merely in order that the Telephone Company could, when its licence expired, claim an enormously enhanced value for its property. A resolution was passed to the effect that every possible step should be taken to oppose the measures.

Appointment.—The Duke of Norfolk has offered the Secretaryship of the Post Office, about to be vacated by the retirement of Sir Spencer Walpole, K.C.B., to Mr. George H. Murray, C.B., now chairman of the Board of Inland Revenue. Mr. Murray has accepted the appointment in deference to the special request of Her Majesty's Government. Mr. Murray entered the Foreign Office in 1873, and was transferred to the Treasury in 1880. He was private secretary to Mr. Gladstone in 1892-94, and to Lord Rosebery in 1894-95, when they filled the office of Prime Minister. Mr. Murray succeeded Sir Alfred Milner as chairman of the Board of Inland Revenue in 1897.

Interruptions to Supply.—*Sheffield.*—On the 9th inst., when four alternators of a total capacity of 1,500 kilowatts were running in parallel in the Sheffield central station, one of the machine fuses on the switchboard melted without warning. This set up an arc across the fuse terminals, and immediately afterwards the remainder of the machine fuses melted and two additional arcs were started on the switchboard. This lasted 20sec., until all steam could be shut off and the field and other switches opened. Afterwards a number of fires, caused by the ignition of resin oil and sulphur, had to be extinguished with the aid of sand and canvas cloths. There was a stoppage of the entire system for 7min., then current could be supplied to a large portion of the central area. As soon as the respective alternators could be tested, the remainder of the circuits were connected up in succession, and the supply was completely re-established in 40min.

Stratford.—On Wednesday night a failure of the supply caused the extinction of all the lamps in the Broadway, Stratford.

Personal.—We are informed that Mr. E. C. Rimington has recently taken over the testing and consulting work formerly carried on by Messrs. Harrison and O'Brien, at 19 and 21, Queen Victoria-street, London, E.C. Mr. Rimington is making a speciality of investigating and reporting on new inventions and apparatus, the standardising of high grade instruments (especially for alternating work), the determining of efficiency of lamps and accumulators, and exact testing of transformer iron insulating materials, &c., for manufacturing firms. For these purposes the laboratory at the above address is well furnished with complete sets of special instruments, and the well-known ability of Mr. Rimington, who will be remembered by many former pupils as senior lecturer at the School of Electrical Engineering, Hanover-square, as well as for his experimental work and frequent contributions to technical literature, will offer a guarantee that all work entrusted to him will be carried out in a thoroughly efficient manner. We are glad to be able to mention that Mr. Hadyn J. Harrison will continue to render his advice and assistance.

Institution Premiums.—At the last meeting of the Institution of Electrical Engineers the following were announced as the winners of the various premiums for the session 1897-8:—The Institution Premium: Mr H. F. Parshall, for his Paper on "Earth Returns for Electric Tramways"; the Paris Electrical Exhibition Premium: Mr. Robert Hammond, for his Paper "The Cost of Generation and Distribution of Electrical Energy"; an extra Premium to Mr. L. Andrews for his Paper on "The Prevention of Interruptions to Electricity Supply." The Premium for original communications has been awarded to Mr. H. N. Allen for "Sparkless Reversal in Dynamos." Senior Students' Premium: J. M. Donaldson for his Paper on "Notes on the Dover Tramways"; Second Students' Premium: M. Solomon for his Paper on "Hertz Waves and Wireless Telegraphy"; Third Student's Premium: E. E. Tasker, for his Paper on "Alternate Current Motors"; and "Sir David Salomons" scholarships to Mr. Tom Rolls Renfree (King's College) and Mr. H. J. Tomlinson (University College, London). The "Fahie" Premium has not been awarded, as no telegraphic or telephonic Papers were submitted during the Session.

Wireless Telegraphy to the East Goodwin Lightship.—We are now able to give further particulars in reference to the experiments made by the Wireless Telegraph Co. between the South Foreland lighthouse and the East Goodwin lightship, already alluded to in our issue of December 23rd and in Capt. Brett's remarks at the Institution of Electrical Engineers last week. Permission was granted by the Trinity House authorities for the Company to make use of either the East Goodwin, the Gull-stream, or the South Sand-Head light vessel—the land station to be at the South Foreland lighthouse—and they chose the furthest off of these light vessels, namely, the East Goodwin lightship, which is 12 miles distant from the South Foreland lighthouse. All the apparatus was brought on the lightship in an open boat and rigged up in the course of an afternoon, and on Christmas Eve the lightship and lighthouse were placed in perfect telegraphic communication. Many messages passed on that day, and there has not been the slightest hitch from the starting of the installation to now, every message sent from either shore or ship being perfectly received at the corresponding station. Although the weather has been most tempestuous since the instruments were installed, they have not been in the slightest degree affected.

The Wear of Steel Rails.—In a Paper on "The Effects of Wear upon Steel Rails," read last Tuesday at the Institution of Civil Engineers, by Mr. William G. Kirkaldy, the author recounted how experiments he had carried out on two steel rails which had broken under traffic had led to his devoting special attention to the subject and to a wider investigation. It was found that the breakage of rails resulted from failure commencing at the top surface, and not from the bottom, as appeared to be the usual belief, and that the deterioration was confined entirely to the top or running head. The deterioration was of the nature of a mechanical hardening of the surface under the action of the rolling load. In some cases this hardening further developed into a species of disintegration by the formation of minute

* In calculating this [illegible]

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transverse cracks, which, by gradual deepening, ultimately resulted in failure, unless the rail was removed in time. A description was given of the tests specially devised for ascertaining readily, and in a practical form, the extent of deterioration in worn rails. Briefly, this consisted in bending the rail in reverse directions and comparing the behaviour It was explained that as the bottom member of a rail was found to be undeteriorated in quality by wear, it became possible to determine very closely the original quality of any rail (apart from the loss of substance) by testing it under bending stress in the normal direction—that was, keeping the worn head in compression—also by testing specimens, prepared from the bottom member, under tensile stress. If no deterioration was present, the rail, when bent with the worn head in tension, would bend to a degree corresponding with its behaviour with the worn head in compression. To illustrate this, examples were given showing the wide divergence in some worn rails between their original properties, as brought out under the normal direction of bending, and their behaviour when the direction of test was reversed. The leading features were illustrated by diagrams. A few representative rails taken from under various conditions of service were referred to. On the one hand, in the case of a rail after being subjected to severe brake action, the deterioration was very clearly marked; while on the other hand, in the case of a rail that was under favourable conditions, although after the exceptionally long life of 23 years' main-line service, the deterioration was very slight. The author drew special attention to the significance of this latter rail. From the commencement he refrained from taking an alarmist view of the condition of rails, considering that where failures or breakages had occurred, there would be definite and special causes sufficient to account for them. He anticipated that the great bulk of rails, where under favourable conditions as to service, would not necessarily be found in a bad state. Reference was made to a number of other rails found to remain in excellent condition after various lengths of service up to considerable periods of time. Striking instances of very severe and rapid deterioration, accompanied with the development of induced flaws, were mentioned, illustrated with figures reproduced from the original reports. The following questions suggested themselves in dealing with this subject: (1) Did all rails suffer alike as to the nature of the deterioration? (2) Did not the quality of the steel affect the resistance of rails to deterioration? (3) Did not the commencement and progress of deterioration of any rail depend on, and vary greatly with, the nature of the traffic, but still more on the special conditions due to its situation?

Experiments in Hertzian Telegraphy.—Herr K. Strecker, whose previous experiments in Hertzian telegraphy we have noted (see *The Electrician*, Vol. XL., pp. 780 and 791), gave an account of some further work in the same direction in a Paper read before the Berlin Elektrotechnischer Verein on November 22nd last. His object was to study the conditions under which one could work with long horizontal wires in place of vertical conductors, in view of the greater convenience in erecting and maintaining the former. Prof. Slaby had in his experiments, using wires 100 metres long and stretched 2 metres above the surface of the ground, succeeded in transmitting distinct signals over a distance of 3 kilometres. In the present experiments, conducted at Müggelsee, some 12 miles from Berlin, Herr Strecker used an induction coil with a 50cm. spark and a motor-driven mercury interrupter breaking the primary circuit 20 times per second. Signals were made with a Morse key having carbon contacts, placed in the primary circuit of the induction coil. The radiator consisted of four zinc spheres placed vertically above one another, the two inner ones having a diameter of 20cm., and being placed 1mm. to 3mm. apart in castor oil, while the outer ones were 2·3cm. in diameter and placed some centimetres away from the larger spheres. Various types of coherer were tried, some of brass filings, some of nickel filings and others a mixture of both. There appeared little to choose between them, except that it was necessary to oxidise the nickel filings slightly. The electrodes were small cylindrical pieces of brass, or strips of silver, placed usually some 2mm. or 3mm. apart. In order not to bring the interrupter of the tapper too near to the coherer, an electromagnetic tapper without an interrupter was used at the coherer itself, the magnet being in series with the magnet of a tapper of the usual form. The relay in the coherer circuit was on the d'Arsonval principle, and sensitive enough to work with a tenth of a milliampere; it had a resistance of 200 ohms, and an E.M.F. of 0·1 volt was employed in the circuit. The connections were similar to those described in Herr Strecker's previous paper, with the exception that another relay was interposed between the d'Arsonval relay and the one in the permanent current circuit, this additional relay being bridged by a resistance. The wires connected to the transmitting and receiving apparatus were 100m. long and parallel to one another, the distance between them being 5·7km. Bronze wire, supported on ordinary telegraph poles and insulators, was employed, that at the transmitting end having a diameter of 4·5mm, and being 9·6 metres above the surface of the ground that at the receiving end 2mm. diameter, and 8·4 metres above the ground. There were no obstacles between the wires. Several wires were connected in parallel, but the experiments did not show whether or not this was an advantage. The transmitting station was on a hill about 800 metres from the eastern end of the lake, and the receiving station on an elevation at the western end, and behind each conductor was a pine wood. It should also be mentioned that the two stations were telephonically connected by an overhead line running round one side of the lake. One end of the transmitting line was connected to the radiator, the other end was insulated and the other terminal of the radiator was earthed. The coherer had one terminal earthed, and the other connected to the receiving wire, whose far end could either be earthed through a condenser of 0·24 microfarad or insulated. The former connection unexpectedly gave the better result, and by increasing or decreasing the capacity the results were less good, thus indicating resonance. In spite of wet weather and difficulties in keeping the apparatus dry, the experiments, which were continued for some weeks, were on the whole successful, distinct signals being received; but the Morse signals were somewhat long, and, in consequence, the transmission was very slow. Several modifications in the arrangements were made—*e.g.*, putting the coherer in the middle, instead of at the end of the line, and increasing the length of the receiving line to 300 metres; but these did not occasion any marked improvement. Herr Strecker concludes that the tests have shown that, employing ordinary telegraph stores, and horizontal in place of vertical wires, signals can be transmitted through a distance over 50 times the length of the wires.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, January 20th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Liquid Hydrogen," by Prof. Dewar, F.R.S.

SATURDAY, January 21st.

INSTITUTION OF JUNIOR ENGINEERS.

3:30 p.m. Visit to the Streatham Hill Depôt of the Brixton Cable Tramway.

TUESDAY, January 24th.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

8 p.m. Meeting at the Albion Hotel, Manchester. Paper to be read: "Electric Traction," by H. F. Parshall.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers for further discussion: (1) "The Effects of Wear upon Steel Rails," by W. C. Kirkaldy; (2) "On the Microphotography of Steel Rails," by Sir W. Roberts-Austen, F.R.S.

WEDNESDAY, January 25th.

INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Students' Meeting in the Library of the Institution, when there will be a discussion on "Systems of Electric Traction."

THURSDAY, January 26th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting, when the following Papers, which will be taken as read, will be discussed: (1) "Rules for the Regulation of the Wiring of Premises for Connection to Public Supply Mains," by J. Pigg; (2) "The Regulation of Wiring Rules," by C. H. Wordingham; (3) "The Institution Wiring Rules," by R. E. Crompton.

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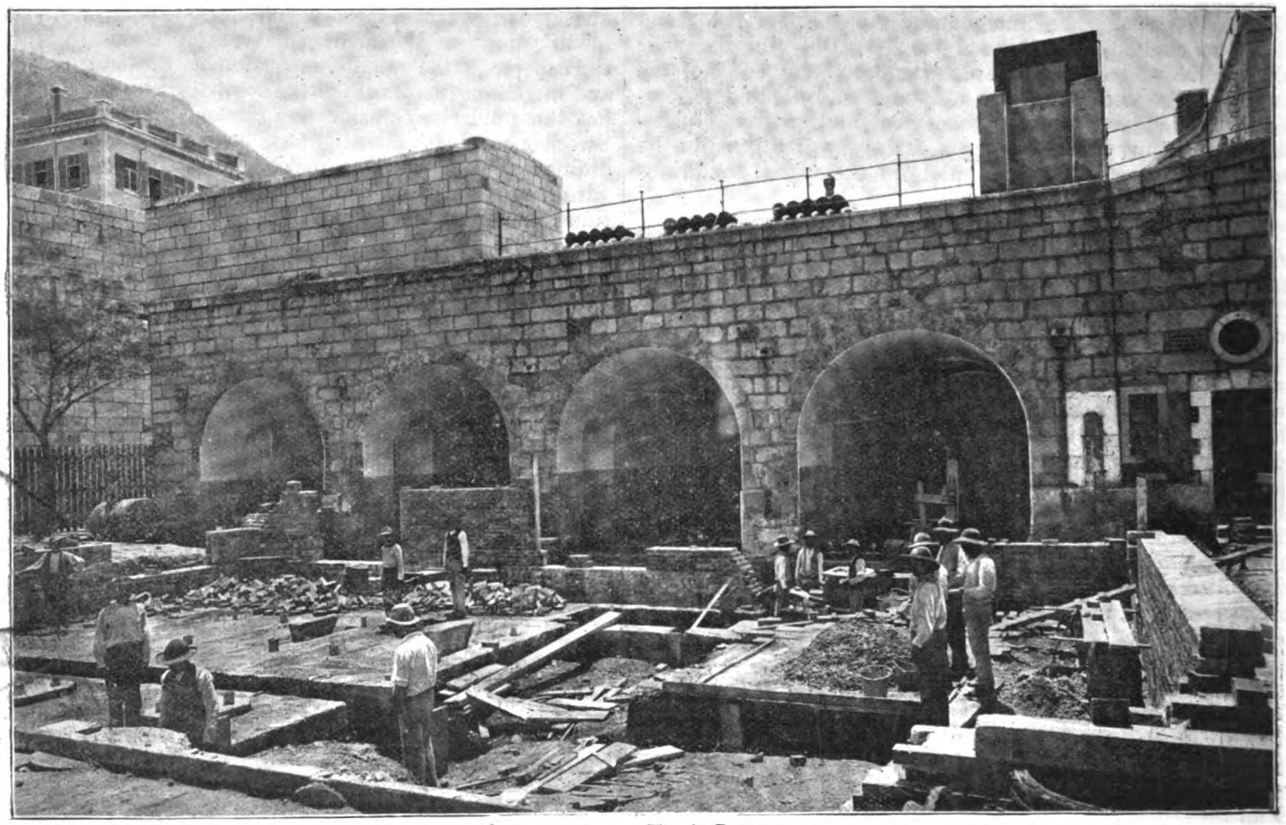
THE ELECTRIC LIGHTING OF GIBRALTAR.

Following the example of Malta, Singapore and other Crown Settlements, Gibraltar has recently inaugurated a complete system of public and private electric supply, chiefly for lighting purposes. This has been carried out to the designs and under the direction of Mr. A. H. Preece. The site selected for the power station is known as the King's Bastion, and is probably one of the best protected spots on the Rock. It was originally an artillery barracks, and, being built on the solid rock, considerable difficulty was experienced in the excavations necessary to adapt the forti-

General View of Gibraltar, Showing the King's Bastion and New Breakwater.



Interior of the King's Bastion.

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ELECTRIC SUPPLY STATIONS OF THE UNITED KINGDOM.

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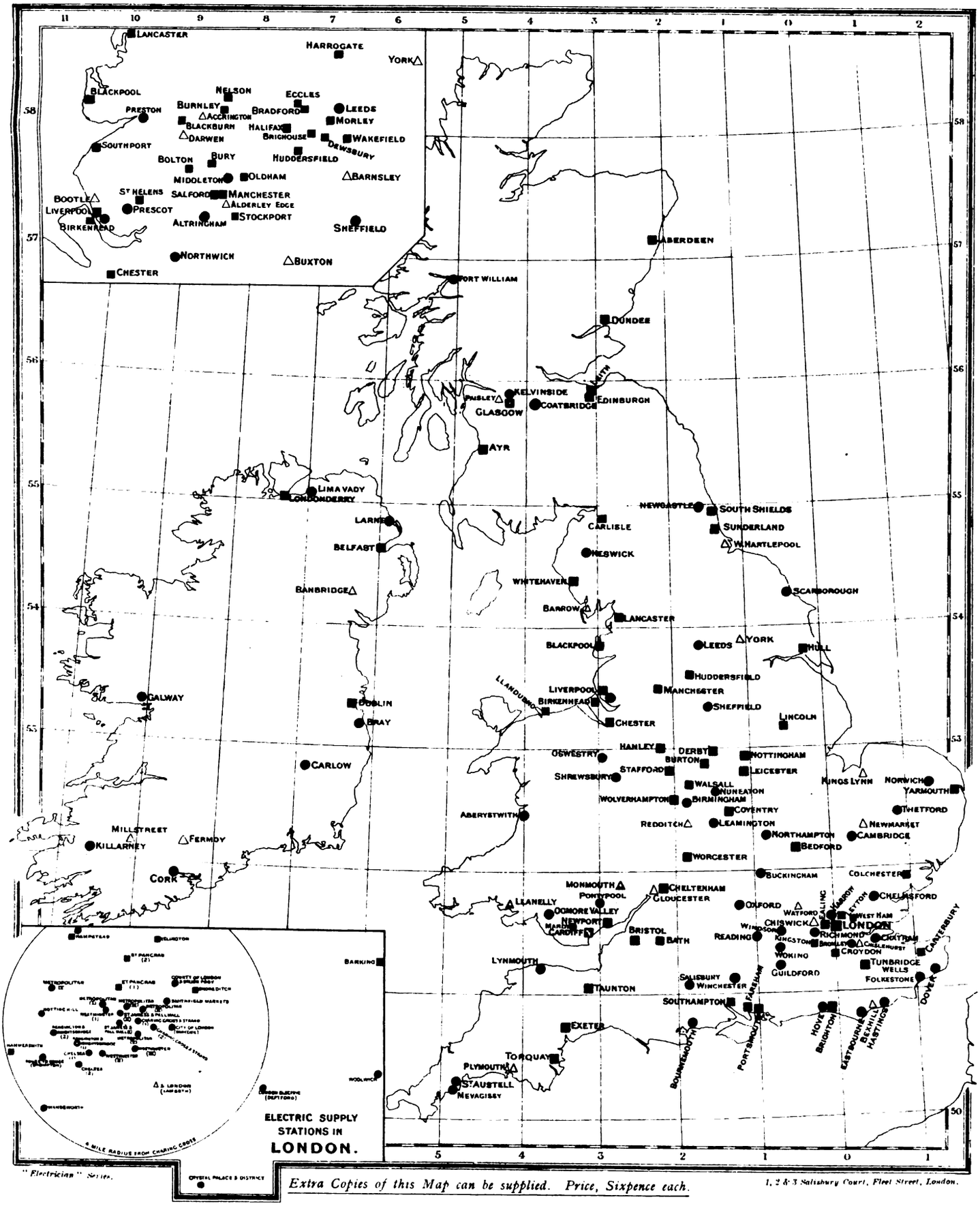
Data relating to these Stations will be found in the Electric Supply Works Table, published with our issue of the 6th January, 1899.



Extra Copies of this Map can be supplied. Price, Sixpence each.

1, 2 & 3 Salisbury Court, Fleet Street, London.

Blue = Continuous Current.
Red = Alternating Current.

□ = Municipality.
○ = Company.

△ = In Progress.

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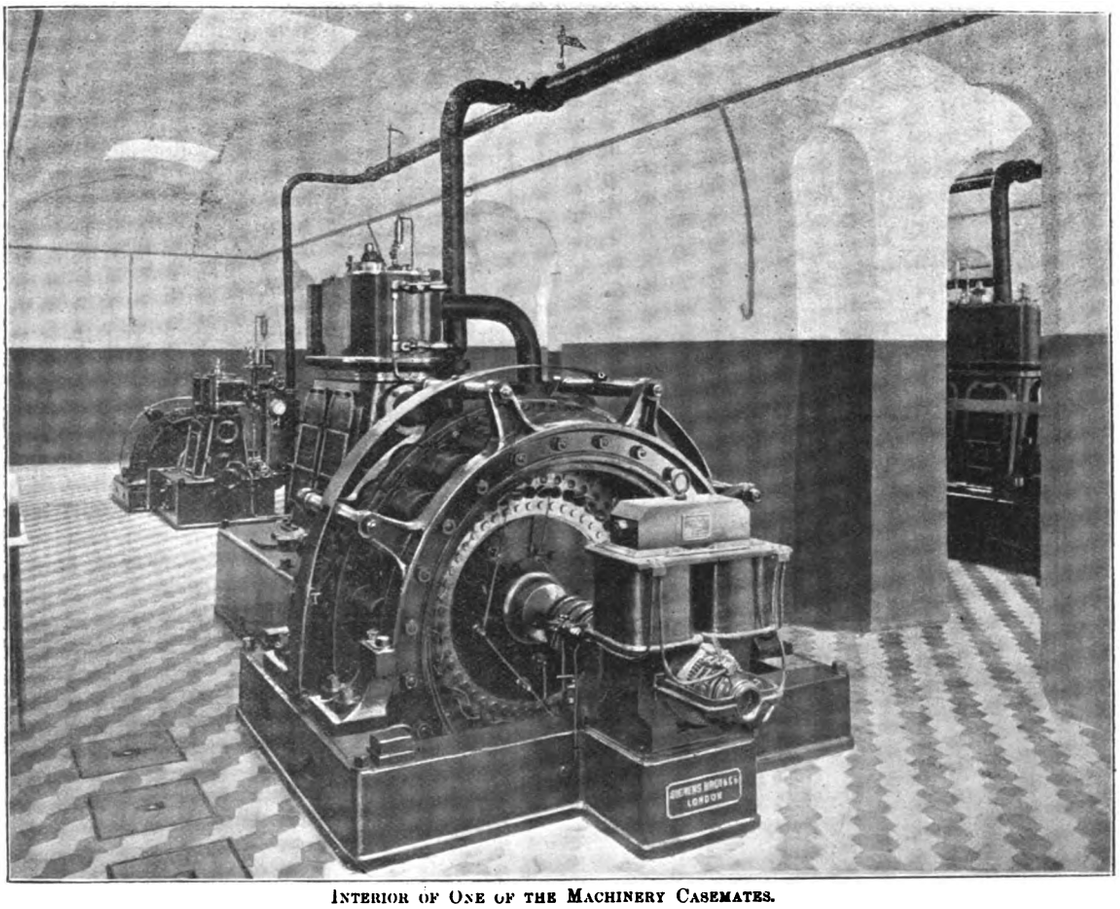
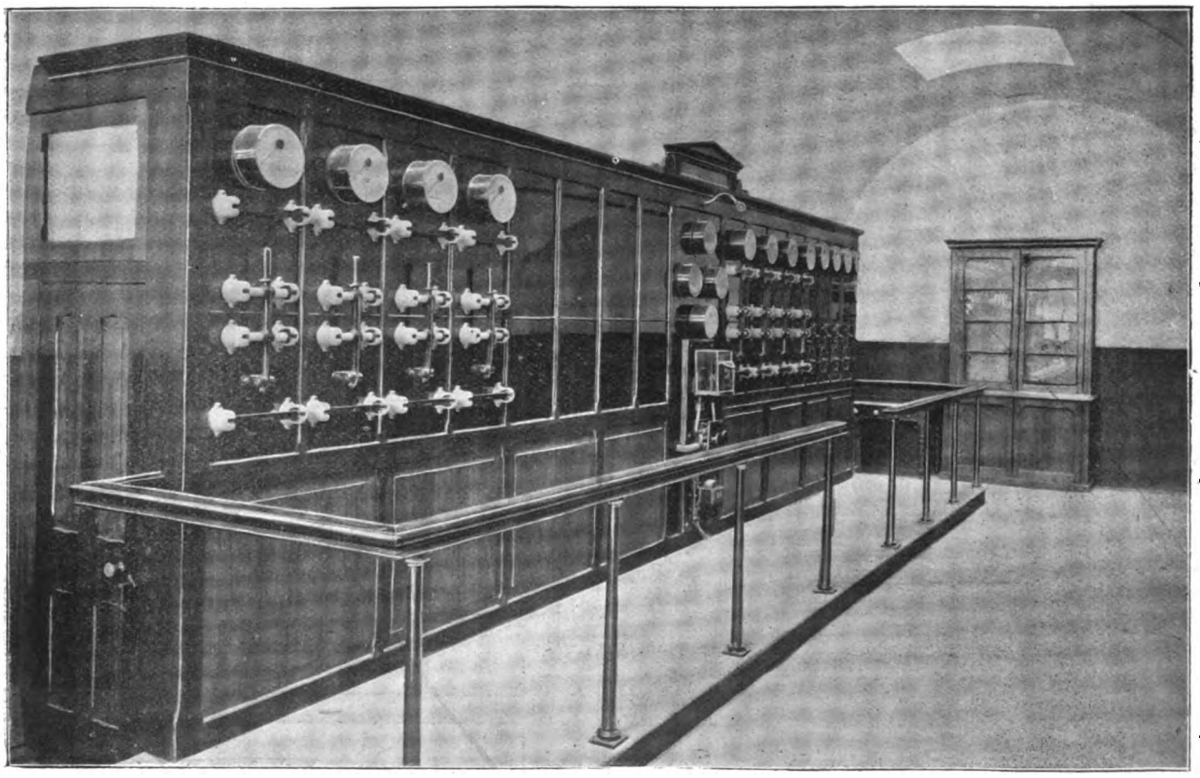
fication to the purpose of an electric light station. Some idea of the work that has been done in this direction may be gathered from the accompanying illustrations and scale drawings. The station buildings consist of a double lean-to structure, built on three different levels, viz.: Firstly, the old level of the barracks; secondly, a lower level for the engine room and casemates; and, thirdly, a still lower level for the boiler house, the latter at about sea level. The buildings, which have been admirably adapted to their present purpose, were erected by the Colonial Engineering Department, which has not omitted to provide accommodation for considerable extensions of the plant when such may become necessary.



INTERIOR OF ONE OF THE MACHINERY CASEMATES.



INTERIOR OF THE SWITCHBOARD CASEMATE.

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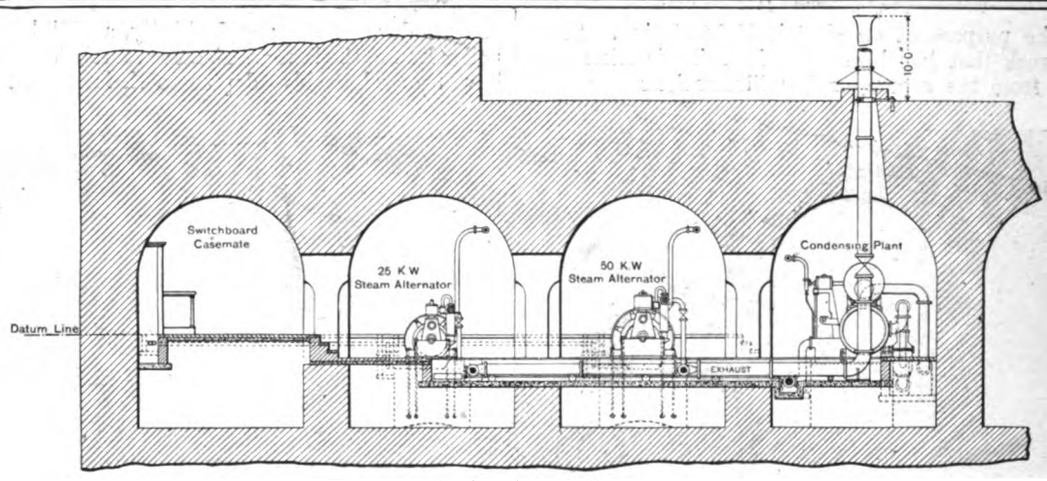
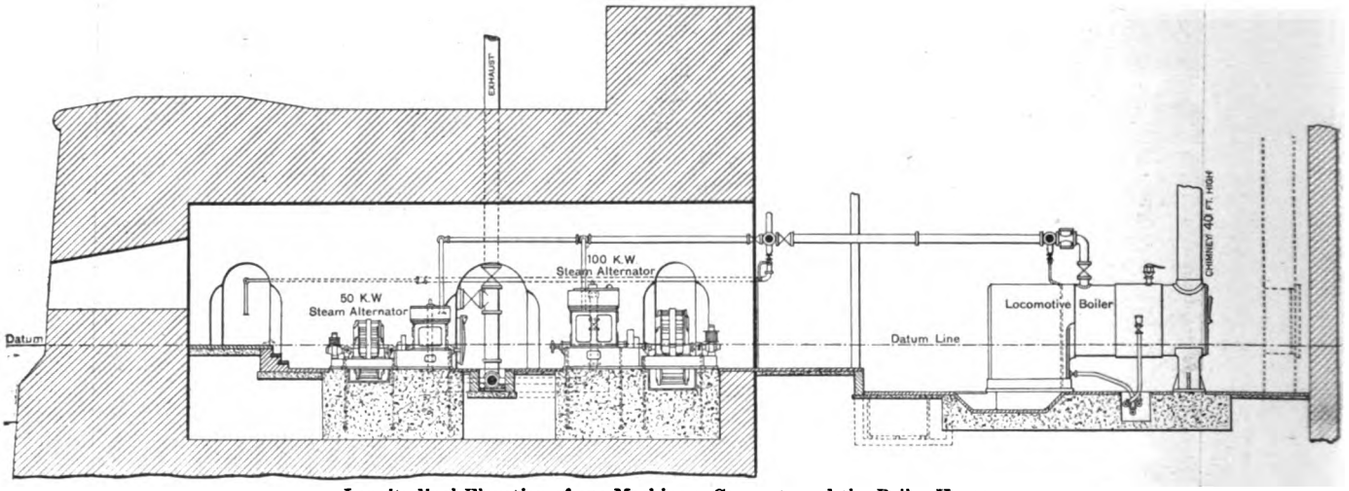
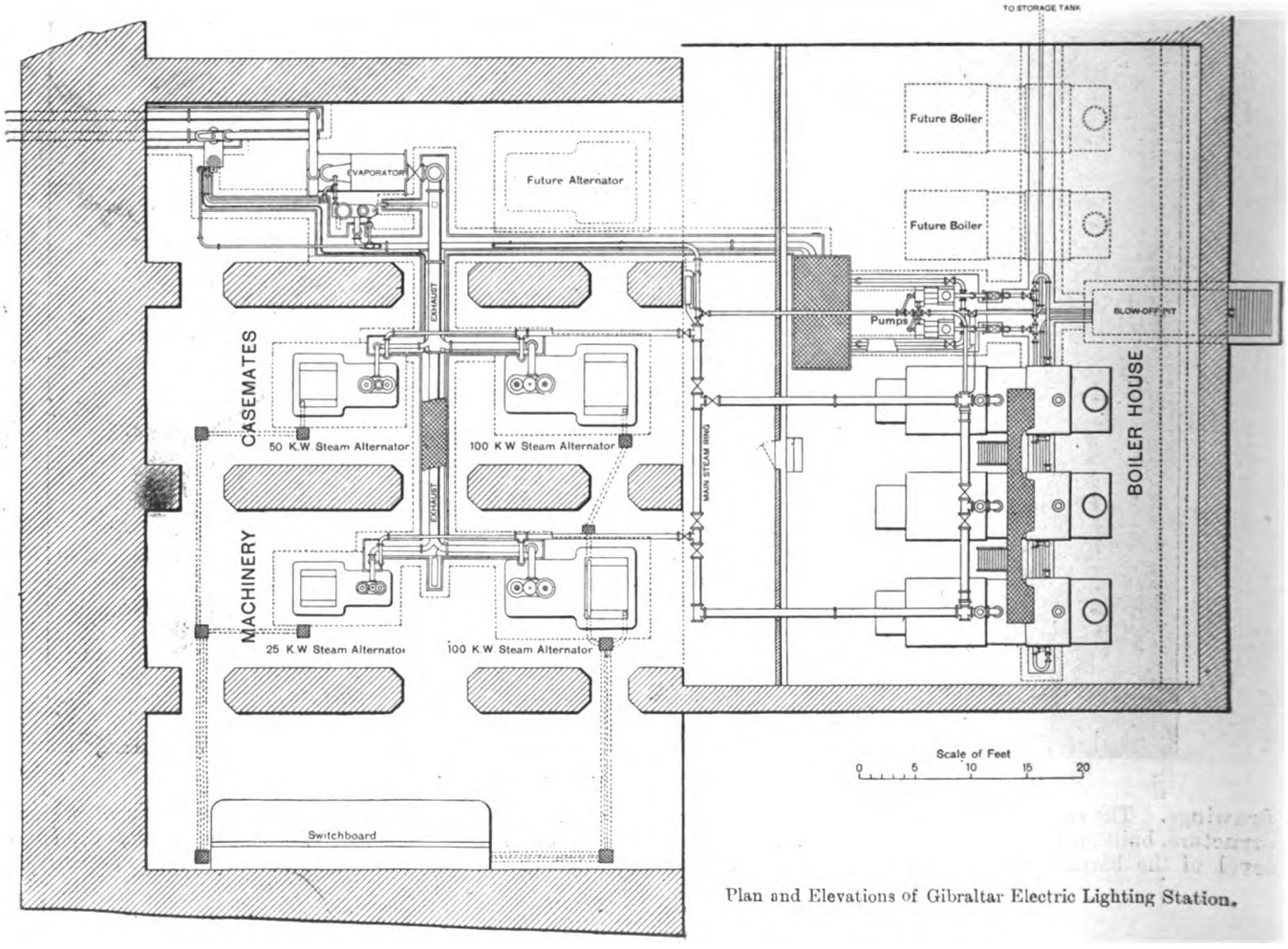


Transverse Section through Casemates.



Longitudinal Elevation of one Machinery Casemate and the Boiler House.



Plan and Elevations of Gibraltar Electric Lighting Station.

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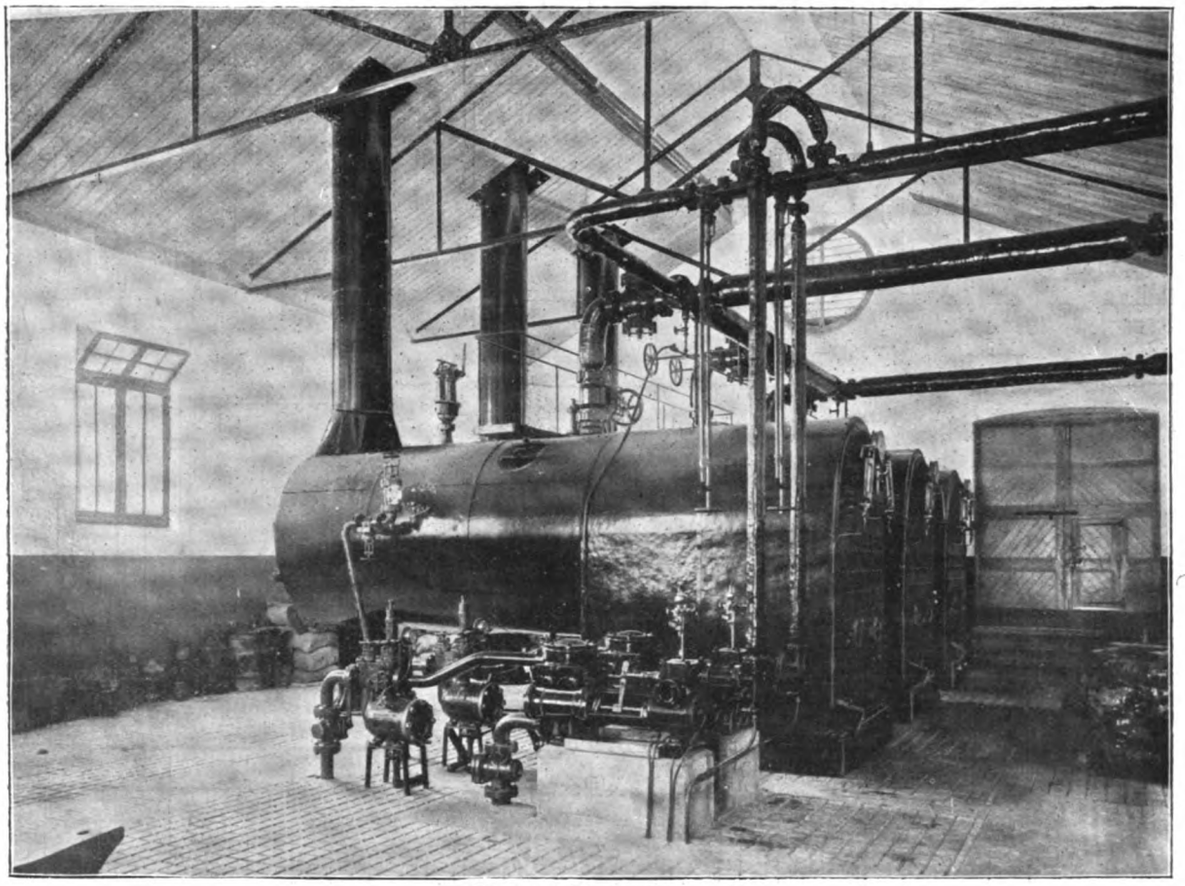
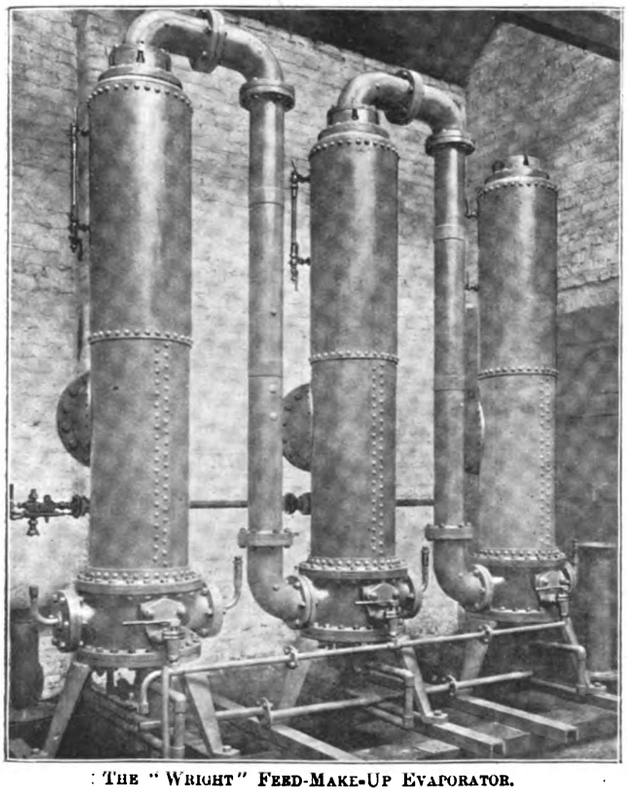
The general arrangement of the machinery in the King's Bastion is sufficiently indicated by the accompanying plans. The station is at present equipped with three locomotive boilers, feeding through a system of steam mains four

have had to be surmounted in arranging for a supply of feed and circulating water.

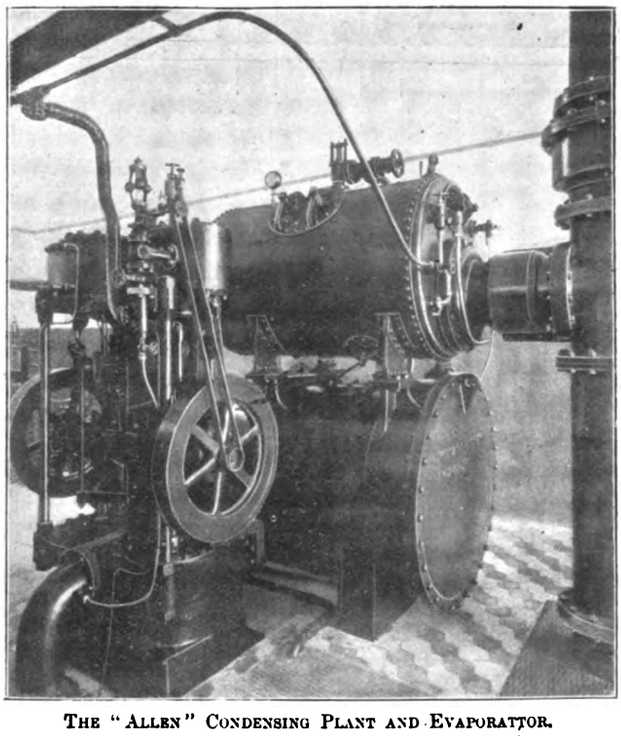
From this station four feeders radiate to the distributing network in the town, and these feeders are worked at the



VIEW OF BOILER HOUSE.



THE "WRIGHT" FEED-MAKE-UP EVAPORATOR.



THE "ALLEN" CONDENSING PLANT AND EVAPORATTOR.

Belliss-Siemens steam alternators. The arrangements for feed-water supply and for condensing are the most perfect o their kind, notwithstanding that numerous difficulties

station pressure of 2,000 volts, with a frequency of alternation of 73 cycles per second. They feed five sub-stations, and from these are fed the 110-volt 2-wire network for the private

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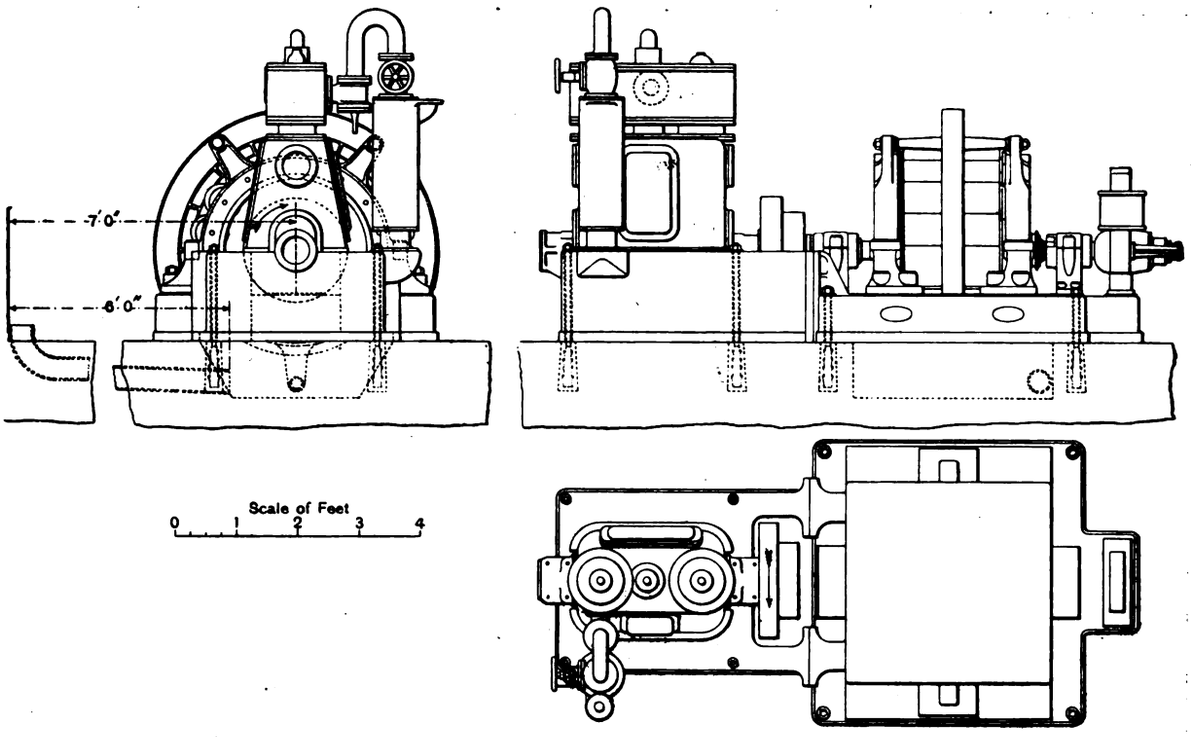
supply, and the 220-volt 3-wire network for the street lighting, which is effected principally by means of Ediswan glow lamps of from 8 to 32 c.p. The capacity of the complete station is 10,000 (16 c.p.) lamps, and there are at present 500 lamps of various candle-power in use for the street lighting. The street lamps are arranged so that alternate lamps are on opposite sections of the 3-wire network, and at midnight one or other of the sections is switched off, thus reducing the consumption by one-half. This switching is done at the sub-stations. Among the public buildings supplied are the Barracks, the "Convent" or Governor's House, and the hospital. Ultimately all the fortifications



PLAN AND ELEVATIONS OF ONE OF THE BELLISS-SIEMENS STEAM ALTERNATORS.

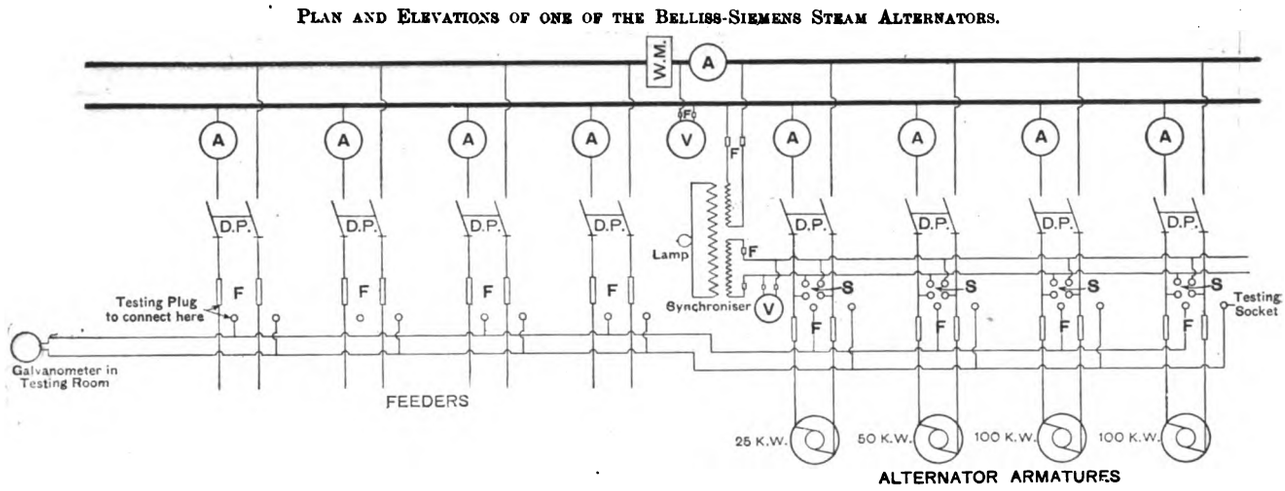
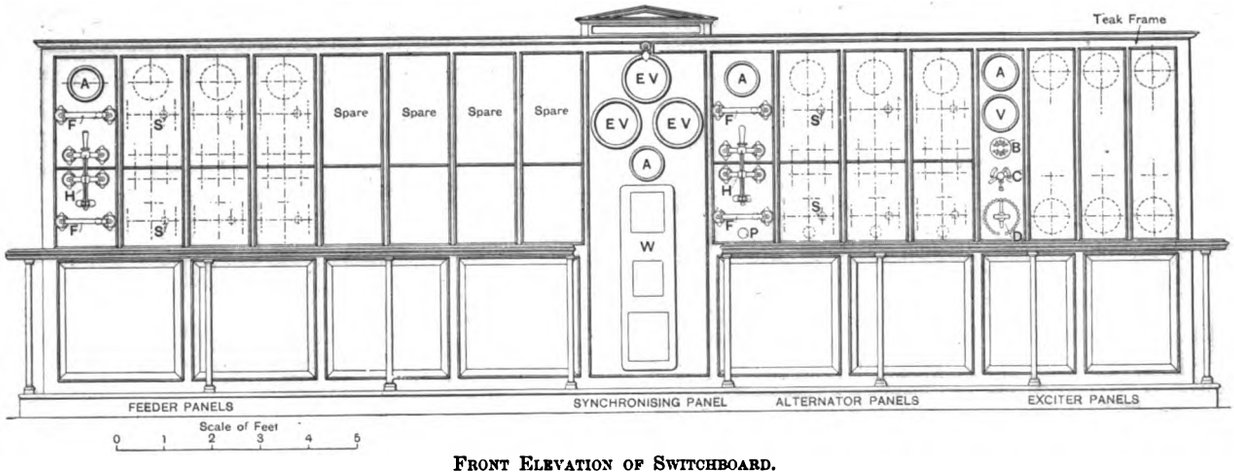


DIAGRAM OF SWITCHBOARD CONNECTIONS.
A, Ammeters; V, Voltmeters; W.M., Wattmeters; D.P. Double Pole Switches; F, Fuses; S, Synchroniser Plug Switches.



FRONT ELEVATION OF SWITCHBOARD.
A, Ammeter; B, Four-Way Voltmeter Switch; C, Field Breaking Switch; D, Field Regulating Switch; E.V., Electrostatic Voltmeters; F, H. T. Fuse; H, Double Pole Switch; L, Synchroniser Lamp; P, Synchroniser Plug; S, Testing Sockets; W, Thomson-Houston Wattmeter.

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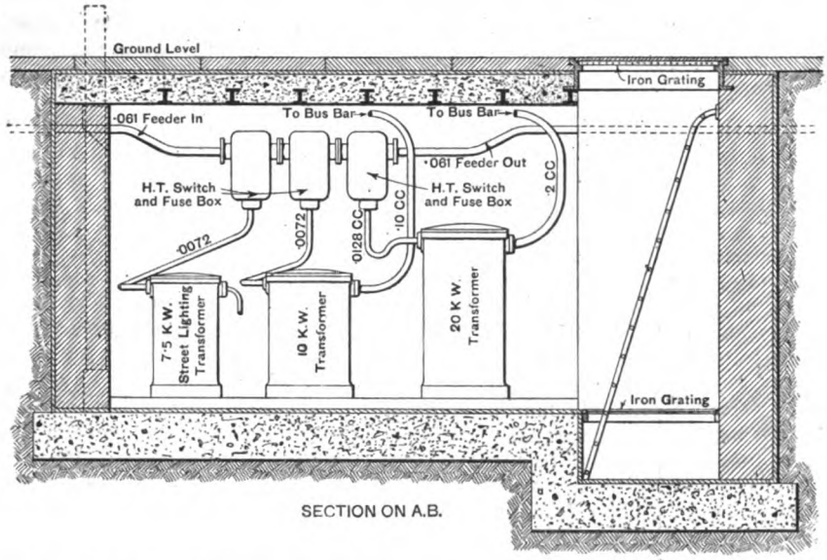
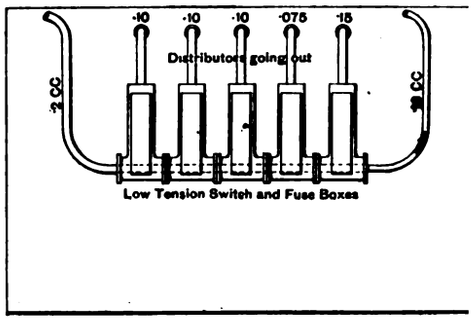
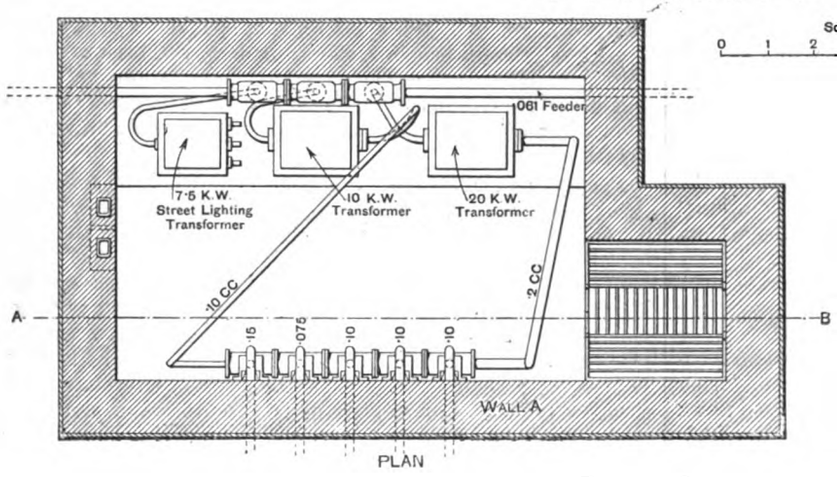


SECTION ON A.B.



ELEVATION OF WALL A



PLAN

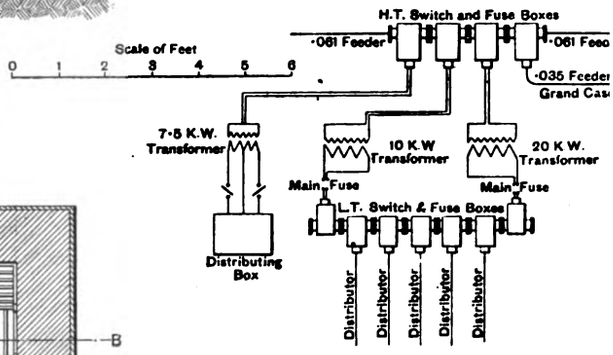
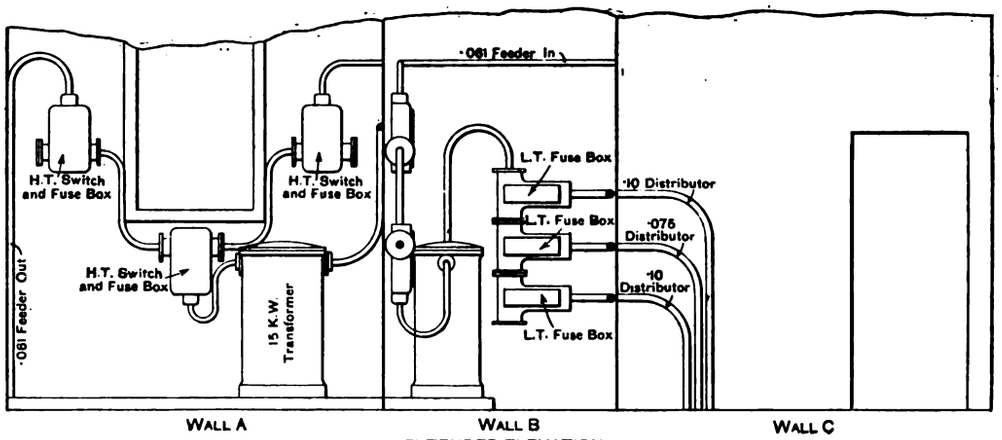
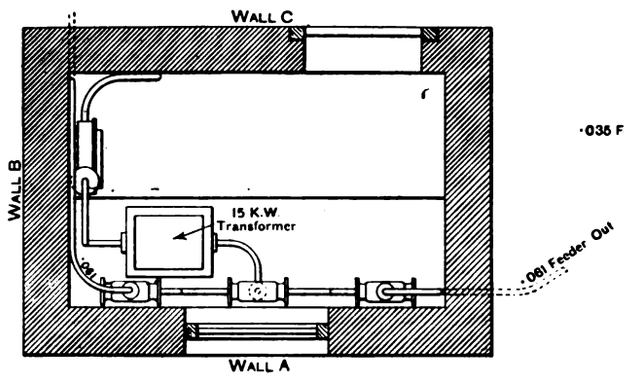


DIAGRAM OF CONNECTIONS

EXCHANGE SUB-STATION.



EXTENDED ELEVATION



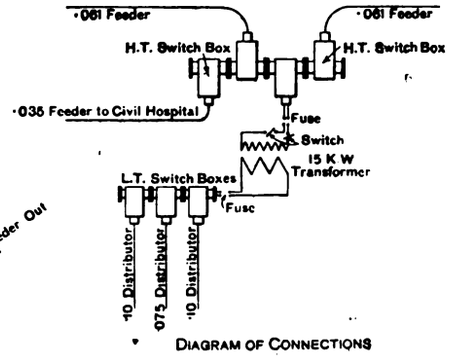


DIAGRAM OF CONNECTIONS

GARRISON LIBRARY SUB-STATION.

E

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will be wired and fitted both for general lighting and for a number of search lights.

The electric supply system, as above described, was carried out by Mr. A. H. Preece, with the assistance, on the spot, of Mr. M. S. Chambers, who has brought to the work the extensive and special experience he acquired in undertaking similar work at Malta and other places. It should be mentioned that the whole of the construction work has been carried out exclusively with native labour, and that these men had to be trained for the work by the Colonial Department under Mr. Chambers' guidance. The wiring of most of the buildings through the solid rock, and the special switching arrangements rendered necessary thereby, has made the work more than usually arduous—and interesting from an engineering point of view. The arrangements for a good supply of circulating water have been especially well designed and carried out. The station was put in operation for the first time on Christmas Day last year. We give below some more detailed particulars of the various departments of the undertaking:—

Boiler House.—As shown in the illustration, the boilers are erected in a building at the back of the original casemates. There are three locomotive boilers, built by Messrs. J. Penn and Sons, of Greenwich, each boiler having a heating surface of 1,300 sq. ft., a grate area of 32 sq. ft., and works at 150lb. pressure. With cold feed and burning the hand-fired Welsh coal, as is now done, an evaporation of 6,000lb. of water per hour is readily accomplished. The boilers occupy one-half of the boiler house, the other half being occupied by the feed pumps, leaving extension space for two additional boilers. The feed pumps, two in number, have a pumping capacity of 4,000 gallons per hour. They are of the duplex direct-acting steam-driven type. A large storage tank just outside the boiler house has been constructed to take the water of three catchments which originally supplied water to the barracks. In addition to this supply, there are two feed-make-up evaporators used in conjunction with the condensing plant. For the condenser circulation salt water is used; and it is thus necessary to evaporate and condense for the feed-make-up. One of these feed-make-up evaporators, built by Mr. Joseph Wright, of Tipton, is shown in an accompanying illustration.

Machinery Casemates.—There are four casemates at present in use, two of these being for the main generating machinery, one for the condensing and feed-make-up plant, and the remaining one for the switchboard. In the machinery casemates there have been erected four direct-coupled Belliss-Siemens high-pressure alternators—viz., two of 100 kilowatt capacity, one of 50-kilowatt capacity, and one of 20-kilowatt capacity. Each generator carries its own exciter on an extension of the alternator spindle. The engines are of the usual well-known enclosed vertical type adopted by Messrs. Belliss and Co. The largest engines run at 380 revolutions per minute, the intermediate size at 456 revolutions, and the smallest at 570 revolutions per minute. The generators work at a station pressure of 2,000 volts with a frequency of 78 revolutions. The contractors for the whole of the generating plant were Messrs. Siemens Bros. and Co.

Condenser and Evaporator Casemate.—In one of the casemates, Messrs. W. H. Allen, Son and Co. have erected a surface condensing and feed-make-up evaporator plant, capable of condensing 15,000lb. of steam per hour under a 25-inch vacuum. Water for the condenser circulation is obtained from the sea, the suction and ejection pipes having entailed a considerable amount of difficult work in their erection, they having had to be passed through brickwork 12ft. thick and taken 100 yards out to sea beyond the new breakwater. The surface condensing plant of Messrs. W. H. Allen, Son and Co., as is well known, consists of a horizontal circular shell, containing a number of longitudinal tubes fixed between two plates and providing a large surface for the condensation of the steam. The condenser at Gibraltar has a tube surface of 1,200 sq. ft. Surmounting the condenser shell is one of the feed-make-up evaporators, which consists of a horizontal shell, containing a smaller circular and longitudinal tube shell, the two being arranged very much after the manner of the shell and flue of a Cornish boiler. Live steam is passed through the tubes in the tube shell, and this evaporates water contained between the inner and outer shells, the water thus evaporated passing away to the hot well as a feed-make-up. The feed-make-up evaporators are, of course, only used on occasion, and not continuously. The circulating pump is of the centrifugal type, direct-coupled to a small vertical steam engine, and the air pumps consist of direct-acting steam-driven pumps of Messrs. Allen's "Conqueror" type. In the condenser casemate there are also erected two oil filters, together with a strainer, for the circulating pump sea water suction, this latter being constructed of galvanised sheet iron.

Switchboard Casemate.—The switchboard, which was built by Messrs. Siemens Bros. and Co., is shown in several of the accompanying illustrations. The panels already fitted include four exciter panels, four alternator panels, and four circuit panels, together with a synchronising panel. The spare panels include two spare alternator panels and two spare circuit panels; all the panels being of enamelled slate. Those for the alternators are each equipped with an ammeter, main switch, two fuses and a synchronising switch. The circuit panels are each fitted with an ammeter, a main switch and two fuses. On the synchronising panel there are three Kelvin electrostatic voltmeters, made by Messrs. James White, of Glasgow, a Thomson-Houston station wattmeter and a station ammeter. The switchboard connections are shown in a diagram which accompanies the scale drawing of the switchboard.

Feeders and Distributing Mains.—The whole of the mains throughout the system consist of concentric cables. Both conductors are insulated by bitumenised fibre, and the outer is then lead-sheathed, yarned, armoured by two steel tapes, and finally yarned and compounded. The cables are laid direct in the ground, and wherever possible they have been kept under the footpaths, great care having been exercised in placing them so that they would not be likely to be injured. In the North District, that is in the town of Gibraltar itself, a heavy high-tension ring main is run from the station to supply the various sub-stations; and the outlying sub-stations at the Moorish Castle, at the Water Port Gate and at Hargraves Parade are connected to the ring by smaller high-tension cables. A high-tension concentric cable is run separately from the generating station to the Alameda to supply Rosia and the southern portion of the Rock.

All the consumers are supplied from the various transformer sub-stations by means of a low tension network. In the Northern section—*i.e.*, the town of Gibraltar itself—these low-tension distributors have been laid in almost every street, so that supply can be given to all intending consumers. The network consists of concentric cables of either 0·15 or 0·10 sq. in. section, there being also a small quantity of 0·075 for the less important streets. In South Gibraltar and Rosia the low-tension network is not yet so extensive, but nearly all the Government buildings are already connected.

In addition to the cables for the supply of house lighting, a very extensive system of mains has been laid to supply the street lamps. All the gas lamps will be replaced by incandescent lamps and the cables to supply these are two and three-core vulcanised bitumen cables, armoured either by steel tape or by lock coil segments. Branches are taken from the underground mains to each of the lamps, the supply cables ending in boxes placed immediately underneath the lantern, so as to afford a ready means of disconnecting any lamp, should such be necessary.

The whole of the mains have been manufactured by the Callender Cable and Construction Co. (Limited) and the work of laying has been carried out under their supervision and with the assistance of their jointers. Mr. Alfred Pocklington has been their resident engineer in Gibraltar and has superintended the work on their behalf.

Sub-Stations.—There are five sub-stations at present equipped, two of which are shown in the accompanying illustration. The transformers in these stations were built by the Brush Electrical Engineering Co., and transform from 2,000 volts to 110 volts (2-wire) for the general supply, and 220 volts (3-wire) for the street lighting. The sub-stations controlling

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the street lighting are provided with switches, as beforementioned, for cutting out half the lamps at midnight.

Street Lighting.—The greater part of the street lighting is by means of Ediswan glow lamps, there being some 500 of these already in operation. These consist of lamps of 8, 16 or 32 c.p., arranged singly or in groups in the lanterns, and carried for the most part in ornamental brackets attached to the walls of buildings. In some few cases these lamps are carried on posts. We may mention that for some years past Ediswan lamps, fittings and accessories have been supplied to Gibraltar.

Conclusion.—In conclusion we have pleasure in acknowledging our indebtedness and tendering our thanks to Mr. A. H. Preece for his assistance in supplying us with some of the particulars and drawings, &c., which have enabled us to prepare this article. Our thanks are also cordially given to Mr. M. S. Chambers, the resident engineer at Gibraltar, for the information with which he supplied us, and the courtesy he showed us upon the occasion of our visit to the electricity supply works at Gibraltar last year. All concerned are to be complimented upon an excellent piece of work.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Gold and Platinum Coherers.—E. Branly controverts the assertion which has been gaining ground that gold and platinum are substances unsuitable for use as coherer metals. As a matter of fact, they are highly sensitive, and require some care, but are capable of giving very constant results. Several metals will give very different results in the hands of different observers. To ensure similar conditions, none but sifted filings should be used, and the diameter of the grains and their massing should bear some relation to the E.M.F. of the cell inserted in the coherer circuit. In the author's arrangement the filings are pressed between the ends of two metallic rods, which are made to approach each other by a screw motion. The latter is hardly necessary, as with a little practice the hand is able to impart the necessary pressure. The coherer is enclosed in a cage provided with a slit. Platinum under the same conditions gives equally good results, and shows a high sensitiveness—about the same as silver. The commercial alloys of gold, from those employed for coinage down to the poorest, may be employed with less caution. All these results are in accordance with Lodge's theory, if we suppose that even the nobler metals are not in close contact under ordinary circumstances.

[Branly, *Comptes Rendus*, Dec. 26, 1898.]

Toronto Magnetic Observatory.—When the British Association met at Toronto in 1897, the foreign magneticians present were invited to visit the magnetic observatory, to inspect the magnetic curves there obtained, and to give an opinion on the advisability of removing the observatory to a site less subject to disturbances from the trolley cars. Profs. Rücker, Carey, Foster, Fitzgerald, van Rijckevorsel and Bigelow accepted the invitation, and came to the conclusion that the efficiency of the observatory had been seriously impaired. It was then decided to remove the observatory, and a point was selected nine miles to the north-east, easily accessible by railway, and yet very unlikely to be invaded by the trolley system. At present there is no electric railway within seven miles, and little prospect of one within five miles for many years to come. The name of the place chosen is Agincourt. The new observatory was finished early in September. By October 1st all the instruments had been adjusted in their new positions, and everything was running smoothly. In choosing the building material every stone was tested for magnetic effect. The office is heated by a copper stove. The results have been very satisfactory. All the photographic records will be sent for development to the Toronto Observatory, which continues to be the central office of the Meteorological Service of Canada.

[R. F. Stupart, *Terr. Mag.* December, 1898.]

Search Light Intensities.—According to A. Blondel, the luminous intensity at any point of a surface cutting a projector beam at right angles may be represented by $k\ u\ i$, where i is the intensity of the source, k the coefficient of transmission, and u the "coefficient of optical effect," depending upon the structure of the apparatus. For dioptric apparatus (Fresnel's lenses) the coefficients k and u diminish from the centre to the edge of the apparatus, whereas in reflecting apparatus the luminous intensity is sensibly the same across the whole section of the beam. A Blondel and J. Rey have verified this for a Mangin projector, using an iron screen placed a little in front of the projector, and pierced with a number of equal holes. The images of the carbon arc produced by these holes were caught upon a photometer screen always placed at the same distance from the sheet-iron screen. By boring the holes at regular intervals across the surface, a very exact estimate is obtained of the candle-power of successive zones. In a Mangin parabolic projector, the luminous intensities in zones, differing in diameter by 6cm., were, counting from the axis of the beam, 0, 104, 181, 205, 208, 214, 208, 206, 200, 186 and 185. The initial zero denotes the shadow of the carbon itself. It will be seen that the luminosity is practically constant, except in the central portion. By adding up the zones, the total effect of the beam may be obtained without leaving the laboratory. The Mangin mirror gives 55,719,000 c.p.

[Blondel and Rey, *Comptes Rendus*, Jan. 31, 1898.]

Reaction Pressure of Cathode Rays.—For our views as to the true nature of cathode rays, the reaction pressure which they exert upon the cathode is of vital importance. It is true that they must exert such a pressure, whether they are waves or projected particles, for, according to the electromagnetic theory of light, the pressure per unit surface is equal to the energy per unit volume. But if the cathode rays are projected particles, the analogy fails, unless they have potential as well as kinetic energy. In order to gain some idea of the amount of the reaction pressure, E. Riecke operated with a simple radiometer, the four vanes of which were made to act as cathodes for the discharge from an influence machine. The most important motion observed was the decreasing motion after the current had stopped. It was registered in all its phases until the total stoppage of the vanes. The calculation was somewhat complicated, but the results were fairly consistent. The pressure was found to be proportional to the current strength, and its mean value was 0·04 C.G.S. units. When the pressure is calculated from the heat developed by the impact of the particles upon the glass wall, it comes out as 0·07 C.G.S. units—certainly, a remarkable agreement, considering the difficulties of measurement. So far, then, the results are another confirmation of the emission theory of cathode rays.

[Riecke, *Wied. Ann.*, No. 13, 1898.]

Simple Cathode Rays.—H. Deslandres describes in detail his own results with regard to the dispersion of cathode rays, which he attributes to electrical oscillations of different frequencies, while Goldstein attributes them to differences in the successive values of the potential of the cathode. Neither of them have as yet accepted the emission theory, but Deslandres approaches it very closely when he says that the Hertzian oscillations which are propagated in the direction of the particles act upon them, and that the particles themselves acquire something like a rotation or oscillation—something, in fact, like Newton's "fits." As regards his experiments, they deal chiefly with the electrostatic deflection of a cathode beam by a secondary cathode. When the beam is sifted through a very small aperture it splits up into a number of rays, each with a different amount of deflection. At the same time the individual rays are broadened out at right angles to the direction in which they are deflected, and the widening increases with the amount of the deflection. The best results are obtained when the hole is very small and the screen as large as possible. Since Trowbridge has shown that every spark is really intermittent, it is not difficult to suppose that the three or four successive portions of the discharge have different discharge potentials, and hence that the particles are projected with successively decreasing velocities.

[Deslandres, *Comptes Rendus*, Dec. 26, 1898.]

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"THE ELECTRICIAN" WIREMAN'S POCKET-BOOK.—"The Electrician" Company will shortly publish a valuable pocket-book for the use of those engaged in wiring work, both external and internal.

CARBONS FOR ALL ELECTRICAL PURPOSES.—By Francis Jehl. A work will shortly be published dealing fully with the manufacture of carbons for all electrical purposes. The book will illustrate the machinery and apparatus used in carbon manufacture on the Continent and in America, and will give the latest practice in this important subject.

THE ELECTRIC ARC.—By Mrs. Ayrton. This work will shortly be published, and will contain an historical sketch of the early experiments on the electric arc, as well as the important results of recent research.

SPECIAL NOTICE.

With this issue of "THE ELECTRICIAN" is published a Coloured Sketch Map of London and Provincial Electric Supply Stations, which all purchasers of the Paper should receive gratis. Complaints of non-receipt should be promptly made to THE PUBLISHER.

NOW READY.—Vol. XLI. of "The Electrician," bound in strong cloth. Price 17s. 6d., post free 18s. 6d. Also ready, Cases for binding. Price 2s., by post 2s. 3d.

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COMPANY PROMOTION "IN BULK."

In several recent issues of The Electrician, but more especially in the editorial columns of the last two numbers, we have directed attention to the more prominent features of the municipalisation of electrical undertakings. We have sought to point out some of the dangers to the profession and to the community at large which appear to be attendant upon municipalisation in the forms in which it has manifested itself; and in doing so we have been actuated by no partisan spirit, but have striven to depict accurately and to deduce justly. The essential principle of municipalisation, viz., the owning and working of commercial undertakings by municipal authorities, may not be, essentially, evil; indeed, it is one of the dangerous features of this latter-day development that in its theoretical or text-book presentment it appears so feasible and as tending so highly to the public good. But, in actual everyday life, the working of commercial undertakings by local authorities—too commonly composed of ignorant and entirely self-interested individuals—has often been attended by many grievous evils, injurious to the interests of the general public and often tyrannising over one or more sections of that public. Between the ideal and the actual, in fact, there would appear to be a wide gulf, the bridging-over of which is a task that gives no sign of being accomplished. In fairness alike to ourselves and to certain local authorities, however, we may say that to the general rule there are some few exceptions—to be found mostly in the larger cities, where the local authorities comprise men able and willing to take a statesman-like and broad view of their responsibilities, and to adopt an equitable and business-like policy therein. In the fortunate localities controlled by such men, municipal undertakings, *e.g.*, for electric supply or tramways, have flourished; and were it

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not that their success furnishes a pretext for universal municipalisation, we should have nothing to complain of in regard to them.

There is, however, another aspect of the conflict between local authorities and electrical companies besides the one we have depicted; and this now calls for consideration. If the welfare of the community has been menaced in some respects by the selfish attitude adopted by local authorities towards genuine schemes projected by certain companies, there is, on the other hand, no small danger that the investing public may suffer from the depredations of bogus companies asking for enormous sums of money in the promotion of schemes that, even if not inherently preposterous, have but small prospect of yielding any substantial return for the investment. Electrical industry has already passed through one boom, with its consequent reactionary series of financial crises; and, though it has at length emerged from that period of depression, and is now a well-established and important section of the industrial world, this happy consummation would have been attained all the earlier had there been no such artificial inflation as the boom to which we have alluded. A second boom like unto the first would be attended by far more serious and lasting results, for the reason that at the present time the amount of capital invested in British electrical undertakings is enormously greater than in the pioneer days when the industry was convulsed by the reaction from the first boom. The latest development in the engineering aspect of electricity supply is the system of distributing energy over a very large area, and supplying it "in bulk," as the phrase for wholesale supply has become. There are some few localities where the industrial and other conditions so favour such a system of distribution that, at the present time, it might be adopted with financial success by any well-organised undertaking. In these localities a wholesale and widespread supply of electric power might do much to foster industry and trade, and it is greatly to be hoped that the powers that be will encourage such enterprise.

But, although the definite project to supply power in this manner—speaking apart from mere paper schemes—is scarcely a year old, there are already not wanting indications that the "in bulk" principle of electric supply is to be made the basis of a corresponding "in bulk" scale of company promotion and financing. We warn the investing public that the advantages of "in bulk" supply, as contrasted with ordinary urban supply, do not warrant the conclusion that it may be adopted with financial success for any combination of adjacent counties that may suggest itself to the fertile imagination of a company promoter. Nor does it at all follow as a matter of course that a group of electrical nobodies, with probably little money to lose, and perhaps less technical or business reputation, will lead such an enterprise to a successful issue. Financial standing as well as electric technical knowledge is essential. Apparently the method most favoured in the office of the promoter we have in mind is, to select on the map a spot in a coal district—it does not seem to matter much where. That is for the power station. Then a big circle is drawn, embracing several counties, and including a good many towns that already possess electricity works and several more that do not require electricity "in bulk"; and a scheme is drawn up for supply over this area. It does not seem to be considered necessary even that the "scheme" should be backed by men of large financial resource. Statistics are got up to show what a rich field this is, and the public is to be asked for several millions sterling for the privilege of sharing the harvest. Again we repeat, there are but few—very few—areas in the United Kingdom, where, in the present stages of electrical generation and supply, such a scheme could have any reasonable chance of success. Even for these a big battle against the opposing local authorities will certainly have to be fought; and, although it would seem probable that Parliament will admit the principle of "in bulk" supply as recommended last year by the Select Committee, and will legislate accordingly, large sums of money and much time will yet have to be expended in legal expenses before even the most commendable of these schemes can receive statutory sanction. Without doubt, when ultimately carried through, the schemes that are based on genuine economic prospects will offer to the investor a good investment for his money, and it is not of these that we would speak in warning tones. Our object is to put the investor on his guard against unscrupulous and irresponsible company promotion "in bulk," where the "bulk" of the capital invited is out of all proportion to the insignificant financial prospects. The electrical industry has much to fear from "wild-cat" company promotion.

CARBONS FOR ELECTRIC LIGHTING AND OTHER PURPOSES.*

BY FRANCIS JEHL.

(Continued from page 380.)

Should the articles that are placed in the furnace contain a great deal of moisture, as is the case with stoneware, &c., an extra passage is built in the furnace as shown at *l*, from which small branch passages run into each chamber at the top of the furnace, as in the sectional drawings (Figs. 37 and 38). As each branch is governed by a sort of valve, any two chambers can be connected by this means. The object of this extra passage and its branches is, that when a chamber is filled with such damp articles, a portion of the hot air, that is circulating through the chambers that are cooling down, is led on into this passage and from there into the above-mentioned chamber, so that a temperature of about 70°C. to 100°C. is obtained which thus drives off the moisture that is forced to pass into the smoke flue by raising the valve *h* of that chamber slightly. If this was not done the moisture would always condense in the cooler chambers. However, for carbonising electric light carbons, &c., which contain no moisture, such passages are not needed.

It is evident that when working with such a system of furnaces, it is impossible for a negligent attendant to overheat or suddenly expose fresh carbons to a large heat, as can be done when using a periodical furnace, where the flames, or rather the gas, must first be so regulated that very little heat is produced, or else the carbons will warp (as has already been explained in the chapter on carbons). The fact that the hot combustion gases must first pass through several chambers through which the intensity of the heat is gradually toned down as it reaches the last chamber, insures perfect immunity against risks. The operation of the furnace is very simple, while at the same time it is adapted to be used in many industries by simply making some minor changes, as in the number of the chambers, or in different modes of directing the flames, &c.

Articles, such as carbons, that are very sensitive to sudden changes in the temperature, either increase or decrease, require, of course, a furnace having more chambers than an article not so sensitive, or where warping or cracking is of no account as is the case when calcinating. A furnace for carbonising electric light carbons, electrodes, &c., should have from 12 to 14 chambers, or a double furnace from 24 to 28. The cubical capacity of each chamber depends upon the quantity of carbons that it is desired to carbonise, and Mendheim makes them from 4½ cubic metres upwards. Then, again, the flames, instead of issuing upwards from the floor of

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the furnace towards the ceiling, are generally forced to act in the reverse direction, that is, from the ceiling downwards towards the floor, as far better results have been obtained by this method when baking carbons. Such a modified chamber system is shown in part in Figs. 39 and 40, where *k* represents the mouths or openings from which the gases and air flow out, and, being well mixed, there is almost perfect combustion as the gases are ignited. The flames shoot upwards and then down towards the floor of the oven, and out at the numerous openings *e*, as seen in Fig. 39, the arrows in Fig. 40 indicating the path of the flames.

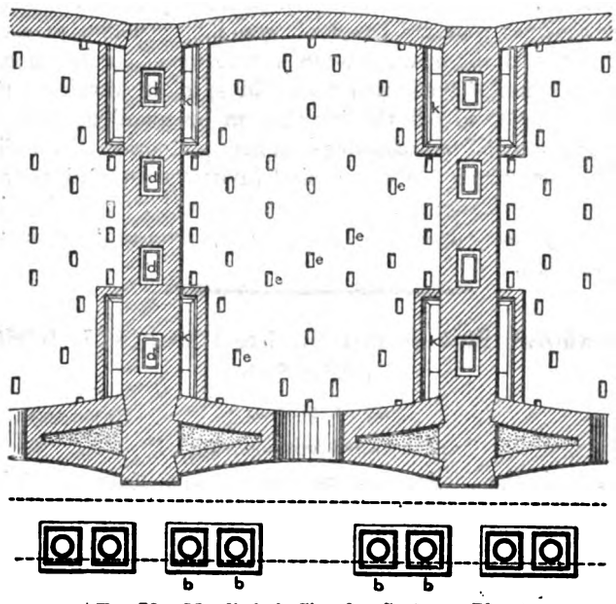

FIG. 39.—Mendheim's Chamber System. Plan.

Each of these four outlets *k* is controlled by valves *b b b b*, by means of which the flow of gas can be regulated.

The gas is led to the outlets by way of the passages *a*, while the heated air that is necessary for combustion passes and circulates through the chambers that have already been finished and thus arrives very hot in the chamber where the combustion is going on, in a similar but reverse direction to that already explained in reference to Figs. 36-38. The heated air has to traverse chamber to chamber by way of the valves *d*, by means of which the chamber can be cut off and the smoke or combustion gases made to pass into the flue *f*

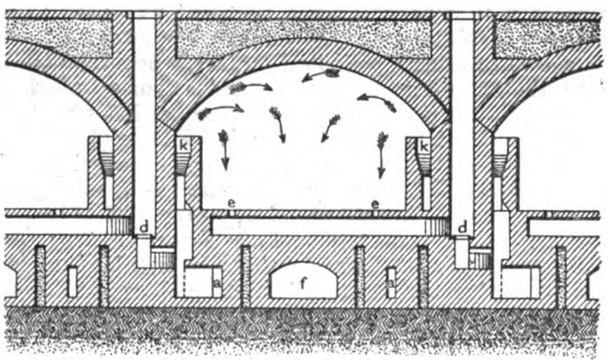

FIG. 40.—Mendheim's Chamber System. Cross Section.

leading to the chimney. The valves in connection with the flue are not shown in the drawings, but it may be stated that the principle of the furnace, its working, &c., is the same as that illustrated in Figs. 36—38, there being only some differences in minor details, such as in the disposition of the air and gas passages, and the direction or path of the flames. From what has been just explained, it will be seen that when retorts containing carbons are placed in such a furnace the whole are enveloped in flames and get evenly heated, as the fire descending from the top divides, and a portion is drawn into each of the openings *e*. Instead of four outlets *k*, as shown in Fig. 39, two long ones can also be made, extending from the front of the furnace to the back on each side of the chambers. The gas and air is generally led into these outlets in a divided way, so that there are a large number of orifices, each alternate one either for gas or air by means of which the gas and air get well mixed, this being so necessary in order to perfect combustion.

It will be noticed what an advantage a carbon factory has that is situated in the natural gas regions of the United States, where such a rich and constant supply of gas can always be obtained. It is then possible to effect a better and more individual regulation of each orifice, and at the same time smaller passages or pipes can be used, as the gas is far more pure, containing as it does far less inert gases than that generated in a generator. Neither is there any danger of condensation of tarry liquids as happens in passages where the gas is generated from fuel containing volatile matter. In fact, the writer believes that the time is very near at hand when the United States will not only make all the high-grade carbons they need, but will be able to supply other foreign markets.

It may be mentioned that there is a saving of fuel of over 30 per cent. when using the Mendheim chamber system of furnace, as compared with that used in a periodical furnace, while in some circumstances, with a negligent workman, the economy may be as high as 60 to 70 per cent. For very small factories, or such concerns that wish to make their own electrodes (of small size), Mendheim builds chamber furnaces, with only two outlets, instead of four, and a slightly different disposition of the passages. Should a furnace with 12 or 14 chambers be too large for such a factory six or eight need only be built, but it is then evident that the work cannot be continuous. With such few chambers the work will be intermittent, but when business increases more chambers can be added, so that the working can be continuous. Nevertheless, even with only a few chambers such a furnace has still a decided economy over a periodical furnace, as some of the waste heat of the combustion gases can still be used, although not in such a perfect sense as when working continuously.

There are some carbon manufacturers who employ the gas ring system of furnace, which, like the chamber system, can also be worked continuously while at the same time there is a similar economy of fuel. Although those conditions and requirements that are necessary for carbonising carbons are also attained in a limited sense in this kind of furnace, it may be mentioned that, on the whole, the chamber system is to be preferred. In fact, one of the best carbon makers of Europe, who worked with the gas ring furnace, built a Mendheim chamber furnace when he erected a branch factory in France. In principle the gas ring furnace is simply a large endless passage in which a shifting fire is always in operation at one part or the other. This passage or ring is generally divided in a number of parts, each part being alternately heated as in the chamber system. The air that is necessary for the combustion does not flow, however, like that in the chamber system, from the bottom or top of a part, or parallel to the gas; on the contrary, it meets the gas at right angles. The air supply simply circulates directly through (in a straight line) those parts which contain the finished carbons, and thus meets the combustible gases that issue either from the floor or sides of the part that is getting heated. The products of combustion continue in the same path until they are forced to enter the chimney flue at some distant part of the ring.

(*To be continued.*)

BOOKS RECEIVED.

"Dictionaire Techique Français-Anglais," by A. S. Lovendal. (Paris: Boyveau et Chevillet.) Price 3fr.

"Working of Steam Boilers," by Edward G. Hillier. (Manchester: J. Collins and Co.) Price 1s.

Massachusetts Institute of Technology. Courses in Electrical Engineering and Physics. (Boston: J. P. Shults.)

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LEICESTER.

Undertaking Worked by..... Leicester Corporation.
Date of Commencement of Supply December, 1894.
System of Supply ..... Alternate-current transformer sub-stations.
Chief Engineer..... Alfred Colson.

YEAR ENDED	DEC. 31, **1896.**		DEC. 31, **1897.**	
QUANTITIES—				
Units generated	243,379		349,433	
„ **SOLD (TOTAL)**.....	169,668		262,179	
„ sold to comsumers	169,668		262,179	
„ sold for public lighting, &c.	—		—	
„ used on works.....	—		—	
UNITS SOLD per 8 c.p. LAMP CAPACITY	8·05		12·4	
Maximum supply demanded	356		515	
Number of public lamps	—		—	
Number of consumers.....	220		331	
Connections to mains in 8-c.p. lamps...	16,864		23,757	
CAPACITY OF PLANT IN 8-c.p. LAMPS	21,080		21,080	
CAPACITY OF PLANT IN KILOWATTS	675		675	
CAPITAL—	**Total.**	**Per kilowatt capacity.**	**Total.**	**Per kilowatt capacity.**
AUTHORISED (TOTAL)	£42,748	£63·4	£76,467	£113·2
Share	—	—	—	—
Loan (including Debenture charges)	42,743	63·4	76,467	113·2
RECEIVED (TOTAL).....	42,748	63·4	42,748	63·4
Share	—	—	—	—
Loan (including Debenture charges)	42,748	63·4	42,748	63·4
AUTHORISED, NOT RECEIVED (TOTAL)	—	—	33,719	50
Share (unissued)	—	—	—	—
Share (uncalled)	—	—	—	—
Loan (including Debentures).....	—	—	33,719	50
REPAID (TOTAL)	—	—	—	—
RESERVE OR SINKING FUND	2,500	3·71	3,741	5·54
DEPRECIATION FUND	—	—	—	—
EXPENDED (TOTAL)	38,215	56·6	45,853	68·0
Lands and buildings	5,566	8·25	5,566	8·25
Plant	18,779	27·8	22,173	32·9
Mains	13,570	20·1	17,814	26·4
Miscellaneous	300	0·44	300	0·44
BALANCE OF CAPITAL ACCOUNT.....	4,534	6·72	−3,105[a]	4·60
REVENUE—	**Total.**	**Per unit sold.**	**Total.**	**Per unit sold.**
TOTAL	£4,721	6·682d.	£6,040	5·530d.
Revenue from supply	4,224	5·980d.	5,446	4·985d.
„ meters, &c.	114	0·161d.	164	0·150d.
„ public lighting	—	—	—	—
„ sale of lamps, &c.	383	0·542d.	430	0·394d.
„ miscellaneous sources...	—	—	—	—
EXPENDITURE—				
TOTAL COSTS	£2,673	3·784d.	£3,282	3·005d.
WORKS COSTS	2,065	2·923d.	2,551	2·335d.
Generation of Electricity.....	*1,848*	*2·614d.*	*2,243*	*2·053d.*
Fuel (including cartage, &c.)	521	0·738d.	578	0·529d.
Oil, waste, water, stores	134	0·190d.	192	0·176d.
Wages at station	1,015	1·436d.	1,047	0·959d.
Repairs & maintenance at Station	178	0·252d.	426	0·390d.
Distribution of Electricity	*217*	*0·307d.*	*308*	*0·282d.*
Wages, &c.	95	0·134d.	182	0·167d.
Repairs, renewals of mains, &c. ...	122	0·173d.	126	0·115d.
Public Lighting	—	—	—	—
Attendance	—	—	—	—
Renewals	—	—	—	—
MANAGEMENT CHARGES, &c.	608	0·860d.	731	0·669d.
Royalties	—	—	—	—
Rent, rates, taxes	*210*	*0·297d.*	*296*	*0·271d.*
Management	*398*	*0·563d.*	*435*	*0·398d.*
Salaries	255	0·361d.	200	0·183d.
Stationery, &c.	9	0·013d.	15	0·014d.
Establishment charges	130	0·184d.	216	0·198d.
Law charges, &c.	4[b]	0·006d.	4[b]	0·004d.
FINANCIAL RESULTS—	**Total.**	**% to mean cap. exp'nded**	**Total.**	**% to mean cap. exp'nded**
WORKING PROFIT FOR YEAR	£2,048	5·70%	£2,758	6·57%
Carried to Depreciation Fund ...	—	—	—	—
Carried to Res. or Sinking Fund..	1,164	3·24%	1,164	2·77%
Net int. on loans (incl. Deb. charges)	1,149	3·20%	1,360	3·24%
BALANCE FROM LAST ACCOUNT	−1,338	−3·72%	−1,603	−3·82%
Do. AVAILABLE for DISTRIBUTION, &c	—	—	—	—
Deficit	*1,603*	*4·46%*	*1,370*	*3·26%*
ORDINARY DIVIDEND PAID	—	—	—	—
% of TOTAL COSTS to GROSS REVENUE	56·6%		54·3%	
Expenditure per kilowatt capacity ...	£3. 19s. 2d.		£4. 17s. 2d.	
REVENUE PER KILOWATT CAPACITY	**£7. 0s. 0d.**		**£8. 19s. 0d.**	
Expenditure per 8-c.p. lamp capacity..	2s. 6½d.		3s. 1½d.	
REVENUE PER 8-C.P. CAPACITY	**4s. 5½d.**		**5s. 8½d.**	
REVENUE PER 8-C.P. CONNECTED ...	**5s. 7½d.**		**5s. 1d.**	
Price charged for lighting, per unit ...	6d.		5d.	
„ for power, per unit	6d.		5d.	
„ for public lighting	—		—	

REMARKS—*a* Over-expended. *b* Auditing.

ELECTRICITY WORKS ACCOUNTS.

Leicester Municipal Electric Supply Works.

The electricity works accounts, which form the subject of our analyses this week, are those of the working during 1896 and 1897 of the Leicester municipal undertaking, which commenced supply December 19, 1894. At December 31, 1897, the total authorised capital stood at £76,467, out of which £42,748 in total had been borrowed, viz., £37,748 on Three per Cent. Redeemable Stock, £4,700 on Three per Cent. Debentures and £300 on Two and Three-quarter per Cent. Debentures. The capital expenditure had, at the same date, amounted to £45,853, representing the low rate of £68 per kilowatt of generating plant in the station.

A comparison of the data in our table for the two years referred to reveals the fact that good progress has been made not only as regards the extent of business done, but also in the matter of economy of working. As compared with 220 consumers, representing an equivalent of 16,864 8 c.p. lamps connected at the end of 1896, we find that at the end of 1897 there were 331 consumers and the equivalent of 23,757 8 c.p. lamps connected to the mains. Corresponding to an output in 1896 of 169,668 units sold, there were 262,179 units sold in 1897, being an increase of 54·5 per cent.

The average total revenue obtained per unit was 5·53d., of which about 4·99d. was for electricity supply and 0·394d. represented the profit on sale of lamps and fittings. As compared with the previous year, the total costs for 1897 show a decrease of 0·78d. per unit; these at 3d., works costs at 2·34d. and generating costs at 2·05d. were still above the average for stations of similar output; however, the substantial reductions effected in these items are we hope but earnest of further economies in the working during 1898 and future years.

A working profit of £2,758 was made, representing 6·57 per cent. of the mean expended capital of the year. Out of this gross profit £1,164 was carried to the sinking fund which amounted to £3,741, and £1,360 was paid as interest on loans. The balance, or net profit for the year, of £234 served to reduce the deficit of previous years' working from £1,603 to £1,370.

The following data respecting the working during 1895 is of interest as a further index of the progress made. At December 31, 1895, the capital expended was £33,080, the number of consumers was 133, and the equivalent 8 c.p. lamp connection 10,184. The output for the year (1895) was 77,797 units sold, the total revenue £2,537, while the corresponding total costs were £1,857.

A NEW ACCUMULATOR SWITCH.

A useful form of accumulator regulating switch, designed to lessen the number of connections between the battery and the switchboard, is being manufactured at an electrical apparatus factory at Aarburg, Switzerland. The principle of the switch, which is due to Messrs. Erlacher and Besso, is shown in the accompanying diagram; in the actual switch, however, the two dials are arranged one above the other, and the handles are interlocking. The diagram supposes 23 regulating cells, but instead of 25 cables being required from the battery to the switchboard, 10 only are required. There are five cells whose terminals are brought to the switch, the other 18 cells being arranged in groups of six. If, as an example, 10 cells are to be cut out, the switch arm *b* of the dial B would be placed on the contact I, cutting out six cells, and the arm *a* of the dial A would be turned to the contact 4. The interlocking arrangement is such that the arm *b* is only moved when the arm *a* passes the

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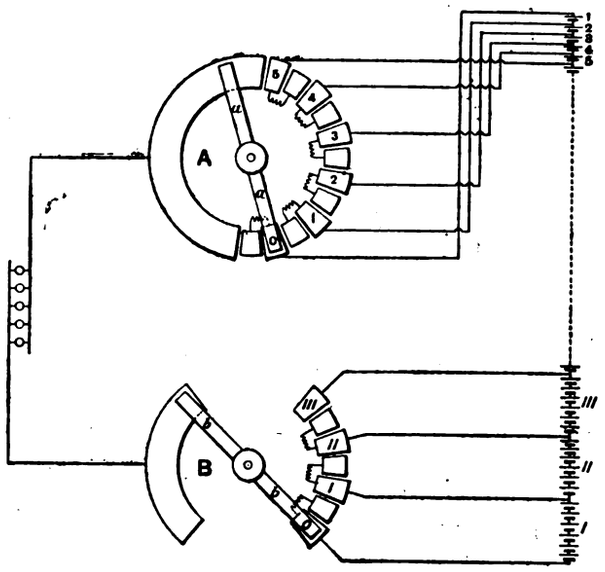
position 5. Thus if at the beginning all the battery is in circuit, by turning the handle *a* the first five cells are successively switched out. The next step of the handle, however, simultaneously switches out the six cells of group I. and restores the first five cells to the circuit, the handle *a* having made half a revolution. In this way, merely by turning the handle which controls both dials, any number of cells from 0 to 23 can be switched out or in again. Resistances are interposed in the usual manner between the cell contacts to obviate short-circuit or total disconnection.

Not only is there a considerable saving in cost by diminishing the number of conductors required, but it is stated, that owing to the diminished number of contacts and connecting thimbles, the



switch itself is cheaper than one of the more common type dealing with the same number of cells. We understand that the makers also supply a switch actuated by a motor through worm gearing, and arranged, if necessary, to act quite automatically.

INDUCTION TELEGRAPHY.

The following is an abstract of the discussion which took place at the Institution of Electrical Engineers, in connection with the Papers on induction telegraphy read by Dr. Oliver J. Lodge, Mr. Sydney Evershed and Mr. W. H. Preece (speakers who have returned their proofs revised being indicated by an asterisk:—

December 8, 1898.

*Mr. W. H. PREECE said that it was the first time he had listened to anybody else holding forth on this subject of wireless telegraphy. It was now exactly 16 years since he first brought the subject before the British Association, and year after year, from 1882 to the present time, he had never failed to report to the British Association the experiments that he had made. Prof. Lodge had that evening explained his views and described his plans for earthing so ably that he (Mr. Preece) felt that the time had arrived when something should be done to test this mode of calling on a practical scale. The next day he was going to have the pleasure of an interview with Prof. Lodge, and he hoped they would come to some decision to give this system a practical trial.

December 22, 1898.

*Mr. SYDNEY EVERSHED said that if induction telegraphy ever came into practical use it would not be to replace or to displace wire telegraphy. It would be for use where a wire or cable could not possibly be laid, and, therefore, it amounted to a matter of cost, and his Paper was rather prepared from that point of view. In order to arrive at the cost they must consider three items—(1) the arrangement of the circuits, (2) the arrangement of the transmitting device and the manner they were to obtain the power and the amount, and (3) the receiving devices—the most important of all. The most important thing to know about this third item was what power did it take to work them, because there was only a very limited amount of power which could possibly be received in a secondary circuit at a distance, and that amount must suffice for working an indicator. He was very glad to see that Dr. Lodge supported the arrangement which, from the very first, he had advocated, viz., that the circuits should be laid in the plane of the earth with their magnetic axes vertical. The very first induction telegraph that he had worked out was in 1892 effecting communication with a light vessel. His idea had been to communicate with all the light vessels round the Kentish coast by laying a circuit completely round the county of Kent. He found, as would naturally be expected, that the cost was absolutely prohibitive unless they had the means of employing an immense amount of power. He then devised a means for communicating with the North Sand Head light vessel, referred to in his Paper. Dr. Lodge had stated that the sea would not have much absorbing influence, but it did have a very considerable influence; even with so low a frequency as 16, the sea caused an absorption of nearly 40 per cent. But even had the sea been absent, the iron of the ship would have been a fatal bar. The total absorption amounted to 97 per cent., and he considered the experiment absolutely conclusive. When they came to telegraphy on land the matter was rather different, because, so far as they knew, the earth was a very poor conductor. If its specific resistance was high enough, telegraphy could without doubt be carried on by means of magnetic induction. He noticed that Dr. Lodge had hesitated whether to take the electromotive force or the current in designing the circuits. Price would depend very much upon the power. Turning to the transmitting devices he said they could use interrupters. They gave trouble from sparking, but this could be got over to some extent by using a condenser. Another arrangement was the one which Dr. Lodge had described, viz., an alternator, and a condenser in order to bring the current into step with the electromotive force, and get the power factor up to unity if possible. However, it was his opinion that if the difficulty of a suitable indicator could be overcome, there was little difficulty in providing a proper transmitting appaaatus. Now he came to the receivers, and as these had to detect alternate currents, it was probable that in every case they would be vibratory instruments. Although at present, in the case of a telephone, they were unable to measure the amplitude and the power, they could measure the minimum ampere turns on the coils necessary to produce an audible note. Mr. Cox and himself had measured this at Woodfield works some years ago, together with Mr. Gavey and Mr. Kempe, of the Post Office, and they all agreed with each other. No doubt the human ear varied from time to time, but under the same conditions four average men had heard just about the same faint note. He had compared his result with that of Lord Rayleigh for a similar type of telephone. Lord Rayleigh had said that 1·6 milliampere turns of alternate current in the telephone made a clearly audible sound (0·8 milliampere turns just audible). Mr. Gavey, Mr. Kempe, Mr. Cox and himself had been able to hear 1·4 milliampere turns, distinctly enough for signalling, and they could hear quite distinctly with half that amount, so that they did not differ very greatly from Lord Rayleigh. However, he would not go into the theory of the telephone, because he thought there would be great trouble in working at anything like a frequency of 400 over great distances, in consequence of the absorption. He had been working at a system operating at something below 50 periods, and the only relay he had been able to devise up to the present was one for calling attention. At present it only rang a bell for calling attention, but something on these lines would ultimately be brought out for giving Morse signals. The complete theory of this relay and a statement of the power it required were given in the Paper. This instrument had been designed to work on board a light vessel—a very difficult position. He had made the rectangles on the twin system in order that any ordinary shaking should not produce an accidental close of the circuit. If a blow was given to the relay, the rectangles were started in the same phase and did not come into contact; but the moment an electrical disturbance came into the coils they were vibrated in opposite phases and came into contact. This proved to be a very valuable feature. As Dr. Lodge had mentioned in his Paper, this relay was in use satisfactorily at Lavernock and Flat Holm. Dr. Lodge had stated, however, that the result had been obtained at the expense of a good deal of power. So far as he could make out, Dr. Lodge himself was now using from 500 to 900 watts in the primary in connection with his transmission between the Liverpool College and his house, whereas they only used 120 watts in his (Mr. Evershed's) call. Possibly Dr. Lodge was judging from the size of the alternators at Lavernock and Flat Holm, but, as a matter of fact, these were far too large for the job. The current there was only 8 amperes, and the resistance less than 2 ohms. The rectangles in his relay would work with but $\frac{1}{1000}$th of an erg per second against 42 ergs for a tuning fork. Many questions had been raised as to whether Mr. Preece's system was due to induction or to leakage. Why did not the people who raised the question measure the leakage? In the spring of this year Mr. Gavey and himself, among other things, measured the leakage at Lavernock, which, to their astonishment, was very great, with continuous currents, but with alternate currents the leakage fell off rapidly as the frequency increased. Referring to Dr. Lodge's experiments at the previous meeting he asked him how much current, or how many ergs per second it took to get audible sounds from the last telephone of the series in his experiment. In conclusion, he stated that throughout, the whole of his work on this subject, he had been assisted in every possible way by the Post Office, and he could practically have done nothing without this help; with it he hoped to be able to do something to clear up definitely this question of absorption.

*Mr. W. H. PREECE informed the meeting that the work the Post Office had done during the past 16 years, and which he had summarised in his Paper, had been purely and absolutely experimental. He showed to the meeting a similar apparatus to the one working between Lavernock and Flat Holm, and operated it successfully.

*Dr. FLEMING considered that the time had hardly arrived for a complete classification of methods of space telegraphy, but, leaving out of account certain methods such as Zickler's, perhaps in an embryonic condition; and, omitting the cases of mere conduction through soil or water which were not space telegraphy at all, it was clear they were in possession of two distinct practical methods which he ventured to denominate the closed circuit and open-circuit systems respectively. The method devised by Mr. Preece and elaborated by Dr. Lodge virtually consisted in the construction of a gigantic air core alternating-current transformer, the coils of which might be several miles apart. Dr. Lodge then very ingeniously took advantage of the resonance effect, well known in connection with alternating-current transformers when worked on long concentric cables, to exalt the secondary electromotive force. The open circuit

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system, brought into notice chiefly by the interesting experiments of Signor Marconi, consisted in the creation of alternating currents of very high frequency in a straight (generally vertical) rod or wire. The disturbance sent off in the form of an electromagnetic wave created at distant places along a certain line a periodic electric force parallel to the primary conductor and a magnetic force at right angles, and the effect in a parallel open secondary circuit placed in the proper position was detected by a Branly detector inserted in it. One terminal of the induction coil and of the coherer or receiver was earthed. Dr. Lodge had suggested that the action of the receiver depended, at least in part, on "electric jerks" received through the earth. Dr. Fleming remarked that he had been led by some little study of the Branly detector to the conclusion that it responded to a certain maximum electromotive force, the metallic filings passing from a condition of nearly perfect non-conductibility to a high degree of conductibility, when the mass was submitted to a certain critical or breaking down electromotive force. Hence, when the coherer was in connection with a long metallic rod, placed in a space through which electric waves were travelling, so that the rod was parallel to the electric force arriving there, the rod integrated the electric force along its length into electromotive force. Accordingly, if the electric force was feeble, but the rod very long, the critical electromotive force might yet be reached. In the closed coil system of space telegraphy it was necessary for the secondary coil axis to be parallel to the magnetic force at its locality. In the open circuit system it was necessary for the secondary or receiving rod to be parallel to the electric force. Dr. Fleming illustrated the above fact by an experiment. From one corner of the hall electric waves were sent out in the customary manner by an induction coil and spark balls. On the table he had a Branly detector connected with a relay, battery and electric bell, in the usual way. The coherer was inserted in the gap between two long receiving rods placed in one line. When the rods were held parallel to the electric force produced at the receiving station, the bell rang out loudly; when the rods were held at right angles to it, the bell nearly ceased to ring. Dr. Fleming then described an experiment he had recently made in Regent's Park, on the absorptive power of water for electromagnetic disturbances. A long copper wire, one-eighth of a mile long, was laid down in the lake, and one end of it was attached to the spark-ball terminal of an 8in. induction coil. The other end was attached to one terminal of the coherer in the above-mentioned bell apparatus. Under these circumstances no electromagnetic impulses could be caused to travel along the wire, although when the wire was lifted out on to the dry ground the waves travelled along it freely, and caused the electric bell to ring. This experiment indicated the impracticability of the suggestion to employ the coherer or Branly detector as a relay for submarine telegraphy through bare wires, a suggestion which had already even found its way into patent specifications. Dr. Fleming added an expression of opinion that in none of the practical Hertz wave telegraphy as yet carried out is there any true electric resonance effect. Before that could be achieved it would be necessary to possess a transmitter which would not merely create irregular or intermittent impulses in the ether, but would establish continuous uniform wave disturbance of high amplitude and small wave-length.

Major-General WEBBER called attention to the following words spoken by Mr. Willoughby Smith on the 23rd March, 1882, in the discussion on Prof. Dolbear's Paper, "On the Development of a New Telephone System":—"I was prepared to have shown that by placing a flat spiral of fine silk-covered wire in the centre of this room, the spiral being connected to a suitable transmitter and battery, that every person present possessing a telephone would have been able to have heard whatever sound was influencing the transmitter, although the telephones were in no way attached to the circuit." He believed this remark had induced many, including himself, to investigate this very interesting subject.

*Mr. C. S. WHITEHEAD said that Dr. Lodge had raised the question as to whether certain of his equations applied when the frequency was as low as 300. As a matter of fact, his equations were, with a certain assumption, directly derived from Maxwell's equations; hence, Dr. Lodge's objection must refer either to the assumption or to Maxwell's equations. His assumption was that the polarisation current could be neglected, since the frequency was only 300, and not comparable with that of light. This, he contended, was justifiable. As to whether Maxwell's equations applied, he referred Dr. Lodge to the books of Prof. J. J. Thomson, Dr. Hertz and Oliver Heaviside, in which, as well as in many other electrical Papers, they all started by using Maxwell's equations. If Maxwell's equations were not true, where were the ones which should be used instead?

*Sir HENRY MANCE suggested to those who were working on this subject, that instead of simply breaking and making the vibration in order to get signals, they should alter the note of the vibration, a method which he thought would enable them to get a far greater sensibility. As a case in point, some thirty years ago he had to deal with a line in which the working broke down regularly every night until they introduced fluid insulators. One of the instruments had the make and break mechanism of an old bell in circuit, and there was a slight hum, from which he could, by the alterations in the note, distinctly read the signals transmitted from the other end of the line, 400 miles distant, although no current whatever could be observed on the galvanometer.

*Mr. A. R. SENNETT was disappointed to hear Mr. Evershed throw a considerable damper upon the question of the connection of lightships and the mainland by wireless telegraphy simply on the score of expense. The English people were proud of their maritime supremacy, and he did not think they ought to be daunted by either electrical or financial difficulties. Mr. Wimshurst had suggested to him that what might be called an induction swivel should be inserted in the cable connecting a lightship and the shore. The Trinity House authorities ought to try such a simple thing. He had made experiments in transmitting vibration through the water, and was strongly of the opinion that no electrical current or influence was necessary. If they transmitted sounds through the water by means of an electrically-driven siren, it was simply surprising how many miles they could hear it. Experiments had been made last century the whole length of Lake Geneva (48 miles), and it seemed to him that all they had to do was to devise a sensitive receiving instrument and tune it with the note they were transmitting through the water. He had made such an instrument, and found it very sensitive. He had first of all taken a membranous diaphragm and put it in the mouth of a Helmholtz resonator, and to the diaphragm had connected a microphone. The secondary of the induction coil went to a telephone magnet, and this was mounted in front of a similar diaphragm and resonator to the first. He had found it advisable to put the first diaphragm at an angle of 60deg. This first diaphragm was not fitted as in an ordinary telephone, but could be tuned as the skin of a kettle-drum. A Helmholtz resonator, as they were aware, was provided with a slider and by pushing this slider in and out they could get this diaphragm tuned to the greatest possible sensibility. He contended that if they were to put an arrangement of this kind on a lightship, and transmit from the nearest harbour, say 20 or 30 miles away, the vibrations from a bell or siren, the sound would be heard quite distinctly. Dr. Lodge had demonstrated the characteristic sound which they all recognised in a telephone, and which was very troublesome. To find a way of getting over it it was only necessary to consider the construction of the human ear. First of all, in the human ear an oval diaphragm was made use of. Secondly, there was glued, as it were, to the back of that diaphragm a bone at a certain angle. This prevented the diaphragm from having more than two radii of the same length, and the consequence was that it practically had no fundamental note. If the ear could speak instead of listen, it would naturally have no intrinsic *Klangfarbe* or note of its own; therefore, if Dr. Lodge put the magnet of his last telephone in the same position as the bone in the ear and constructed a diaphragm after the manner of the human ear, he would considerably diminish the characteristic or nose sound.

*Prof. W. E. AYRTON thought it possible that the members present may not have appreciated the importance of the investigation to which Mr. Whitehead had referred. Some three years ago, when Mr. Evershed had made such an extremely sensitive call as the one he had exhibited that evening, he did not know what sized piece of copper to put between the primary and secondary coils to represent the sea in his experiments. He (Prof. Ayrton) had entered into a correspondence with Mr. Oliver Heaviside on the subject, who was of the opinion that the absorption of the sea would not be a sufficient justification for Mr. Evershed not to try his system practically. Mr. Whitehead, who was then a pupil of Prof. Ayrton's, had, at his instigation, taken up the matter mathematically, and had shown his results to Prof. Ayrton before bringing them before the Physical Society. He (the speaker) was, therefore, to an extent, responsible for the basis of the calculations. Now, if that calculation was wrong in principle, he would be extremely obliged if Dr. Lodge would point out why it was wrong. If Maxwell's equations did not hold good he should like to know what equations did. So far as he remembered, the discussion on Mr. Whitehead's Paper, as reported in the *Proceedings* of the Physical Society, consisted chiefly in a long communication from Mr. Oliver Heaviside, in which the only point he objected to was the conductivity of sea water. But, thanks to Mr. Heaviside's kindness and interest in the subject, another method of attacking the problem was suggested, which, however, he (Prof. Ayrton) need not enter into then. Therefore, up to the time that Dr. Lodge had read his interesting Paper a fortnight ago, he (Prof. Ayrton) had been under the impression that the equations were correct. It was important to know whether, in 20 metres of sea water, there was an absorption of something like 79 per cent. If that were a fact, it seemed almost hopeless to continue the method which Mr. Evershed had tried for calling attention by acting inductively through such thicknesses of sea water. If, on the other hand, the fundamental equations were wrong, he had no doubt that Mr. Whitehead would attack the problem again and see what he could get. Since the last meeting Mr. Whitehead had brought him another investigation which he had made on the absorption between coil and coil laid flat on the land. This had been based on the same equations of Maxwell, and until they were sure about the accuracy or inaccuracy of these equations he would not suggest that Mr. Whitehead should publish the results of this new investigation. He gathered from Mr. Evershed's Paper that it only took $\frac{1}{10^{60}}$th of an erg per second to work one of his relays, so that 10,000 million of his relays could be worked with one watt. Would Dr. Lodge tell them what power had to be given to the first telephone of his train of telephones—was it more or less than this?

*Dr. OLIVER LODGE (replying to the discussion as far as it had gone that evening) said that he had been unaware of what Mr. Evershed had been doing, but he was very glad that he had now published it. He never intended to suggest that space telegraphy would displace wire telegraphy as Mr. Evershed had seemed to think. He had always said that whenever they could lay a wire it was better to do so. There were cases, perhaps, such as newspaper intelligence when they wanted to shout it all over the country, but even then he did not think Mr. Preece would like them to do it by induction telegraphy, because it would disturb the telephones. But perhaps Mr. Preece did not care whether they were disturbed or not. So far as he had had it working at Liverpool, his call had taken more power at the sending end than Mr. Evershed's, but nothing like that amount was necessary with a long base-wire or with the receiving apparatus he had shown. From the results of his experiments in his laboratory he felt convinced that the power that was used for getting an audible sound—which was quite a small power—would be quite sufficient to work the call with his magnifying arrangement. He could not answer the question at once as to how many ergs were required to work the first telephone, but could only say that it was much less than was required to work an ordinary telephone. He would endeavour to supply the figure at the next meeting. The speed of signalling by a tuning fork might have been expected to be rather slow; but using a

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frequency of 300 or 400 per second, as fast as an operator worked the key, the telephone responded. He had slightly modified his tuning fork arrangement by making the upper prong of the fork carry the screw and the lower prong carry the carbon. Therefore, when the fork vibrated properly, the microphone was put into action; but any small jarring of the fork, as a whole, did not affect the apparatus. He did not wholly agree with Prof. Fleming's remarks as to the uselessness of an earthed wire. He had made some experiments with an earthed wire or gas pipe by sending an electrical "jerk" or rapid rise of potential through it, and had been surprised at the immense distance at which a coherer could feel the effect of this current. If the wire was very clean, no doubt it did not go so far; but what they meant by bare wire was a roughly and imperfectly insulated one, and with such a wire he believed, by the method of "jerks" on the coherer, a good deal more could be done than Dr. Fleming's remarks would lead them to believe. It was not necessary to put the coil at the bottom of the sea, in signalling to lightships electromagnetically. It should be kept in the dry, and the absorption of the sea water would then have less effect. He was anxious to remove the misapprehension into which Mr. Whitehead seemed to have fallen. He had not meant to convey that Mr. Whitehead was wrong, but that these were discrepancies between the calculations of different mathematicians. His feeling was that the theory as given by Maxwell could not apply to all frequencies. In the problem of the transmission of light through a partial conductor, the absorption of energy comes out independent of the frequency, yet they knew experimentally that conductors were not equally opaque to waves of every length. Then there was another problem, as to the effect of the earth near but not between a pair of induction circuits; this was a matter for mathematicians, and last week he had written to Prof. J. J. Thomson suggesting this problem to him. Just as he came to the meeting that evening he had had a letter from Prof. Thomson saying that he had got a solution, but that he had not yet reduced it to arithmetic.

January 12, 1899.

Mr. SYDNEY EVERSHED corrected his statement made in his Paper that he had been appalled by the large size of the condenser necessary, consequent on the large self-induction of the circuit, in connection with his scheme for laying a circuit round the county of Kent, in order to effect communication with the lightships round the coast by means of an induction telegraph. He intended to say that, in consequence of the low frequency at which his apparatus was intended to work, the size of the condenser was necessarily large. Of course, the larger the self-induction the smaller the capacity of the condenser. The reason that the circuit required such a large condenser was that he proposed to work at a frequency of 12 periods per second.

*Dr. O. J. LODGE asked Mr. Evershed to correct another statement of his, viz., that his relay at Lavernock took less power than was required for the telephone. In other words, that a telephone, working at 400 periods per second, had 600 times the power applied to it it would get at 16 periods, meaning that the power varied as the square of the frequency, but this was ignoring the self-induction of the line altogether. The pL term was 10 times as great as the resistance term in the Lavernock line wire at 400 frequency. Working at 16 periods per second, on the other hand, r could stand alone as the denominator. He had been asked last time as to the power necessary to work his magnifying telephone—the first of the series. He had had a determination made, and had found that the current required was about a micro-ampere in a circuit of an ohm resistance; one millionth of a millionth of a watt was sufficient to give an audible signal. The magnifying telephone was in fact about 30 times as sensitive as an ordinary telephone, and that was without taking any precautions whatever; probably with care it could be made more so. But in Mr. Evershed's relay there was a visible motion of the rectangle, the wire actually moved in a magnetic field, and, therefore, they got a back electromotive force. In his system it was merely necessary to vary the pressure on the carbon—there was probably no back electromotive force to speak of. All that the signalling current had to do was, as it were, to pull a trigger, thereby throwing fresh energy into the circuit from the local batteries, and the resulting energy from the final telephone bore no necessary relation to the current in the circuit that pulled the trigger. As to the opacity of sea-water, he had got to the bottom of this and realised a sort of reconciliation between Clerk Maxwell's calculations and those of Mr. Whitehead. It turned out that both were right, but that both referred to different cases. They were both extremes, and if either was wrong in its application it appeared to be Maxwell. Maxwell dealt with gold leaf, and got a transparency less than experiment gave. But Mr. Heaviside had, in 1887, published a more general theory which included both these extremes, and this had reconciled the whole thing. He proposed to say something about that at a meeting of the Physical Society on Feb. 10th. He would ask Mr. Evershed if in his experiments on the Goodwin Sands the ship was of iron, if the cable was inside the ship, and if the primary cable at the bottom of the sea was sheathed in iron. If these things were so, no further explanation was needed as to the failure of the experiment. He made some experiments himself about six months ago on the effect of neighbouring conductors near the primary coil. A sheet of copper produced a great effect, as they might expect; a sheet of tin foil produced very little, and a pan of dilute acid produced no appreciable effect, hence he had thought it likely that liquid conductors need not very much be taken into account. Prof. J. J. Thomson's solution of the effect of the earth, which he mentioned last time, was very complicated, but it appeared from it that the earth might almost as well be taken as a perfect conductor, in which case it would not do to work with horizontal coils. Looking at the subject from an elementary point of view the horizontal coil above the earth's surface induced an image below the earth's surface, the current through which would be in opposite phase to the upper one, so that at a distance the effect would hardly be felt. Mr. Preece would no doubt be glad to hear that he was coming round to the opinion that vertical coils might, after all, be the better. Prof. J. J. Thomson had also calculated the effect of vertical coils. If they set up coils vertical to the earth then the conductivity of the earth, instead of hindering, actually helped. Thinking of the matter in the image way, the image of a vertical coil will be in the same phase as itself. He thought vertical coils would be especially good for ship signalling. It had always been a difficult matter to put effective horizontal coils on board a metal ship. Mr. Preece had urged that the best way was to arrange to have the circuit spanning the masts and then use earth plates, and that thus they would get the advantage of earth tapping as well as induction. The disadvantage, however, of a ship fitted up in this way was, that while it could signal broadside on, it could not signal end on. Sir Henry Mance had suggested signalling by two notes; he had evidently meant a system of dots and dashes or right and left signals between two bells, but the following would be more practicable. Suppose a ship was trying to enter a harbour in a fog. On either side of this harbour let there be signalling stations, each with apparatus tuned to a different note, while on board the ship there was apparatus tuned to both these notes. They would hear a musical interval when coming in straight, but if they were to turn the ship a bit they would hear one note increase and the other decrease and when it got exactly end on, one note would stop and the other be heard at a maximum. Then swing the ship till it could hear only the other note. By this means he thought it could take its bearings and find out exactly where it was. With horizontal coils this could not be done. He was much obliged to Mr. Preece for the promised help of the Post Office, for he felt that by working in conjunction with the Government some good work could be done. It now only required a little friendly co-operation and the absence of rivalry to put the matter on a sound basis.

*Mr. W. P. GRANVILLE emphasised the practical side of the question, because he thought it was well for electrical engineers to have some idea of the difficulties that would probably arise in the practical application of wireless telegraphy. First, however, he would like to say something of the work of the late Mr. Willoughby Smith, who had already been referred to at the last meeting by Major-Gen. Webber. On the occasion of his inaugural address, in 1883, Mr. Smith had described a large number of experiments made by him on magnetic induction, and the speaker exhibited and explained some of the original diagrams Mr. Willoughby Smith had used on that occasion. Mr. Smith had suggested, at that time, the use of magnetic induction as a means of telegraphing with trains in motion, and also for other purposes where ordinary telegraphy could not be utilised. The idea had not been very well received at the meeting, but times had changed since then. During the last 10 years Mr. Willoughby Stathan Smith and himself had had the task before them of devising some method which would be suitable for telegraphing to those places, which would be impracticable by ordinary means, such as outlying rock lighthouses, and they had made a large number of experiments in the laboratory, and also at the Needles Lighthouse in Alum Bay. The results were such that they had since devised a system which, in conjunction with the Royal Commission on lighthouse communication, had been established at the Fastnet lighthouse. The tower of the lighthouse was built of boiler plate, although it was lined with brick, and everything around it was of a conducting nature. In fact, the rock itself was the only non-conducting body for eight miles round. It was very clear that in a case of this sort it was absolutely impossible to employ the methods they had heard explained in the Papers. They heard about the installation at Flat Holm which required a circuit base of something like a quarter of a mile, but here was a case where no base was available. Then they came to the case suggested by Mr. Evershed of a coil. But a coil would never last in the rough sea around the lighthouse. They laid a cable and anchored the end in 12 fathoms of water in the near vicinity of the rock, and by sea leakage they picked up the shunt current from the rock, and, by means of a suspended coil galvanometer, they effected communication. They were still in a more or less temporary condition, although daily messages were exchanged by the lightkeepers with the shore. The rock was of granite hardness, and they had taken about four months to cut a chase down the side of the rock to lay one of the earth lines in, and yet it was washed out soon afterwards. So the object had been accomplished by drilling down through the rock with a diamond drill. Coming to the Papers he drew attention to the statement made by Dr. Lodge that the whole matter, whether wireless telegraphy was aided by induction or conduction, might be settled by experiments, but that in certain cases such experiments would be absurd. Was that necessarily so? If they had one coil with no earth, was it absurd to consider that another coil with an earth on would not possibly pick up the current by conduction? Was it not true that the inducing coil would induce currents in the earth which would be picked up by any earthed conductor? Mr. Preece had mentioned in his Paper an experiment in which he first took a length of wire, put it on poles and used it as his sending circuit, and secondly had employed a sending circuit of the same amount of wire made up into a coil, and had found the first form better. In the former case, no doubt, Mr. Preece got the benefit of earth leakage, and after the results of his own experience he had come to the conclusion that whether using Hertzian waves, the coil system or the system at Lavernock, mother earth *did* affect the results very largely.

*Captain BRETT regretted that Dr. Lodge appeared to have discarded Hertzian wave telegraphy. Mr. Evershed had pointed out that the electromagnetic method possessed, as it certainly did, the advantage that calculation was easier. On the other hand, the wave method possessed the enormous advantage that experiment was considerably easier. It was a case of experimenting with a vertical wire in the wave method against transporting tons of copper in the magnetic induction system. He did not think the statement in Dr. Lodge's Paper, that Mr. Preece's system at Lavernock was the only one in actual regular work, could be quite accepted, as Mr. Marconi had for nearly 12 months been exchanging messages between Alum Bay and Bournemouth, a distance of 18 miles, which was

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nearly six times as far as the existing installation between Lavernock and Flat Holm. The excellence of the messages received over this 18 miles had to be seen to be believed. Also, by Mr. Marconi's method, the problem of communication between lightship and shore had been solved, as the Goodwin lightship had been in uninterrupted communication, since last Christmas Eve, with the South Foreland lighthouse, a distance of over 12 miles. Some of the messages were transmitted during very rough weather, on one occasion when all Channel traffic was stopped. On this occasion, whenever the assistant operating the apparatus on the lightship was *hors de combat*, one of the seamen, who had a slight knowledge of the Morse alphabet, had maintained the communication sufficiently well. Iron masts and wire stays did not make any difference to the clearness of the messages, a fact which he thought would be interesting to the previous speaker on the boiler plate lighthouse. Another interesting item was the fact that the alternators on the South Foreland lighthouse did not affect the system even when the vertical wire was brought to within one inch of the alternator circuit, and also the telephones in the same building were quite unaffected. He thought the speed of the signals of secondary importance. Space telegraphy was not coming to replace telegraphy by wires; it was to facilitate communication where it was not previously possible, and people would not grumble because the rate of signalling was slower. With regard to Dr. Lodge's statement, that earth conduction played a considerable part in coherer signalling, he said that Mr. Marconi had made an experiment during the week on that point, and on the earth connection of the receiver being removed during the receipt of a message, the latter was not interrupted in the slightest. If any change took place it was that the signals were rather more powerful than before. He did not think that earth connection was a necessity of the receiver. It was a necessity to the transmitter for the reason that it seemed to assist in converting the long flaming spark into an oscillating one.

*Mr. DANE SINCLAIR said that the word "earth" had been referred to as a common quantity, that was to say, it seemed to have been taken for granted that the earth behaved at the different places on its surface in a constant manner. From a very long experience of using the earth in a practical way, he found that it varied very much indeed. In practice it would be found that where they were at about the level of the sea with a sandy soil it was almost impossible to get anything like a good earth, while with a clay soil it was almost impossible not to get a good earth. Another point was that to get an earth for two points 50, 60 or 100 miles apart was an easy matter, but to do this for two points, say, half-a-mile apart, was another matter altogether. With regard to the stepping up of the receiver in Dr. Lodge's series of telephones, he thought that if they could get a step-up motion in the reverse way they would have a relay, which for ordinary telephone work would have an immense importance indeed. Perhaps Dr. Lodge had considered it from that point of view.

*Mr. A. C. BROWN thought that right through the discussion it had been well brought out that a low frequency was much the best for transmitting energy, but that a high frequency was better for affecting the most sensitive receivers which were in existence, viz., a telephone or a coherer. Up to the present, however, it had been the custom to use the frequency which was best adapted to operate the receiver, without reference as to whether or no it was the best frequency for transmitting the energy across the space. It did not seem to have occurred to anyone that it might be possible to use both these advantages, viz., that it might be possible to transmit the energy at a low frequency and still retain the advantage of having the receiver affected by the frequency best adapted to operate that; in other words, to split up the received current in these induction telegraphs. Probably this explained the reason why Dr. Fleming had failed to get his signals through a bare wire submerged in water. No doubt he had transmitted his waves at the very rapid rate usual with such apparatus. If Mr. Preece would take his rapid make-and-break out of the primary circuit at Lavernock and put it into the receiving circuit he thought he would obtain still better results, or could overcome a greater distance, provided that no current was produced in the receiving circuit from the current used locally to operate the make-and-break.

*Dr. O. J. LODGE, replying to Mr. Granville's criticism of his statement that experiment was absurd, said that if he used these words he wished to withdraw them. Experiment was never absurd. He only meant to say that he did not expect earth conduction to have any effect if either one of the coils was perfectly insulated. At the same time, he would not deny Mr. Granville's assertion that if only one of the coils was earthed the earth might have some effect. He was much interested in Mr. Granville's statements and photographs about the Fastnet lighthouse. As to his adhering to the subject of his paper, and not diverging on to the cognate subject of telegraphy by means of Hertzian waves, he had been told that Mr. Marconi was down to read a Paper before them this year, and the subject could be discussed then. He had not forsaken it, however, and was continually making experiments, though not on a large scale. Mr. Marconi had much better facilities than he had, and was evidently doing very good work. With regard to the earth connection being of no use for the receiving system, he should be the last to deny that the coherer could be affected direct by Hertz waves, but he knew it could also be affected by pulses coming through the earth. Mr. Sinclair had mentioned that it was more difficult to get earths for small distances than for long ones. It was perhaps not generally known that the resistance of a sphere like the earth was independent of distance. If two small spherical electrodes were introduced in the skin of a sphere, then, whether they were close together or separated by a large distance, the resistance was the same theoretically. Naturally, in a line a thousand miles long the resistance of the earth seemed smaller than with a shorter length.

Mr. SYDNEY EVERSHED, in reply to the discussion, said he did not see that the second correction to his Paper that Dr. Lodge had referred to was necessary. If his statement, that there were 600 times the amount of current available for working a telephone at 400 periods than there was for his relay at 16 periods, was not qualified, it would be absurd, but if they looked at equation 4, which was really the foundation of his Paper, they would find it distinctly stated that the equation referred to that condition in which the electromotive force and the current were brought into phase. The statement with regard to the power did not relate to Lavernock in any way whatever. It was not a part of the Paper that was referring to these experiments, but was a plain statement of the truth that when they had no self-induction, or had neutralised it, and brought the electromotive force into step with the current, the power at 400 periods was 625 times as great as it was at 16 periods per second. He was glad that Dr. Lodge had given them particulars of the power used in his telephone, but unfortunately he had only given them the C^2R losses, and had omitted the most important factor of all, viz., the back electromotive force due to the motion of the diaphragm. What he would have to do was to raise the electromotive force of the telephone, either by re-winding it or by raising its field, until he made the back electromotive force equal to one-half the impressed electromotive force. He would then get the maximum activity. At present he was not doing himself justice. In reply to Dr. Lodge's queries, the Great Sandhead lightship was built of iron, he had put the coil inside the ship, and the primary cable was armoured. The latter had been absolutely unavoidable, as otherwise the cable would not have lasted a week. He felt perfectly confident that the armouring of a cable must necessarily cut off all induction at 400 periods. He had measured the resistance of the armouring, and calculated the inductive effect of it, and found that at 16 periods per second the absorption was 10 per cent. He had made a great many experiments on absorption, but must confess they were entirely fallacious. If they reduced the size of the circuit, they must at the same time increase the specific resistance of their absorbing medium, and the increase in the specific conductivity must be as the square of the scale of the model. When he made his experiments with models, he found that by having a cable ring about a foot in diamete for a lightship, he had to use zinc for his sea. Mr. Whitehead, Dr. Lodge, Mr. Heaviside and Maxwell were all apparently at loggerheads as to how much absorption there would be in any given case. Well, he measured the absorption of this sheet of zinc and compared it with Mr. Whitehead's formula. Mr. Whitehead's figure for the particular piece of zinc that he measured was 38 per cent., while his figure (the speakers) was 27 per cent. Such a difference in a matter of this kind was of no moment whatever. It showed that Mr. Whitehead was on the right track and it gave them an idea of the absorption. If they had taken one of Maxwell's formulæ they would have arrived at a wholly wrong result, because p was given at the top of the fraction instead of at the bottom. Mr. Sennett made some interesting remarks on Mr. Wimshurst's ingenious scheme for communicating with a lightship by means of an induction coil, the primary and secondary parts being the two parts of a swivel, and had wondered why such a thing had never been tried. No such apparatus put into sea stormy would last more than a few days. Since last meeting it seemed that Dr. Lodge had abandoned horizontal coils and left him apparently the sole possessor of them. The question of vertical coils on ships was one which ought to be worked out; it was apparently the only one that would ever work, but the ingenious manner in which Dr. Lodge suggested that a ship would be able to find its bearings was one which he thought likely to break down at the critical moment. In reply to Captain Brett he did not regard induction telegraphy as a thing that would be applicable everywhere; the simplicity of the Hertzian wave system was an immense advantage. But what the cost was, or the expenditure of energy, nobody had ever seemed to trouble about. Mr. Brown seemed to have misunderstood the point of the speaker's experiments at Lavernock. He seemed to imagine that it was leakage that was causing the difference in the received current. It was not so. It was the difference in the leakage current solely, and the extraordinary thing was that the leakage current should fall off so much between a continuous current and 16 periods per second. Therefore, his point was that if it fell off to such an enormous extent between continuous current and a current at 16 periods per second, it might fall off to such a very large extent at 400 periods per second that the result in the telephone would be enntirely due to induction.

A hearty vote of thanks was then passed to Dr. Lodge, Mr. Evershed and Mr. Preece.

CORRESPONDENCE.

INDUCTION TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Dr. Lodge has suggested that the result given in my Paper, to which he referred, does not agree with a result given by Maxwell, and that neither agree with one given by Prof. J. J. Thomson. As regards Maxwell's result, from the equations Dr. Lodge wrote on the black-board, I presume he was referring to Maxwell, Vol. II., Art. 798, where the equation is obtained—

$$F = e^{-ps}\cos(nt - qz),$$

provided

$$q^2 - p^2 = \mu K n^2,$$
$$2pq = 4\pi\mu C n.$$

If, however, the frequency is small, $\mu K n^2$ is very small (for a frequency of 300, $\mu K n^2$ is about 4×10^{-15}). So that $q = p$ very nearly. $\therefore p = (2\pi\mu C n)^{\frac{1}{2}}$, which is precisely the result I arrived at.

I regret that I am unable to find in "Recent Researches" the result of Prof. J. J. Thomson, to which Dr. Lodge alluded, so I cannot say why or where we differ.—Yours, &c.,

C. S. WHITEHEAD.

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LEGAL INTELLIGENCE.

Stegmann v. O'Connor.

In the Queen's Bench, on Saturday, an appeal from the decision of the Official Referee, in an action brought by Mr. G. Stegmann against a client at Clapham, was heard.

Mr. TINDAL ATKINSON (for plaintiff) said he had to ask their Lordships to set the decision aside because it was against the weight of evidence, and because the Referee's decision was against the contract and specification. In 1898 defendant required an installation put down, and his architect prepared specifications. The contract was given to the plaintiff, and he proceeded to execute it; but a complaint arose that he was not finishing the work in time, and the work was then completed by another engineer. The Official Referee found that the work was not done according to the specification. He allowed plaintiff a certain amount for the actual value of the work taken over by the engineer called in, gave a penalty of £50 for the non-completion, and ordered judgment to be entered for defendant on the claim and counter-claim for £38. 1s. It was in respect of that that the plaintiff now complained. He said he did complete the work. It was true he admitted that in one particular he did not do it according to the specification, but he completed it so that the installation would work all right, and that in the circumstances the Official Referee was wrong in penalising him. The point was, the true construction of the specification. It provided that all the wires were to be encased, and what the plaintiff had to do upon the construction of the specification was to encase the wires in American wood, and then paint the wood so as to prevent decay or corroding. But it was said that he should not have used wooden cases at all, but "compo" cases, and sink them into the walls, because it was said that was a better preservative for the wires. The amount of the contract was £76. 10s.

Their LORDSHIPS pointed out that the casing was to be "proper," and the Referee evidently did not think American wood cases "proper."

Mr. ATKINSON submitted that when "compo" cases were required they were always specified.

The hearing was adjourned.

Hilary Sittings.

The following cases of electrical interest have been ordered for trial at the Royal Courts of Justice during the present sittings:—

COURT OF APPEAL.

Chancery Final Appeals.

Vestry of St. Mary, Battersea, *v.* County of London and Brush Provincial Electric Lighting Co. (Limited). (Appeal of defendants from order of the President of the Probate, Divorce and Admiralty Division, dated April 21, 1898.)

Mica Insulator Co. *v.* Electrical Co. (Limited). (Appeal of plaintiffs from order of Mr. Justice Kekewich, dated June 30, 1898.)

Castner-Kellner Alkali Co. (Limited) *v.* Commercial Development Corporation (Limited). (Appeal of defendants from order of Mr. Justice Bigham, dated August 3, 1898.)

Queen's Bench Final Appeals.

Eastern Telegraph Co. (Limited) *v.* Dent and Others. (Appeal of A. and E. Dent from judgment of Mr. Justice Kennedy, dated June 21, 1898.)

Holliday *v.* National Telephone Co. (Limited). (Appeal of plaintiff from judgment of Mr. Justice Wills and Mr. Justice Lawrance, dated Nov. 29, 1898.)

CHANCERY DIVISION.

Bristol Tramways Carriage Co. (Limited) *v.* National Telephone Co. (Limited). (Action without pleadings.)

National Co. for Distribution of Electricity by Secondary Generators (Limited) *v.* Gibbs. (Action and counterclaim.)

Electric Construction Co. (Limited) *v.* Imperial Tramways Co. (Limited). (Action.)

Cooper *v.* Metropolitan Electric Supply Co. (Action, with witnesses.)

Electric Exploration Co. (Limited.) (Petition of Sussman Electric Miners' Lamp, Limited. Winding up.)

QUEEN'S BENCH DIVISION.

Pearson *v.* Charing Cross, &c., Electricity Corporation. (Defendants' appeal from County Court.)

National Telephone Co. *v.* Day. (Injunction.)

Cooper *v.* Electric Installation Co. (Contract.)

Electric Welding Co. (Limited) *v.* Burdett-Coutts. (Calls.)

Wood Seasoning by Electricity.—A new process, says the *Engineering and Mining Journal*, is announced for seasoning wood by electrical action. The timber to be treated is put into a quadrangular tank of liquid, immersed to rather more than half its depth, and an electric current applied through a metallic conductor, so arranged as to distribute it throughout the area, and it is stated that in a space of four minutes the sap begins to exude at the lower end of the wood; in six hours it is all extracted. The wood is then placed in another tank from which a sceptic solution is forced into the pores "by an electro-capillary method."

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury court, Fleet-street, London:—

NOW READY.

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. The Author hopes that, besides Telegraph and Telephone Engineers, it may, perhaps, also prove of service to those in charge of cables for the transmission of light and power. The localisation of faults has been very fully investigated, including the different degrees in which the various methods are affected by the presence of a second fault or of general leakage.—*Extract from Preface.* Demy 8vo, fully illustrated. 10s. 6d., post free; abroad 11s.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinsor, M.I.E.E., &c., fully illustrated; price 12s. 6d.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition now ready.*

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition. Price 2s, post free.

"WIRELESS TELEGRAPHY: SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES."—By Dr. O. J. Lodge, with many original illustrations. *Enlarged Edition*, 2s. 6d. net, 2s. 9d. post free.

"ELECTRIC MOTIVE POWER," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"LABORATORY NOTES AND FORMS."—With the above title we have ready the New Edition of a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated. price 1s. 6d.; post free, 1s. 9d.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97.' A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. Prospectus on application.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. A fine large paper edition with wide margins for notes can also be supplied. Price 12s. 6d.; post free, 13s.; abroad, 13s. 6d. *New Edition in the press.*

"THE ALTERNATE CURRENT TRANSFORMER," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *New Edition.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

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"ARMATURE WINDINGS OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free; abroad, 6s. 6d. Digest post free.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free; abroad 13s. 6d. Prospectus post free.

"The Electrician" Electrical Trades' Directory and Handbook.—An important announcement in connection with the 1899 issue of the "Big Blue Book" will be found in an advertisement on another page of the present issue, to which our readers will please refer.

Electricity Supply Data and Statistics.—In the large sheet tables of electricity supply statistics issued with *The Electrician* for Jan. 6 there were some omissions which we hope to remedy in the final issue of the tables the first week in February, when the tables will form part of "The Electrician" Electrical Trades' Directory and Handbook for 1899, and will also be obtainable on rollers and in cloth cases. The Editor will be obliged if station engineers and others who can assist in completing the table will send in particulars as to: (1) The total capital expenditure to Dec. 31, 1898 (actual or approximate); (2) The total units generated for year to Dec. 31, 1897 (actual); (3) Units generated for year to Dec. 31, 1898 (actual or approximate); (4) Any other particulars which will help to make the table fully complete to Dec. 31, 1898. It is hoped that the information sought will reach *The Electrician* office by Jan. 26.

TENDERS INVITED.

The Electrical committee of the *Whitechapel* (London) District Board of Works invite tenders for the supply and erection of:—(*a*) Armoured and unarmoured cables; (*b*) arc lamps and posts; (*c*) steam dynamo and balancing booster; (*d*) storage batteries; (*e*) boilers and fittings, feed pumps, pipes and heater. Specifications can be obtained from Mr. Arthur Wright, 26 and 27, Bush-lane, Cannon-street, London, E.C., after the 27th inst., and tenders must be sent to the clerk of the Board (Mr. Alfred Turner), 15, Great Alie-street, London, E. Further particulars are given in an advertisement elsewhere.

The *Buxton* District Council invite tenders for the supply of feeders, mains and arc light heads. Copies of specifications, &c., may be obtained from Mr. Josiah Taylor, Town Hall, Buxton, and specifications and drawings may be seen at, but not obtained from, Prof. A. B. W. Kennedy, 17, Victoria-street, London, S.W. Tenders must be sent in to Mr. Taylor by Monday, Feb. 6. An advertisement elsewhere gives further particulars.

The *Burton-on-Trent* Corporation invite tenders for the supply and erection of three steel Lancashire boilers at the electric light works. Copies of conditions, specifications, &c., may be obtained from Mr. F. L. Ramsden, Gas and Electric Light Works, Burton-on-Trent. Further particulars are given in an advertisement, and tenders must be delivered to the town clerk (Mr. T. N. Whitehead) by 10 a.m. of Saturday, 28th inst.

As announced in an advertisement, the Electricity committee of the *Belfast* Corporation invite tenders for the supply of the following:—Cast iron pipes, cast iron frames and covers, earthenware conduits, insulated cable, and Lancashire boilers. Specifications and conditions of contract may be obtained from Mr. Victor A. H. M'Cowen, city electrical engineer. Tenders must be lodged with the town clerk (Sir Samuel Black), City Hall, Belfast, by Thursday, Feb. 2.

The *Metropolitan Asylums Board* invite tenders for the supply and erection of the following electric lighting plant at the Northern Hospital, Winchmore Hill, N.:—(1) Switchboards, booster and connections; (2) battery; (3) electric mains; (4) steam exhaust, feed and drain pipes; and (5) wiring and fittings. Tenders must be lodged at the office, Norfolk House, Norfolk-st., London, W.C. by 10 a.m. of 25th inst.

The Commissioners of *Govan* invite tenders for the supply and erection of (1) water tube boilers and feed heater; (2) engines and dynamos, equalising transformer, boosters, &c.; (3) lead-covered armoured cables; (4) storage batteries; (5) arc lamps; and (6) arc lamp pillars. Tenders to Mr. A. Macdonald, Hillock House, 752, Govan-road, Govan, by 23rd inst.

The Corporation of *Lowestoft* invite tenders for the supply and erection of the following plant:—(*a*) boilers and fittings, economisers, feed pumps, &c.; (*b*) pipe work, &c., for engine and boiler house; (*c*) steam dynamos and motor boosters; (*d*) storage batteries; (*e*) main switchboard and connections; (*f*) overhead travelling crane; (*g*) underground mains and conduits, road work, &c.; (*h*) arc lamps and posts; (*i*) station lighting. Tenders to the Town Clerk, at the offices, 115, High-street, Lowestoft, by noon of Feb. 6.

The Commissioners of the Burgh of *Stirling* invite tenders for supply of mains. Tenders to Town Clerk's Office, Stirling, by 30th inst.

The *Sunderland* Corporation require tenders for road work with stoneware casings, and supplying and laying cables. Tenders addressed to chairman of the Lighting committee, Town Hall, Sunderland, must be sent to Mr. Fras. M. Bowey, by 27th inst.

The *Ealing* (London) Council require tenders for two 500 H.P. steam alternators, and one 150 H.P. steam dynamo alternator. Tenders to clerk, Ealing, W., by 30th inst.

Tenders are required for an electric light installation, including boilers and accumulators to 150 H.P. Particulars from Mr. H. Cleaver, engineer, 52, Bridge-road, *Southampton*.

The *Halifax* Corporation invite tenders for a 600-kilowatt steam alternator. Tenders to the Town Clerk by noon of 24th inst.

The *Hull* Corporation invite tenders for a water softener for dealing with 400 gallons per hour and three steel tanks for the tramways department. Tenders to Chairman of Works committee by 25th inst.

The *Bradford* Corporation invite tenders for electric lighting their Hammerton-street destructor works. Tenders to town clerk by Feb. 1.

Tenders are invited by the Directors of the *General Accident Insurance Corporation* for the supply of electric bells and telephones at their new offices, Tay and High-streets, Perth. Particulars from Mr. G. P. K. Young, 42, Tay-street, Perth.

The *Rathmines and Rathgar* District Council invite tenders for the erection of electricity station buildings and foundations. Tenders to Chairman, Town Hall, Rathmines, Dublin, by 30th inst.

The *London* County Council invite tenders for four continuous-current dynamos, one motor generator, two switch-boards with switches, measuring instruments and other work required for the proposed Victoria Embankment electric generating station. Tenders to Mr. C. J. Stewart, County Hall, Spring-gardens, S.W., by 10 a.m. Jan. 31.

The *Norwegian* State Telegraph Administration are inviting tenders for the delivery of about 140,000 porcelain telegraph and telephone insulators. A copy of the specification, conditions, &c., can be seen on application at the Commercial Department of the Foreign Office, and tenders must be sent in to the Administration at Christiana by 12 noon of Feb. 26.

The *London* County Council also require tenders for the erection of four gas engines at the proposed Victoria Embankment electric generating station. Tenders by 10 a.m. Jan. 31.

Tenders are invited by the municipal authorities of Merbes-le-Château, *Belgium*, for the electric lighting of the town. Particulars can be had from Le Bourgmestre.

TENDERS RECEIVED AND ACCEPTED.

The Shoreditch Vestry received the following tenders for the supply and fixing of three 66 kilowatt and three 33 kilowatt transformers and switch gear:—

	Six transformers.	66 kilowatt armature.	33 kilowatt armature.	Long-range switch.
Electric Construction Co. (*accepted*)	£4,497	£270	£185	£65
Thomas Parker (Limited)	4,914	250	180	50
Brush Co.	5,388	420	230	79
Mather and Platt	*3,870	270	185	—

*Not including switch gear, estimated at £1,000.

The contract for supplying and erecting an electric lift at the new Y.M.C.A. Buildings, Newcastle-on-Tyne, has been placed with the Otis Elevator Co., and Messrs Bland Bros. have obtained the contract for wiring and supplying ventilating fans, &c.

On the recommendation of the Electricity and Public Lighting commitee the St. Pancras Vestry have accepted the quotation of the Brockie-Pell Arc Lamp (Limited) for the supply of 50 Brockie-Pell arc lamps at £8. 15s. each.

The tender of Messrs. Johnson and Phillips has been accepted by the Southport Corporation for the supply of two 60-kilowatt transformers at £110 each.

The Electric Lighting committee of the Edinburgh Town Council on Tuesday accepted the tender of Messrs. Mather and Platt for the supply of electric lighting plant at the Macdonald-road station at £9,136.

The Electricity committee of the Bolton Corporation have accepted the tender of Messrs. Hick, Hargreaves and Co., for two electric feed pumps, and that of Messrs. Musgrave and Son for a new water tank and a new travelling crane for the electricity works.

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APPOINTMENTS VACANT AND FILLED.

The Torquay Corporation require a mains electrician for their electricity department. Applications must be sent in by Saturday, 28th inst., to the Corporation electrical engineer (Mr. P. Storey), Electricity Works, Torquay. See advertisement.

A resident electrical engineer is required at the Mullingar (Ireland) District Asylum. Salary £60, with board, &c. Applications to the medical superintendent. See advertisement.

The Worcester Corporation require two improvers as switchboard attendants. There are also vacancies for two pupils at the electricity works. Applications to city electrical engineer (Mr. C. J. Sutherland). See advertisement.

A switchboard attendant is required at the Morecambe electric light works. Applications by the 24th inst. to the electrical engineer (Mr. C. F. Parkinson, M.I.E.E.). See advertisement.

The Great Indian Peninsula Railway Co. require an assistant telegraph superintendent. Applications have to be sent to "C.E.," 5, Victoria-street, Westminster, London, S.W. See advertisement.

A mains superintendent is required for the Southport electricity works. Applications to town clerk by Wednesday next.

An electrical tester and an improver are required by the South Shields electricity department. Applications by 28th inst. to borough electrical engineer.

A second assistant engineer is required for the Ashton-under-Lyne electricity works. Applications to borough controller by 30th inst.

Mr. F. W. Clements, having resigned the position of resident engineer at the St. Luke's station of the County of London and Brush Provincial Company to accept an important post in Australia, is succeeded by Mr. W. J. Dale, promoted from the company's Wandsworth station. Mr. A. A. Whitlock, late resident engineer at Dover, succeeds Mr. Dale as resident engineer at Wandsworth, and Mr. L. W. Woodman, late chief assistant at Dover, has been appointed resident engineer at Dover, Mr. T. W. Bloxam becoming first assistant at that station. At Coatbridge, Mr. J. B. McIndoe has been appointed resident engineer, succeeding Mr. G. C. Laird, now first assistant to Mr. Teague at Paisley. At Wandsworth, Mr. A. R. Bacon becomes first assistant-engineer, Mr. C. Carew-Gibson second, and Mr. W. G. Hardy third.

Mr. C. R. Bellamy has been appointed general manager of the Liverpool tramways, at a salary of £800 per annum, rising by annual increments of £100 to £1,000. Mr. M'Kenna has been appointed assistant manager, at a salary of £300.

Mr. James Keith, B.Sc., has been appointed chief electrical engineer to Messrs. Tuck and Co. (Limited), Dublin.

Mr. G. R. Hulme, of the Blackpool Electricity Department, has been appointed secretary of the Blackheath and Greenwich District Electric Light Co. (Limited).

Mr. E. J. Scown, C.E., assistant borough surveyor of Huddersfield, has been appointed engineer to the tramways department of the Manchester Corporation. Mr. Scown commences his duties on 6th prox.

Mr. A. G. Bird has been appointed assistant electrical engineer at Bristol, at a salary of £175 per annum. Mr. Bird has recently been with the Yorkshire House-to-House Electricity Co.

Mr. George G. Scurfield, of Sunderland, has been appointed assistant engineer at the Carlisle electricity works.

BANKRUPTCIES, LIQUIDATIONS, &c.

A receiving order has been made against Thos. Ford, trading as Thos. Ford & Co., electric fittings, &c., maker, The Retreat, Selly Park, Worcs., and Victoria Works, Emily-street, Highgate, Birmingham.

In the bankruptcy of Chas. Leigh Clarke, electrical engineer, Hope-road, Newton-le-Willows, trading at 7, South Parade, Manchester, as the Northern Counties Electric Construction Co., the trustee (Mr. W. A. Smith), 17, Cooper-street, Manchester, has been released.

The Britannia Motor Carriage Co. (Limited) is to be wound up voluntarily, and the Hon. J. H. H. Berkeley, Throgmorton House, London, E.C., has been appointed liquidator. The company's undertaking has been acquired by the London Exploration Co.

It has been decided to wind up the Direct Telephone Exchange Syndicate (Limited) voluntarily and to appoint Mr. T. Featherstone-Smith, 8, Minories, London, E.C., liquidator.

The creditors of Jacob Gutmann (trading as J. Goodman and Co., electrical supplies dealers, 48, Commercial-street, London, E.), met yesterday (Thursday) at the offices of Messrs. Lovering and Newstead, trustees, 3, Church-passage, Guildhall, E.C. The meeting was called to receive the trustee's and solicitor's reports, and to consider the advisability of further investigating the affairs of the debtor. Mr. Osborne, who presided, said that the trustee had been making inquiries in regard to certain important items in connection with this failure. In June last, a month before the filing of the petition, the debtor assigned the whole of his estate to Goodman and Co., Ltd., and received 4,000 fully-paid shares in exchange, the debtor's explanation of this peculiar transaction being that "it was done to protect his estate." Gross liabilities are £3,850, out of which trade creditors stand to lose £3,733. The whole of this loss was incurred between December, 1897, and July, 1898, and (observed Mr. Osborne) no trace whatever can be found as to the disposal of the goods obtained from creditors. No proper books of account had been kept. The disappearance of the goods was only to be accounted for by one clue which had been unravelled in investigating the matter, and this clue led to others of a somewhat sensational and suggestive character. It was clear that the debtor only made over to the company a very small quantity of goods and no money whatever. The debtor appeared to have recently become connected with a dealer in electrical accessories and sundries, and the creditors would have to look closely into this connection, and into an item amongst the liabilities of £1,450 alleged to be due to a man named Barnes, in whose employ (Mr. Osborne observed) Goodman now is. The trustee reminded the creditors that there were no available assets in this case. A letter from the solicitors suggested a consultation of the creditors and the solicitor to the estate to see if some course of action could be decided upon to lead to a full investigation of the debtor's affairs. This was for the creditors to decide, because the preliminary cost of a prosecution would have to come out of the creditors' pockets, although the Public Prosecutor would relieve them of all further expense if he approved of action being taken after the facts had been put before him. The replies of the debtor to questions by the chairman were considered most unsatisfactory, and the meeting ultimately (on the motion of the Phaeton Electrical Co., seconded by Messrs. R. S. Keep and Co.) agreed—"That the trustee be instructed to take further steps to investigate the affairs of this debtor, and that the creditors be asked to contribute a sum of 1s. in the £ on account of their respective debts towards the preliminary expenses of such investigation." The meeting then adjourned.

Business Notice.—The Wireless Telegraph and Signal Co. (Limited), have taken a factory in Chelmsford for the manufacture of instruments and apparatus connected with the company's system.

To Let.—Messrs. Willis Bros., auctioneers, Gloucester, announce in an advertisement that they have premises suitable for electrical engineers and others to let in the centre of the city of Gloucester.

Exhibition.—The Executive Council of the Glasgow International Exhibition (1901) notify in an advertisement elsewhere that they are now in a position to receive applications from electrical and general engineers and others who propose to exhibit. Particulars can be obtained from the engineer (Mr. Thomas Young), 4, West Regent-street, or the general manager (Mr. H. A. Hedley), 141, Buchanan-street, Glasgow.

"**Electric Wiring Practice**" is the title of a Paper, by Mr. F. Bathurst, A.I.E.E., which deals with "the present practice and probable development of the art of electric wiring." Mr. Bathurst points out that there are in operation or in progress in this country more than 200 electricity supply stations, and that, therefore, the subject of interior electric wiring is a matter of concern to all actual and potential consumers of electric current for interior lighting. The object of the publication of the paper is to bring before architects, consulting engineers and electrical contractors the advance shown by the introduction of the Conduit and Insulation Co.'s system of steel armoured insulating conduit. The paper is issued in pamphlet form and can be obtained, free of charge, by any person interested in the subject. Mr. Bathurst, and those who think with him, urge that, in order to make electric wiring thoroughly effective, durable and permanent, it is necessary that a perfect mechanical and electrical protective duct should be provided for the whole course of the wires, capable of withstanding injury from any and all outside conditions; and he claims that the special type of conduit manufactured by the Conduit and Insulation Co. fully meets this up-to-date requirement. As evidence of the advance in public favour which this type of conduit is meeting, Mr. Bathurst points to the fact that although steel armoured conduits are the highest in price of any conduit on the market, there is a steadily extending use of this material in installation work in this country, and this report confirms information received from other firms engaged in this branch of the electrical industry. Among many installations in which the Conduit and Installation Co.'s conduit system has been adopted may be mentioned:—Kensington (London) Town Hall; Brighton Town Hall; Bridgwater House Picture Gallery, Pall Mall, London; Technical Schools, Brighton; Hyde Technical Schools, Manchester; New Guildhall School of Music, London; Stafford County Infirmary; Middlesex Hospital, London; St. Andrew's Hospital, Northampton; Victoria Nurses' Home, Bradford; Ayr Brewery, Scotland; St. Luke's (London); Islington (London); Knightsbridge (London) and Southampton Electricity Works; Liverpool Grain Storage Co's Docks and Ware-

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houses; J. Barker and Co.'s Stores and Harrod's Stores (London); Law Union and Crown Life Insurance Buildings, Manchester; Royal Insurance Co.'s Buildings, Glasgow; Sir J. Causton's New Printing Works, Clapham; Anglo-Caucasian Oil Co. Works, Silvertown; Queen's Docks, Glasgow; Jewish Synagogue, Cardiff; Board of Trade Laboratory, Whitehall; New County Offices, Wakefield; Municipal Chambers, Glasgow; and a number of famous country seats, theatres, restaurants, &c.

Ediswan Leaflets.—The Edison and Swan Co. have just issued leaflet No. 120 describing and illustrating Capt. Walter's patent night light switch, which can be fixed in the place of any existing switch and ensures an economic use of current during night hours. Leaflet No. 111 is also to hand graphically illustrating and describing Ediswan ball fittings for various uses.

Calendars.—Messrs. Nalder Bros. and Thompson forward a useful pad calendar for 1899, copies of which can be obtained by the trade on application.

Local Government Annual.—We have to acknowledge from the office of the *Local Government Journal*, Dorset-street, Fleet-street, London, the 1899 "Local Government Annual and Official Directory," which contains a large amount of information of service to firms in business relation with the local authorities of London and the provinces. The price of the book, bound in cloth, is 2s. 6d.

Telephone Directory.—The January, 1899, Supplement to the Telephone Directory (with additions, alterations and corrections) is to hand from the National Telephone Co.

Babcock-Wilcox Boilers.—What is probably the largest order for stationary boilers ever given out was placed, during the month of December, with the Babcock and Wilcox Co. in New York on behalf of the Westinghouse Electric Co., Pittsburg. The order was for 60 boilers, each of 1,000 I.H.P. The boilers will be made in America, but the bulk of the wrought steel from which they are to be constructed will be sent out from this country.

The "Universal" Engine.—The Brush Co. are sending out a well-illustrated pamphlet describing the chief features of Raworth's Patent "Universal" steam engine. The text includes instructions on erecting and starting the engine, and also for connecting and operating the "Garagon" steam lubricator.

Electric Heating Apparatus.—We are informed that the English Industrials (Limited), of Manchester, have purchased from Messrs. Hummel and Helberger the sole rights for the United Kingdom and the colonies of Patent No. 13,594, relating to electrical heating apparatus and various acccessories in connection therewith. A high degree of efficiency is claimed for this apparatus.

Soldering Paste.—We have received from Messrs. Beanland, Perkins and Co. a sample tin of Burnley's rozinal soldering paste, which resembles vaseline in appearance. It is claimed that this material forms a better flux than ordinary rosin, with the advantage of being easier to manipulate.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Jan. 11 to Jan. 17, with the ports of destination:—

Australasia—Adelaide, £44; Lyttelton, £35; Melbourne, £360 (telegraph material); Sydney, £653. *Belgium*—Ostend, £23. *Brazil*—Rio de Janeiro, £80. *Burma*—Rangoon, £31. *Ceylon*—Colombo, £27. *China*—Shanghai, £89. *Denmark*—Copenhagen, £17. *France*—Boulogne, £76. *Germany*—Bremen, £50; Hamburg, £110. *Gibraltar*—£33. *Holland*—Amsterdam, £30. *India*—Bombay, £545 (including £35 telegraph material); Calcutta, £763. *Japan*—Hiogo, £12; Yokohama, £562. *Malta*—£75. *Norway*—Christiania, £360. *Russia*—Helsingfors, £357 (telegraph wire); Reval, £126 (including £71 telegraph material). *South Africa*—Cape Town, £544; Delagoa Bay, £28; Durban, £705; East London, £377; Port Elizabeth, £18. *Spain*—Barcelona, £33; Santander, £11. *Straits Settlements*—Singapore, £927. Total £7,101, against £5,951 in the corresponding week last year (Jan. 12 to Jan. 18).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Aberdeen.—A discussion arose at the meeting of the City Council this week upon the advisability of equipping the Woodside tramway route on the overhead trolley system, but it was decided, before coming to a decision, to send a deputation to Glasgow and other places where electric tramways are in operation.

Acton (Middlesex).—The District Council seem disposed to take a supply of electricity in bulk from the Metropolitan Electric Supply Co.'s new station at Willesden and negotiations are proceeding as to terms. The company offers current at 3d. per unit for seven years.

Asuncion (Paraguay).—Mr. N. Sellers has obtained a concession for establishing electricity supply works in this city.

Brazil.—We learn that the San Paulo Gas Co. have decided to at once erect electricity supply works for the supply of current for lighting and power purposes. The company have entered into an agreement to light the new railway stations in course of erection in Sao Paulo. The company has, we understand, decided upon this course because of the strong position they hold with the new concession for 30 years. The company's consulting engineer has been instructed to prepare the plans and specifications and obtain tenders for carrying out the work with the least possible delay.

Brecon.—The Mayor, Col. Morgan, has decided to erect electric lighting works in the town.

Bristol.—There is at present an equivalent of about 64,000 8 c.p. lamps connected to the electric lighting mains, and there are in hand applications for another 7,000. The capacity of the station when the present extensions are completed will equal 80,000.

Brussels Telephone Service.—There will shortly be opened in Brussels a spacious building exclusively devoted to the telephone service of Brussels. The building, which will provide accommodation for the connection of 15,000 subscribers, is situate in the old quarter of the town, and has cost nearly £40,000. The building comprises a basement, ground floor and three storeys, and the main room is 147ft. in length, 65ft. wide and 30ft. high, and one floor of large dimensions is reserved exclusively for the use of the telephoning public. By the time the building is open the entire service will be on the twin-wire system. It has been decided to place nearly all the telephone wires of the service underground. The d'Anthonay heating system has been adopted, and is worked by a 3 H.P. gas engine operating a turbine, which forces cold air into the heating apparatus, and is claimed to reduce to a minimum the amount of moisture and dust resulting from overheating and bad ventilation. It is claimed for this particular system that it is as effective for providing cool air for the summer as for heated air in the winter.

Cape Colony.—By a recent order of the Government at the Cape the rebate on imported goods passing through the colony to the inland states has been reduced from 5 per cent. to 3 per cent., the reduction applying to the South African Republic, Orange Free State and Rhodesia. The new law will affect electric cables and wires and posts for same and their fittings, electric lamp posts and their fittings, electric lamps and switches (*excluding* fancy and ornamental switches and fittings for indoor lighting); tramway equipment requisites (cars, trolleys, water tanks and turntables); wires, bells and gongs for signalling and for use in and about mines (on which rebate will be allowed on the whole customs duty). The following articles are admitted free of duty under the customs union tariff on importation into Cape Colony, irrespective of their ultimate destination:—Machinery to be driven by electricity and apparatus and appliances used in connection with the generation and storage of electric current (but not including electric cables, wires, posts, lamps and switches previously mentioned); railway and tramway construction or equipment requisites (rails, sleepers, fastenings for same, girders, iron bridge work, locomotives, tenders, trolleys or other articles not previously enumerated); and telegraph materials for use in construction of telegraph lines.

Chatsworth.—On the occasion of the recent county ball given at Chatsworth by the Duchess of Devonshire several hundreds of additional electric lamps were fixed in the ball room, orangery, statue gallery and other parts of the building by Messrs. Drake and Gorham, who have carried out all the electrical work at this famous country seat.

City of London Lighting.—A report from Mr. A. A. Voysey electrical inspector to the London Corporation, states that in the main streets there are 493 arc lights. The total number of lamp failures in the past year had been 1,466, the average time of extinction per lamp being 236 minutes. A sum of £352 had been paid in penalties by the City of London Electric Lighting Company for failures and lateness in starting. Arrangements for testing the supply of electricity to the public lamps had not yet been made. The company, who were responsible for the provision of instruments at their own expense, were now in communication with the Board of Trade as to their requirements, the instruments being subject to the Board's approval. The private electric supply amounted to an equivalent of nearly 300,000 8 c.p. lamps.

Datchet.—The Council have expressed themselves willing to consider any practical scheme for providing the parish with the electric light, and offers to support the application of the Slough and Datchet Electric Light Co. for a provisional order.

Dawlish.—The District Council have invited Messrs. Taylor and Field to state their terms for preparing a report on the electric lighting question.

Electric Motor Cab.—A Press view was given last week of the Krieger electric cab, which has been introduced by the Motor Car Co. The vehicle is well known in Paris, but has not yet been adopted there or elsewhere as a public conveyance. It carries twice as many passengers as the electric cabs with which we are now so familiar in London, and it is claimed that a single charge is sufficient to take the vehicle 60 or 70 miles.

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Devonport.—The Town Council have decided to purchase a site for electricity supply works.

Dynamo Electric Machinery Exports.—For the year 1897 Japan imported dynamo electric machinery to the value of nearly £104,000, of which Great Britain supplied £18,500, the United States about £68,500, and Germany about £17,000. These figures show a considerable increase over 1896 and 1895, except in the case of Great Britain, whose exports decreased from £26,500 value in 1896 to £18,500 in 1897.

Edinburgh.—The Town Council have asked the Electric Lighting committee to report on the necessity for laying aside a sum either by renewal fund or otherwise for renewals of the electric light plant.

Electricity v. Gas.—Interesting figures have just been issued as to the relative cost of electric *v.* gas lighting at the School Chapel, Harrow. The average cost of lighting by gas in 1893, 1894 and 1895 was £20. 1s. 8d., and the average cost of lighting by electricity (with additional lights under the organ loft in the south aisle) in 1897 and 1898 was £17. 10s. Meter rent was included in each case. The price of electric current at Harrow is 8d. per unit, gas 4s. 3d. per 1,000ft.

Fatality.—A sad drowing fatality occurred on the 15th inst., near Porthcurnow, the Eastern Telegraph Co.'s station near Penzance. It seems that, notwithstanding the heavy weather, a party of telegraphists from the station decided to bathe in the sea at Penberth, a sheltered cove. The swell of the sea was, however, unexpectedly severe, and one of the party, a young man named Laing, was thrown against the rocks and rendered insensible. Assistance was promptly rendered, and he was landed, but not before death had taken place by drowning. Mr. Laing was a native of Exeter.

German Electrical Industries.—In a report on the foreign commerce and industrial progress of Germany for 1897-98 presented to the United States Government by the American Consul-General at Frankfort, the following notes on the development of German electrical enterprise occur:—The electrical manufacturing companies worked literally night and day during 1897 for months of phenomenal activity. The Allgemeine Elektricitäts Gesellschaft, of Berlin, entered upon 1898 with orders on its books representing £5,000,000 in value, against £3,250,000 on Jan. 1, 1897. The Schuckert Co., of Nuremberg, had in June, 1897, orders on hand representing nearly £5,000,000, or more than double the orders on hand at the same date in 1896. Particular attention is called to the large amount of capital invested in the manufacture of calcium carbide. The market for German electrical appliances has obtained almost a monopoly in Eastern Europe. In Turkey electric lighting is being carried on almost exclusively by German contracting firms, and at Kalamata (Greece) an electric lighting station has been equipped for the municipality by a German house. At Kalamata also Messrs. Hiedemann and Co., of Colbgne, have constructed an electric railway to the harbour of Kallivia.

Glasgow.—The High-street extension of the electric tramways will be opened for traffic next week.

Gloucester.—A Local Government Board inquiry was held here on Wednesday into the application of the City Council for authority to appropriate funds from the sale of corporate property for the purchase of a site for electric liphting works. There was no opposition.

Grimsby.—The Town Council agreed at their meeting, last week, to apply for sanction to borrow £43,000 for the erection of electricity supply works.

Halifax.—The Commercial-street-Salterhebble electric tramway extension is approaching completion. The Board of Trade inspection takes place next week.

Hanley.—The Town Council have decided, in consequence of the resignation of Mr. Sutherland, who was until recently joint engineer with Mr. Cowell, of the electricity supply works, to appoint the latter gentleman to the post of Corporation electrical engineer, at a salary of £250 per annum. Mr. Lobley continues as engineer for capital expenditure in connection with the undertaking, and consulting engineer on revenue account. Two junior assistant engineers are also to be engaged. In future distributing mains required in the district outside the compulsory area are to be arranged for a pressure of 200 volts at consumers' terminals, and the existing mains are to be converted from 100 to 200 volts. Sanction has been obtained to borrow a further £4,000 for electric lighting purposes. The future charge for current will be 5d. per unit (with discount) for all current consumed in the quarter for 150 hours of the maximum payment indicated, and 2½d. net per unit for all current beyond.

Hastings.—The Town Council have taken possession of the electricity supply works, a cheque for £58,000 having been handed to the Hastings Company, leaving only a balance for extensions carried out during the year.

Haulbowline (Cork).—The Admiralty have decided to light the docks, wharves, fitting shops, &c, electrically.

Hobart (Tasmania).—The Hobart Gas Co's. electricity supply station was formally opened at the end of November. The machinery was supplied by Messrs. Siemens Bros. and Co., of London.

Huddersfield.—On Wednesday the Chairman of the Electricity committee (Ald. Calvert) referred to the recent interruptions of the supply of electric current, and said that these were due to the great demand for current which was a heavy tax upon their resources, as the delivery of additional machinery for extensions had been delayed owing to the engineers' strike.

Hurstpierpoint (Sussex).—The Parish Council have notified the promoters of the electric lighting and tramway scheme for Hurst and district that no opposition will be made to the scheme.

Inquest.—On Friday last an inquiry was held into the circumstances attending the death of an engine driver on the City and South London Railway, named Pugh, who was found dead on his engine. The medical man who made the post-mortem examination on the body found no external marks of violence, and the body was well nourished and apparently that of a man who enjoyed good health. There was no disease, the organs being particularly healthy and normal in size and weight. "Having regard, therefore, to all the circumstances of the case," the medical gentleman was of opinion that death was due to shock from electric current, and in this view he was supported by a fellow practitioner who was present at the autopsy. The City and South London Railway Co., however, did not accept this theory, and in order that the body might be examined on their behalf the inquiry was adjourned.

Japan.—A recent report from Japan on the subject of the metal and machinery trades announces that 56 per cent. of the electrical machinery imported into Japan is of British manufacture, against 28 per cent. American, and 12 per cent. German; steam boilers, engines and pumping machinery 80 per cent. British, 16 per cent. American. For 1897 the imports of electrical machinery were valued at £267,000, and boilers, engines and pumping machinery £61,000. Telegraph and other wire imports for 1897 were valued at £25,000, against £22,000 in 1896. About 20 per cent. of the wire imports are British, Germany being the principal source of supply.

Lee (London).—The Blackheath and Greenwich District Electric Light Co. have notified the District Board of Works of their intention to lay mains in a number of streets in the district.

Light Railways.—The Board of Trade have confirmed the order amending the Flamborough and Bridlington Light Railway Order of 1897 and also the order for the construction of the Ventnor Light Railway. The total length of the latter line will be about 1,100 yards. The motive power will be electricity.

Marylebone (London).—The attempts by the Vestry in the last session of Parliament to obtain electric lighting powers are said to have entailed an expenditure of £1,457. 6s. 11d., and £700 has already been spent in preparing the bill now before Parliament.

Newcastle-on-Tyne.—The directors of the Newcastle Electric Supply Co. are considering the question of supplying continuous current for power work throughout their district, and have already entered into a contract to supply the current for driving an electric passenger lift, ventilating fans, &c., in the new Shaftesbury Buildings now in course of erection. They are also to supply current for over 500 incandescent lamps with which the new range of buildings are to be lighted.

Nuneaton.—Representatives from the promoters of the electrical tramway scheme for Nuneaton and Chilvers Coton appeared before the District Council this week to explain their proposals. The overhead trolley system is to be employed. The Council unanimously approved the scheme.

Ogmore and Garw.—The District Council have renewed the contract with the Ogmore Valley Electric Power Supply Co. for the lighting of the district for the ensuing year.

Paddington (London).—On Tuesday the Electric Lighting committee presented a report to the Vestry recommending that counsel's opinion be taken as to the powers of the Metropolitan Electric Supply Co. under existing acts and its provisional order to lay down trunk mains or other electric lines through the parish of Paddington for use in other parishes or districts. Col. Barchard (chairman of the committee) said it had been discovered that the company intended laying down five large cables through their streets, each cable of 10,000 volts capacity, to be brought from Willesden, and the committee considered it a very important question whether the company had power to lay such lines in the district controlled by the Vestry. If the Vestry later on decided to purchase the company's undertaking (so far as it exists in Paddington) this question would become a serious factor in their negotiations. The committee had taken action to prevent the work being proceeded with without referring to the Vestry. It was agreed to take counsel's opinion and to give the committee powers to act as occasion might demand. A communication was read from the Metropolitan Company in reply to a letter from the Vestry, in

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which the Company deny that any obligations in their provisional order of 1896 remain unfulfilled, and stating that testing stations have been established in accordance with the terms of the order. Sir T. G. Fardell, M.P., said that counsel's opinion should also be taken as to the powers remaining with the Vestry to enforce certain obligations which, he contended, had not been fulfilled in accordance with the order. There were many streets scheduled for the laying of electric mains which had not been laid; whilst other thoroughfares not so scheduled had been opened for the purpose. With regard to testing stations, he contended that what was meant by the order was that testing stations should be established away from the company's premises, so that if a consumer were dissatisfied with the supply of electric current he could go to the station and have the matter tested. Col. Barchard said it was idle to state that the company was not fulfilling its obligations, as the Lighting committee knew that they were. There were 28 miles of streets scheduled in the company's order, and in 24 miles the company's mains had been laid. If the company were compelled to observe the strict letter of their order consumers would not be able to obtain their supply at a cheap rate. At Amberley-road station the company had sufficient power to supply the whole of Paddington, and if the Vestry decided to-morrow to purchase the undertaking for this district this could be effected, as the company could disconnect Amberley-road from their other stations. The matter was left for the committee to deal with.

It was decided that the Vestry should oppose the Baker-Street and Waterloo Railway bill, which provides for the erection of a generating station in the parish. The Central London Railway bill, however, is not to be opposed, nor is the North West London Railway bill so far as Paddington is concerned.

Pokesdown (Bournemouth).—The District Council will oppose the application of the Bournemouth Electric Lighting Co. for a provisional order for the district.

Poplar (London).—The District Board of Works has decided to strenuously oppose the County of London Company's new bill so far as it relates to the Poplar District.

Private Bill Legislation.—In the bill which is being promoted by the Charing Cross, Euston and Hampstead Railway Co. power is sought to extend its authorised system to the Highgate-road station of the Midland Railway Co., and to purchase or lease a portion of the Baker-street and Waterloo Co.'s line. Working agreements are to be entered into with the Midland, London and North-Western, South-Eastern and Baker-street and Waterloo Companies. It is proposed to raise £360,000 additional capital, with borrowing powers for £120,000.

The Great Northern and Strand Railway Bill seeks powers to construct an electric railway in two tunnels from the Great Northern Company's Wood Green Station, via Islington, to the King's Cross station of the Great Northern Company, and thence via Southampton-row and High Holborn to St. Clement Danes in the Strand. The share capital is fixed at £2,400,000 with powers to issue debentures to the extent of £800,000.

The South Staffordshire Tramway Company have deposited a bill to repeal the restrictions upon the sale or transfer of their undertaking and to empower them to lease their system to the British Electric Traction Company. The company also seek power to modify the usual purchase powers by extending the period to 35 years, after which the undertaking can be purchased at the end of any subsequent seven years. The company also wish to increase their borrowing powers from £50,000 to £100,000.

The Sunderland Corporation are seeking powers to acquire and extend the tramways in the district of Southwick, and to introduce electric traction. Power is also sought to extend the electric lighting area so as to include the district.

At the Westminster Palace Hotel last week a meeting was held of representatives of municipal corporations affected by the bills of the General Powers Distributing Co., the South Lancashire and Cheshire Electricity Co., the Lancashire Electric Power Co., and the Midland Electric Power Co.'s provisional order. Ald. Higginbottom, chairman of the Manchester Electric Lighting committee, presided. The resolution passed at the autumn general meeting of the Municipal Association, to the effect that opposition to the General Powers Bill and other similar bills should be organised, was read; and resolutions were unanimously passed that all corporations be requested to urge their members of Parliament to oppose the bills and provisional orders on second reading, and that a statement of the grounds of opposition be issued and circulated.

A meeting of the Council of the Association of Municipal Corporations was also held on the same day, when it was resolved to oppose the bills promoted by the National Telephone Co.

The Corporations of Coventry, Loughborough and Sutton Coldfield, and the District Councils of Rugby, Erdington and Aston Manor, have presented memorials in opposition to the Leicestershire and Warwickshire Electric Supply Co.'s Bill.

Provisional Order Transfers.—The Barnet District Council propose to transfer their provisional order to the North Metropolitan Electrical Power Distribution Co., in return for the company's agreeing to pay the cost of obtaining the order and guaranteeing to give a supply of current by Sept. 1, 1900. The company also engage to provide and erect fourteen 500 to 600-watt enclosed arc lamps in the High-street. The remainder of the streets will be lighted by 146 columns supplied with 16 c.p. incandescents. Powers of purchase are reserved by the Council.

The Weston-super-Mare District Council propose to transfer their order to the Weston-super-Mare and District Electric Supply Co. (Ltd). The Council reserve right of purchase at 10½ years.

Prussia.—In a Foreign Office report received from Berlin in November last, and just published (24 8vo. pages) (!) dealing with the subject of local government in Prussia, attention is called to the terms of the concession granted by the City authorities to the Berlin Tramways Co. By the terms of this concession the city receives 8 per cent. of the gross revenue, and, when the excess of revenue over expenditure permits of a higher rate than 12 per cent. interest being paid on capital, the balance profits are divided equally between the city and the company. The tramways pass through the neighbouring communes of Charlottenburg and Schöneberg, and the local authorities of these districts receive a yearly rental of 3 marks per metre of single line and 6 marks per metre of double line. The company is entitled to pension its officials. The concession expires in 1919. The budget for the city of Berlin for 1898-99 includes £47,000 receipts from the Berlin Electrical Co. for the use of the streets, and £69,000 rentals from the tramways.

Radcliffe.—The District Council have received three proposals for the construction of electric tramways in the district. The Council have already applied for powers to borrow £16,000 for establishing electricity works, and the consulting engineer is of opinion that the current required for working the tramways alone would almost pay the working expenses of the electric lighting station if current were supplied at 1½d. per unit.

Resignation.—Mr. Robert Knight, J.P., Newcastle-on-Tyne, has resigned the position of general secretary to the Boilermakers' and Iron and Steel Shipbuilders' Society, which he has held for 28 years.

St. Luke's (London).—A special committee has been appointed to report upon the desirability or otherwise of the Vestry applying for a provisional order for the municipal supply of electric current in the parish, and to obtain the necessary technical and professional assistance. Twelve months ago the Vestry rejected a similar proposition. Mr. A. Pond, who sponsored a motion to the above effect at the last meeting of the Vestry, pointed out that Shoreditch, Islington, Hampstead and other parishes in the north of London were engaged successfully in supplying electric current. Messrs. Howes, Pond, Standring, Rumball, Miller, Elven, Basterfield and Whitehead form the committee.

Consent to the application of the Smithfield Markets Electric Supply Co. for a provisional order for the St. Luke's district has been refused.

St. Pancras (London).—A report of the Electricity and Public Lighting committee to the Vestry, on Wednesday, stated that by the aid of temporary plant at the Regent's Park supply station the Christmas extra demand for current was satisfactorily met. The new station is progressing satisfactorily but for occasional delays through the weather. Two out of the four boilers have been delivered, and one has already been in use. The committee further reported the receipt of a quotation from the Brockie-Pell Arc Lamp (Limited) for the supply of 50 Brockie-Pell arc lamps, at £8. 15s. each, and "in view of the satisfactory running of the old lamps during the past seven years" it was decided, on the recommendation of the committee, to accept the quotation.

Salford.—Mr. Haworth, in presenting the Electricity committee's report to the Town Council, on Wednesday, said that when the new committee was formed the electricity undertaking was working at a loss of £4,000 per annum. In the first twelve months they increased the average consumption of current per lamp from 5·2 to 14 units per annum, and the revenue went up from 2s. 9d. to 4s. 2d. per lamp. In 1897 they sold 110,000 units, and last year 324,000 units, and but for a serious accident the deficit for the year ending March would not be more than £300. Owing to the increasing demand for current, and also in view of the prospect of the adoption of electric traction, he moved that Messrs. Lacey, Clirehugh and Sillar be appointed consulting engineers for a term of three years, at a salary of £500 per annum. A discussion ensued, but the question was adjourned until Wednesday next.

Saltburn.—Messrs. Cox-Walkers, Darlington, are putting down electric light plant for supplying current for private lighting in this district.

Shoreditch (London).—At Tuesday's meeting of the Vestry, Mr. H. E. Kershaw submitted the report of the Lighting committee giving some figures prepared by the chief electrical engineer concerning the growth in the demand for current. The units sold in the quarter to Sept. 30, 1897, were 57,452, to September, 1898, 203,892, and in December to 313,558 units. These figures, the committee urged, justified the expenditure in connection with the

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projected new generating station. The committee have appointed a sub-committee to consider the question of available sites for the new station. On the recommendation of the committee, it was resolved to order new cables from the British Insulated Wire Co. at a cost of £2,750.

Southampton.—At the meeting of the County Council, last week, the Tramways committee reported that they were now in a position to present a complete electric tramway scheme. A report has been prepared by the consulting engineers, Messrs. Kincaid, Waller and Manville, who approve the overhead trolley system as already adopted by the Council, and recommend the doubling of all lines where possible; also the retention of double-deck cars throughout the system, the lowering of the roadway through the Bargate, the taking of a protected trolley wire under the gate, the electrical equipment of the entire system, and the provision of a stock of 20 motor cars with running sheds. The estimated cost of the entire scheme complete is £63,722. The above estimate includes the cost of providing equipment for three additional miles of line and six miles of new tramroad. The whole of the committee's recommendations were adopted.

Southport.—Electric current is to be supplied for motive power at 7d. per unit for the first hour and 2d. after.

Tariff Changes.—Cylinders, rods, sticks, pencils, plaques, sheets or blocks, &c., of agglomerated carbon for use in electrical apparatus are now subject to a duty of 5 per cent. *ad valorem* on importation into *Belgium*. Brass fittings for electric lamps are assessed for duty at 75 lire per quintal on importation into *Italy*.

Uitenhage (South Africa).—The Town Council are anxious to establish electricity supply works, and Sir James Sivewright has been requested to name a consulting engineer for drawing up a scheme.

United States Patent Law.—Messrs. Fairfax and Wetter write:—An important decision affecting many English inventors was given by the Commissioner of Patents, at Washington, on Dec. 20. According to Sec. 4,887 of the U.S. Statute which became operative on Jan. 1, 1898, an inventor who had first applied for a patent in a foreign country would not be debarred from receiving a patent for the invention in the United States by reason of its first having been patented abroad, unless the application for said foreign patent was filed more than seven months prior to the filing of the application in the United States. Now, as the majority of inventors in England file a provisional specification, and obtain provisional protection before they file a complete specification, on the base of which the patent is granted, a few experts had arrived at the conclusion that, in the case of the English patent, the date of application referred to in the said Statute would be the date of filing the complete specification. On Dec. 20 the question came before the Commissioner of Patents, who held that the date of application for an English patent is the date on which the original application was filed, even if it has been accompanied only by a provisional specification, the reason given being that, according to English law, provisional protection is not analogous to a caveat. And the patent, when granted, is dated as of the day of application, instead of bearing the date of the actual grant or issue, as is the case in the United States and some other countries. English inventors must therefore be careful to apply for a United States patent in good time, if they wish to obtain protection for their invention in the United States.

Wellingborough.—The electrical engineer to the Leyton District Council (Mr. H. Collings Bishop) has paid a visit to this town, and will report upon the question of the erection of electric light and refuse destructor works.

Whitechapel (London).—The London County Council is be asked to grant a loan of £25,000 to the District Board of Works to defray the cost of the purchase of land in Osborne-street, George-yard and Wentworth-street for an electricity supply station, and the Electrical Committee recommend, and the Board approve, the application to the Council for a further loan of £60,500 for the erection and equipment of the station. The erection of a new dust destructor, at a cost not exceeding £15,000, has also been agreed to.

Workhouse Lighting.—The Islington (London) Guardians have instructed Mr. J. S. Enright to prepare a report on the electric lighting of the workhouse at a fee of ten guineas. There were 34 applications for the appointment.

Dinners and Presentations.—Last week a farewell dinner was given at Dover to Mr. A. A. Whitlock, resident engineer at the Dover electricity works, on the occasion of his leaving Dover to take the position of engineer at the County of London and Brush Provincial Company's station, at Wandsworth (London). Mr. Whitlock has also been the recipient of a presentation from the Directors of the Dover Electricity Supply Company, in recognition of his services.

The annual dinner of the staff of the Langdon-Davies Electric Motor Co. was held on Saturday at the Bridge House Hotel, London Bridge. Mr. A. Soames (managing director) occupied the chair, supported by Mr. W. Langdon-Davies (engineer), and Mr. W. F. Davidson (works manager). About 50 sat down.

Electro-Harmonic Society.—A smoking concert will be given at the St. James's Hall Restaurant, Regent-street, London, on Friday evening, Jan. 27, at eight o'clock. A lengthy and attractive programme will be provided.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom all information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

December 31, 1898.

27,593. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). London. Improvements in systems of train control for electrically-propelled vehicles. (F. E. Case. United States.)*

27,599. C. DUBEY. Liverpool. Improvements in electro-hydraulic brakes for railway vehicles and other purposes.*

27,613. C. HOWARD. London. Improvements in electric fuse holders.*

27,614. J. R. HATMAKER. London. Electrolytic or battery liquid.

27,636. A. M. ARTER. London. Improvements in electric arc lamps.

January 2, 1899.

2. J. S. HIGHFIELD. St. Helens. Improvements in apparatus for connecting electric mains.

8. W. H. VAUGHAN and T. FOSTER. Manchester. An improved electric reversing switch with liquid resistance.

20. T. E. WEAVER. Wolverhampton. A new or improved electric heater.

44. W. H. HARFIELD. London. Improvements in apparatus for electrically controlling engines, electro-motors and other machinery.

January 3, 1899.

96. J. M. ANDERSEN and A. ANDERSON. London. Improvements in supports for electric conductors.*

101. T. A. WILLARD. London. Electrodes for storage batteries.*

102. T. A. WILLARD. London. Means for producing battery electrodes.*

108. J. H. NOAD. London. Improvements in direct-reading electricity meters.

132. R. A. DAWBARN and A. B. MOUNTAIN. London. Improvements in or in connection with electrical motors for working lifts, cranes, machine tools and like stationary machines.

133. R. A. DAWBARN and A. B. MOUNTAIN. London. Improvements in and in connection with electric railway and tramway propulsion.

153. H. MONNARD. London. Improvements in dynamo electric machines or motors.

January 4, 1899.

155. A. E. BAINES. London. An improved means of sealing enclosed arc electric lamps.

163. S. CROWTHER. Leeds. An automatic switch (for use in conjunction with electric bells that ring continuously when the door of the shop or like place is open).

165. C. T. BRISCOE and E. JONES. Blackburn. An improvement of the electrical cord grip lamp holder.

193. C. J. W. HENSINGER. London. Improvements in telephones.

200. G. THOMAS-DAVIES. London. Improvements in or connected with enclosed arc lamps.

214. L. DE M. G. FERREIRA and H. J. PRYCE. London. Improvements in apparatus for electrically interlocking the block and mechanical signals on railways to render it more efficient and certain.

216. J. G. LORRAIN. London. Improvements in electric railways. (F. C. Esmond, United States.)

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1897.

29,257. BOULT and BOULT. Electric signalling, particularly on railways.

30,065. HUISMAN and GOVER. Key switch holders for incandescent electric lamps.

30,295. HOLT. Automatic locking lever and lifting lever combination for electrical lifts, cranes, or other machinery.

1898.

331. MÜLLER and TUDOR. Preventing sparking when making and breaking electric circuits.

1,809. CLAREMONT. Automatic switch, or cut-out.

2,299. GUÉRIN. Joints between the glass globes of electric arc lamps, and the supports by which they are carried.

2,522. ECKSTEIN and COATES. Electrical striking mechanism for bells.

2,761. COWAN and STILL. High-tension electric switches.

2,784. IMMISCH. Electric switches.

3,802. EDMUNDS. Electrical conductors.

4,514. FEENY (Becker). Electrolysis and cathodes therefor.

21,841. SIEMENS BROS. AND CO., (LIMITED (Dumas and Grimston). Armatures of multipolar dynamo electric machines.

20,964. VANDAM and MARSH. Plug switches or wall contacts for electric circuits.

23,243. RIBBE. Electric accumulators.

23,397. LEWIS and THE MUTUAL ELECTRIC TRUST (LIMITED). Enclosed arc lamps.

23,716. HADDAN (Miller). Secondary or storage batteries.

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COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Co. (Limited).

The fifty-third half-yearly ordinary general meeting of this Company was held yesterday (Thursday) at Winchester House, Old Broad-street, London, under the presidency of the Marquis of TWEEDDALE, K.T.

The SECRETARY (Mr. George Draper) having read the notice calling the meeting,

The CHAIRMAN said that he would as usual draw their attention to the more important features of the business of the past half-year. The gross revenue for the six months to September last amounted to £444,011, or an increase of £284 over that of the corresponding period of 1897. During the September half of 1897 they derived extra traffic from Crete owing to the disturbed condition of that island, but this traffic had since resumed its normal state. There were other fluctuations in various classes of traffic, but in no case were they so important as to call for special attention. The total ordinary expenses for the half-year to September last were £121,376, showing an increase over those of the corresponding period of 1897 of £12,133. This increase comprised in the present half-year's figures several items of an exceptional character which did not appear in the corresponding period of the previous year, and which would not recur. The increase in the ordinary expenses had really amounted to £5,503, and the nature of this increase was fully explained at the last meeting. He might remark that their expenses had a tendency to grow in a greater ratio than the revenue. A Company such as theirs existed for the benefit of the public as well as for that of its shareholders, and they had accordingly spent, and would continue to spend, large sums in improving the efficiency of their service; and from time to time they had also made extensive, and they hoped to make still further, reductions in their rates. For the reasons given at the last general meeting it was not possible to compare several items in abstract "A" (general expenses in London) and abstract "B" (working expenses at stations). The expenses attending repairs and renewals of cables during the half-year had amounted to £41,716, or an increase of £10,079. In comparing the actual ships' expenses they found a decrease of £2,571. The increase in the total was due to the large amount of cable used on repairs, the Malta-Alexandria No: 2 cable alone requiring no less than 222 knots. The amount received from Governments and other companies for repairs to their cables during the half-year amounted to £7,172 less than in the corresponding period of last year. The net result of the working during the half-year might be briefly summed up as follows:—The gross revenue amounted, as he had already pointed out, to practically the same figure as last year, but the working expenses, the expenses in connection with repairs to cables, and the charges against revenue in respect of dividend on the additional amount of Preference stock were all heavier, so that they carried £5,000 less to the general reserve fund, £15,000 less to the minor reserves, and £6,457 less balance forward to next half-year. Notwithstanding these reductions, however, he thought, after the explanations he had given, that they would consider the result on the whole satisfactory. He was glad to be able to add that the receipts so far as they had gone in the current half-year had been fully maintained. The Preference stock certificates had practically been all issued, and the greater portion (about 8,000) of the Ordinary certificates had been issued, but there were still about 800 shareholders who had not sent in their old Ordinary share certificates to be exchanged for Ordinary stock certificates. If any shareholder should be present who had not done so, they would feel obliged by his giving the matter attention without delay. With reference to the additional cables between Porthcurnow and Gibraltar, Malta and Alexandria, the first section had been laid; and since the report was issued the remaining sections between Malta and Gibraltar and Malta and Alexandria had also been successfully completed, and they would shortly be opened for traffic. The cost of these cables would be partly taken from the general reserve fund. They had under consideration tenders for a new cable repairing steamer to replace the "John Pender," which had been sold. The amount received for the old ship would be credited to the maintenance ships' fund, and the cost of the new vessel would be taken out of that fund. He concluded by moving the adoption of the report and accounts.

The VICE-CHAIRMAN and MANAGING DIRECTOR (Mr. J. Denison-Pender) seconded the motion, which was carried unanimously.

Resolutions were afterwards passed re-electing the retiring Directors—Mr. C. S. Colvin, C.S.I., and Sir Henry C. Fischer, C.M.G.—and the auditors, Messrs. Deloitte, Dever, Griffiths and Co., and Messrs. Welton, Jones, and Co.

An extraordinary general meeting was held subsequently, to consider the following resolutions:—

"*1. That Article 29 of the Company's Articles of Association be altered by striking out the amount £10, and inserting in lieu thereof £1.*"

"*2. That the Directors of the Company be and they are hereby authorised (in accordance with Section 6 of the Eastern Telegraph Company's Act, 1898) from time to time to create and issue Debentures or Debenture stock charged on the revenue and undertaking of the Company, so, however, that the total amount of Debentures or Debenture stock for the time being created and issued shall not exceed one-third of the total amount of the capital in Ordinary and Preference stock and shares for the time being created and issued and paid up, and so that all Debentures or Debenture stock created and issued by virtue of this section shall rank* pari passu *with the existing 4 per centum Debenture stock of the Company.*"

The CHAIRMAN, referring to the resolutions, explained the necessity for altering the Articles of Association and the advisability of granting powers to the Directors to issue from time to time the balance of the mortgage debenture stock.

On the motion of the CHAIRMAN, seconded by the VICE-CHAIRMAN, the resolutions were put to the meeting separately, and were carried unanimously.

Mr. PARRITT afterwards proposed a vote of thanks to the Chairman, Directors, the Secretary, and Staff, and having warmly recognised their services to the Company, congratulated the Chairman on the honour which had been conferred upon him by Her Majesty.

Mr. G. B. SYMES seconded the motion, which was carried unanimously.

The CHAIRMAN acknowledged the vote, and the proceedings then terminated.

[*We shall publish a full report of these meetings in our next issue.*]

Potteries Electric Traction Co. (Limited).

An extraordinary general meeting of this Company was held on Monday to consider a resolution to amend the articles of association. The chair was taken by Mr. EMILE GARCKE.

The SECRETARY (Mr. J. G. B. Elliot) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, this is an extraordinary general meeting called for the purpose of altering the articles of association as required by the Stock Exchange, and it is necessary for us to carry them out before we can proceed with the application for a quotation of the shares. I am glad to have the opportunity of treating this meeting as if it were the statutory meeting, and thus giving any shareholder the opportunity of asking questions as if we were holding the statutory meeting. My first duty, however, is to propose the resolution, of which notice has been given and which the Secretary has read, and before sitting down I will mention a few matters for your general information. The Company was registered on June 28, and the statutory meeting was called in October and adjourned to November, when it was held. Then we issued a prospectus, and the whole of the share capital was subscribed, namely, 20,000 Preference shares and 20,000 Ordinary shares, which were allotted. The 20,000 Ordinary shares included 6,666 which were issued to the British Electric Traction Co. as fully paid in part payment of the purchase price. You may, perhaps, have heard that the shares were not very fully subscribed by the outside public, but the British Electric Traction Co. and the Electric and General Investment Co., took up the whole of the capital which was not so subscribed. After referring to the appointment of Mr. C. S. Drummond to a seat at the Board, the Chairman continued: You are aware that the undertaking practically consists of three separate tramways. The first is the North Staffordshire Tramways, which we have taken over; the second is the tramways extensions which were authorised under a Provisional Order of August, 1896; and the third comprises the lines authorised under the Light Railways Order, which was confirmed by the Board of Trade in December, 1897. With respect to the North Staffordshire Tramways, they have been in course of conversion to electric tramways for some months; we are very hopeful that they will be opened for traffic by electricity in the course of a few weeks now, and we believe that this will have a very marked effect on the revenue of the undertaking. There have been many delays. I cannot, at this meeting, precisely say to whose fault the delays are attributable. In undertakings of this kind we have various difficulties to meet with. With reference to the tramways extensions—which I call the second undertaking—they have been under construction for some time; the electrical equipment is also well in hand now, and we hope to make rapid progress towards completing those lines. With respect to the light railways, they are also under construction, but we are not in so great a hurry to complete that work, as we have ample time to do so under the Light Railways Order. Still, it is very desirable to complete them as soon as possible, because, until the whole of the lines are completed and working by electricity, we shall not derive the fullest advantage from the system. For the Tramways Extension Order—what I call our second undertaking—we had not a very long time given to us for completion, and the time allowed by the Board of Trade expires on February 7th next; but we have applied to that department for a further extension of time, and I am glad to say that, although at first there was some opposition from the local authorities to the further extension, they have now approved of the proposal. They will, therefore, support the application to the Board of Trade for an extension of time for six months, but I hope that we shall not want the whole of that period. I think I have now touched upon all the points that it was necessary for me to inform you upon. After the resolution for which this meeting has been called has been passed, I shall be happy to answer any question.

Mr. J. S. RAWORTH seconded the motion, which was carried unanimously.

A vote of thanks to the Chairman terminated the proceedings.

London Electric Omnibus Co. (Limited).

The third general meeting of this Company was held on Saturday last Major S. FLOOD PAGE presiding.

The CHAIRMAN reminded the shareholders that about a year ago a committee was appointed, and that, as the result of their investigations, the Directors received a mandate to go on and see if anything better could be done. During the period which had since elapsed they had been endeavouring to ascertain exactly the whole of the conditions necessary for the working of electric traction, especially in reference to accumulators for omnibuses. He believed they had got a good asset in the Sola accumulator, but they had not been able to take any steps for dealing with it, owing to rival claims which were set up. The matter had been referred to arbitration, and he understood that a decision had now been given. The

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Board long ago came to the conclusion that this Company could not manufacture omnibuses, even if they possessed the capital, and it, therefore, became necessary to obtain the services of people with considerable electrical knowledge who would be able to deal with the problems involved. With this object they had assisted in establishing a Company for the manufacture of omnibuses at Wolverhampton—the Electric Street Car Manufacturing Co.—of which he was the Chairman. He had been told that an electric omnibus had, within the last two weeks, been running about the streets of Berlin. With that exception there was not a single electric omnibus in Europe running along the streets without rails. This Company had not made any progress except of a theoretical character. They possessed three omnibuses which had been driven about the streets of London three or four hours a day successfully, but they had not yet been able to run their 26-passenger omnibus continuously throughout the day, and that was what they must do to compete with the horse-drawn omnibus. The Board had learned that there was a great deal more to be done than anybody thought at the time the Company was started. He stated in conclusion that Mr. Flack and Mr. Fox had resigned their seats on the Board.

Lieut.-Col. T. T. TURNBULL (Managing Director) remarked that when he came to look into things at the works he found it necessary to put a stop to a great deal of expenditure there. As to the Company's 26-passenger omnibus, it was impossible to find a man competent to drive it about the streets of London in its present shape. It was altogether too heavy a vehicle. He believed the Sola accumulator was a good one, but it required to be further developed. The mistake which this Company had made was that they had started with omnibuses of a weight which was beyond the power of the present accumulators to work. At Wolverhampton a lighter omnibus had been manufactured, which was, in many respects, a serviceable vehicle. He had driven it quite easily, but it contained certain defects which made it impossible for him to recommend its immediate purchase by this Company. He hoped the existing defects would be remedied before long. It was for the shareholders to say if they considered it worth their while to join together and find a little more money to carry on the Company. He thought that it would be, as it was his opinion that they had now reached that stage when all money put into the Company might be regarded as a good investment.

Mr. W. M. HAWKINS asked what was the price of the new omnibuses which had been referred to?

The CHAIRMAN replied that the price was about £500 each fully equipped.

The CHAIRMAN, referring to the agreement which was to be submitted to the shareholders for terminating the arrangement between Mr. M. Radcliffe Ward (one of the vendors and the engineer) and the Company, said that the conditions of that gentleman's engagement were of an onerous character. He not only received £1,000 per annum, but had full control and authority over the technical and engineering staff of the Company. Designs for omnibuses could not be accepted by the Board except with the consent of Mr. Ward. The accounts kept by that gentleman had not been properly kept, and the Directors had been obliged to accept his word for large sums. If the shareholders decided on the liquidation of the Company he (the Chairman) should propose that it should be wound up under the supervision of the Court so that everything might be disclosed to the shareholders.

Mr. WARD said that he challenged the fullest investigation into all the expenditure with which he had been concerned. Although nominally a vendor, he was not one actually, and had only received £200 in cash. Speaking of the Company's omnibuses, for the manufacture of which he was responsible, he said that their cost would bear favourable comparison with that of any first vehicles of a similar kind.

After further discussion the report and accounts were adopted; and the shareholders indicated by a show of hands, that they were favourable to the reconstruction of the Company, whereupon the Chairman stated that the Board would in a short time submit a scheme for that purpose.

At an extraordinary general meeting the provisional agreement, dated November 16th last, for severing Mr. Ward's connection with the Company was unanimously approved.

The trouble between the directors and Mr. Radcliffe Ward indicated in the above report has led to the publication, by the latter gentleman, of a circular, setting out his grievances against the board. In this circular—which, by-the-way, is accompanied by illustrations of an electric omnibus which is described (in the circular) as one of the most successful automobiles yet produced, but which bears indication of French origin—the directors are charged with issuing a report of a shamefully meagre character, and he asks for more daylight to be given to the shareholders on the subject of the prospectus of the company generally, and as to the scheme of reconstruction. The circular has little interest for anyone not a shareholder in the company, but, as is usually the case in documents of this nature, a good deal of forcible language is used—some of it in large type.

Amazon Telegraph Co. (Limited).

The report of the Directors of this company for the year ending June 30 last, states that the revenue, including £5,137. 16s. 4d. brought forward last year, amounts to £29,466. 8s. 10d., and the working expenses to £18,494. 10s. 3d., leaving, after deducting £8,870 for debenture interest and sinking fund, £2,081. 18s. 7d. to be carried forward. This shows an increase of £4,148. 14s. 2d. over the year to June 30, 1897, notwithstanding that several sections of the cable were interrupted. When the through line works regularly a steady and increasing traffic is at once developed. Owing to the unusually heavy flood season, the system has again, unfortunately, been subjected to interruption, and in parts where safety was reasonably expected, the banks in places were washed away, but every effort is being made to cope with these difficulties. The Directors are substituting indiarubber for guttapercha core, as the former is less liable to damage from heat; and they have recently sent out 100 miles of indiarubber cable, which is now being laid in some of the localities where interruptions have occurred. It is also proposed to try aerial lines where exceptional difficulties have arisen, and by this means bridge over such dangerous places. In order to carry out these and other improvements, further financial assistance is required. The Directors have, therefore, arranged for advances to be made from time, as may be necessary, against a deposit of the companys Debentures, and will ask the shareholders' sanction for the creation and issue of the balance of £75,000 unissued Debentures, in order that these may be available as security for such advances as may be required.

Yorkshire House-to-House Electricity Co. (Limited).

The following report of the Directors of this Company is issued for the year to Dec. 31 last:—

The Leeds Corporation, in exercise of the powers conferred by the Company's Provisional Order, gave notice on Aug. 4 last, requring the Company to sell its undertaking. As the result of negotiations, it was agreed that the sale should take effect, as regarded capital expenditure, on Aug. 31, 1898, and as regarded revenue on Sept. 30, 1898, and that agreement was approved at a meeting of the Company, held on Nov. 21 last. The capital expenditure to Aug. 31, 1898, after deducting depreciation, was found to be £217,420. 10s. 4d., and the purchase price is therefore to be paid, in accordance with the provisions of the Provisional Order, by the issue of £217,420 of Leeds Corporation Five per Cent. Stock, redeemable only by agreement between the Corporation and the holders of the stock for the time being. The amount of capital assets included in the accounts is merely the nominal value of the stock, the market value of which cannot at present be accurately estimated. The transfer of the undertaking was completed on Dec. 15 last. The Corporation have retained the services of the whole of the Company's staff.

The shareholders will be invited to pass a resolution for the liquidation of the Company, and the Directors will submit the name of Mr. Grosvenor Talbot (chairman of the Company) as liquidator, and the names of the other members of the Board as an advisory committee. Mr. John Gordon, the Company's auditor, will be appointed to audit the liquidator's accounts.

The supply of electricity by the Company on its own account having ceased on Sept. 30 last, the revenue account now submitted shows the result of only nine months' trading, and excludes the most profitable quarter of the year. The profit available for dividend, including £1,329. 2s. 5d. brought forward, and after providing £2,612. 6s. 8d. for depreciation, on the scale demanded by the Board of Trade auditor, is £10,740. 5s. 10d., which the Directors propose shall be appropriated as follows:—

Interim dividend at the rate of 5 per cent. per annum on the Ordinary shares for the half-year to June 30, 1898	£3,671	6	5
Dividend on amount called and paid up on same shares (which, with interim dividend, equals the rate of 6¾ per centum per annum for year to Dec. 31)	6,981	9	8
Balance forward	87	9	9
	£10,740	5	10

The number of lamps connected to the Company's mains increased during the nine months ending Sept. 30, 1898, from 49,150 to 65,328 (35 watt lamps).

The Directors express their hearty appreciation of the work done by the staff during the existence of the Company, more especially by Mr. Green, the secretary, and Mr. Harold Dickinson, the engineer, who have held their positions since the commencement, and whose ability and disinterested services have been of the greatest value in developing the undertaking. The Directors also recognise the conspicuous care and skill exercised by Mr. Robert Hammond, consulting engineer, in designing and superintending the construction of the works, as well as his valuable efforts in establishing the Company and obtaining the Provisional Order for supply of electricity in Leeds.

NEW COMPANIES, STATUTORY RETURNS, &c.

KALGOORLIE POWER SYNDICATE (LIMITED).—This company was registered on Jan. 10, with a capital of £10,000, in £1 shares, to promote a company to provide and apply electric power for mining and other purposes. The first subscribers (each with one share) are:—M. E. Williams, G. Neville, J. B. Sealy, and J. Doyle, E. Pope, G. Baker and C. E. Mozley.

SWANSEA MOTOR OMNIBUS CO. (LIMITED).—This company was registered on Jan. 10, with a capital of £20,000, in £10 shares, to construct, maintain and work omnibuses, vans and other vehicles, by electricity, steam, oil, or other motive power. The first Directors are:—J. C. Morris, J. Williams, O. Walters, T. P. Thomas and E. H. Leeder.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has appointed the 26th inst. a special settling day for 100,000 £1 Ordinary shares (10s. paid, and numbered 1,201 to 101,200) of the Blackheath and Greenwich District Electric Light Co. (Limited), which the Committee has also ordered to be quoted in the Official List, as well as the further issue of 5,403 fully paid £5 Ordinary shares (Nos. 484,598 to 490,000) of the National Telephone Co. (Limited).

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CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Oct. 13, 1898). Price of silver 27 9/16d. per oz. (Jan. 19). Consols (2¾ per cent.) 111¼—111⅜ for money, 111 5/16—111 7/16 for account; 2½ per cent. 103¾—104¼ (Jan. 19). Stock Exchange Settling Days: Consols, Feb. 1; Stocks and Shares Continuation Days, Jan. 25 and Feb. 8; Ticket Days, Jan. 26 and Feb. 9; Pay Days, Jan. 27 and Feb. 10; Mining Share Carry over Days, Jan. 24 and Feb. 7.

BRITISH ELECTRIC TRACTION CO. (LIMITED).—The Electric and General Investment Co. have this week invited applications for 20,000 Six Per Cent. Cumulative Preference shares of £10 each in the British Electric Traction Co. (Limited) at £12 per share. The additional capital is required for the development of a large number of electric light, tramway and railway undertakings in which the British Company are interested, either as owners or lessees. Applications from registered holders of shares in the British Electric Traction Co. were preferentially considered. The list closed yesterday (Thursday) for both town and country.

BRITISH INSULATED WIRE CO. (LIMITED).—The Preference dividend for the half-year ending Dec. last (3s. per share, less tax) has been declared.

CITY AND SOUTH LONDON RAILWAY CO.—The accounts of this company show a balance (after providing for debenture interest and the full dividend on the Five per Cent. Preference shares) sufficient to allow payment of a dividend on the Consolidated Ordinary stock at the rate of 2 per cent. per annum, carrying forward £1,419 to the new account. The distribution for the corresponding period last year was at the rate of 1¾ per cent. per annum, the balance carried forward being £1,510. 14s.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHT CO. (LIMITED).—An extraordinary meeting of the shareholders was held on Monday to consider the bill for compulsory powers promoted by the company. The meeting was called to comply with Parliamentary standing orders. Lord Rathmore said the main object of the bill was to enable the company to obtain compulsory powers for acquiring sites for generating stations and rights of way for connecting its various districts.

DUBLIN UNITED TRAMWAYS CO. (LIMITED).—Subject to final audit, the Directors of this company have declared a dividend of 6 per cent. per annum on the Preference shares and 5 per cent., free of tax, on the Ordinary shares for the half-year to Dec. 31. Including amount brought forward from the June half-year, the surplus profits amount to about £9,000.

EASTERN EXTENSION, AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—The interest on this company's 4 per Cent. Mortgage Debenture Stock for the half year ended 31st inst., will be paid by warrant on Feb. 1. The stock register will be closed from 27th to 31st inst. inclusive.

ELECTRIC CONSTRUCTION CO. (LIMITED).—The transfer books of the Ordinary shares of this company are closed from 18th to 31st inst. inclusive, for the payment of the second half of the dividend of 6 per cent. per annum declared on July 21.

GLOBE TELEGRAPH AND TRUST CO. (LIMITED).—The financial papers announce that this company has declared a quarterly interim dividend of 3s. per share on the Preference shares and 1s. 9d. per share on the Ordinary shares.

HAMPSTEAD ELECTRIC SUPPLY CO. (LIMITED).—The Directors of this company notify the payment of the dividend on the Five per Cent. Cumulative Preference shares for the half-year ended Dec. 31.

HASTINGS AND ST. LEONARDS-ON-SEA ELECTRIC LIGHT CO. (LIMITED).—At a meeting of this company, on Thursday last, it was decided to wind up the company voluntarily, consequent upon the acquisition of their undertaking by the Corporation, and Mr. James Woodhams, auctioneer, Havelock-road, Hastings, was appointed liquidator.

WESTERN AND BRAZILIAN TELEGRAPH CO. (LIMITED).—Notice is given that Debentures, series A, to the amount of £8,900, and series B, to the amount of £10,500, will be drawn for payment at par, at the offices of the company, on Wednesday next.

WEST INDIA AND PANAMA TELEGRAPH CO. (LIMITED).—The estimated amount of the traffic receipts of this company for the half month ended Jan. 15 is £1,891, against £1,997 in the corresponding period of 1898.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Jan. 14	3,754	+ 296	...	...	—
Blackpool Corporation...	" 12	111	+ 4	41	16,582	+ 2,467
Blackpool and Fleetwood Co.	" 14	113	...	2	280	...
*Bristol Trams & Carriage	" 13	2,557	+ 191	2	5,063	+ 234
City & South London Ry.	" 15	1,107	+ 22	3	3,286	+ 27
Dover Corporation	" 14	151	+ 43	41	7,504	...
Dublin United (Southern)	" 13	606	+ 183	2	1,115	+ 356
Liverpool Overhead Rly.	" 15	1,337	− 24	3	3,967	− 189
*Sheffield Tramways.....	" 15	1,207	+ 246	2	2,485	+ 511
*South Staffs. Trams......	" 13	629	+ 19	2	1,087	− 64

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Jan. 11.		Price Wednesday, Jan. 18.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Week Ending Jan. 18. Highest.	Lowest.
			TELEGRAPHS					£ s. d.			
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	101	104	101	104	3 16 11	January and July	..	..
25,000	10	—	Amazon Telegraph	3	4	3	4	—	—	—	—
£125,000	100	5%	Do. 5 per Cent. Debentures	91	94	91	94	5 6 5	—	—	—
£906,560	Stock	15/0	Anglo-American	66	63	67	69	4 7 11	Feb., May, Aug., Nov.	68¾	67½
£3,047,220	Stock	30/0	Do. Preferred	117	118	118½	119½	5 1 8	" "	119½	117½
£3,047,220	Stock	5/0	Do. Deferred	17	17½	16½	17½	—	—	17¼	16¾
130,000	10	3/0	Brazilian Submarine	15½	15¾	15½	15¾	4 8 11	Mar., June, Oct., Dec.	15⅝	15 7/16
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	110	114	110	114	4 7 9	June and December	..	..
10,000,000	$100	$2½	Commercial Cable Capital Stock	180	190	180	190	4 4 3	Jan., Apr., July, Oct.	..	..
£1,332,523	Stock	4%	* Do. 4 per Cent. Debenture Stock	103	105	103	105	3 16 2	" "	..	—
16,000	10	8/0	Cuba Submarine Ordinary (Deferred)	10	11	9½	10½	6 11 4	February and August	10 1/16	..
6,000	10	10/0	Do. Preference 10 per Cent.	17	18	17	18	5 11 1	" "	18	..
12,931	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October	..	—
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	—	—
£90,000	50	4½%	Do. 4½ per Cent. Debentures	104%	107%	104%	107%	4 4 1	January and July	..	—
60,710	20	3/0	Direct United States Cable	11½	12½	11½	12½	5 6 1	Jan., Apr., July, Oct.	12¼	12 3/16
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	102	105	102	105	4 5 9	—	..	
£4,000,000	Stock	6%	Eastern Ordinary xd	174	179	174	179	3 18 3	Jan., Apr., July, Oct.	178½	175
£1,296,000	Stock	3½%	Do. 3½ per Cent. Pref. Stock xd	104	107	103	103	3 6 0	" "	105½	103½
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	124	123	124	128	3 2 6	May and November	123½	122½
£99,900	100	5%	* Do. 5 per Cent. Debentures, 1899	101	104	101	104	4 17 0	February & August	..	..
£500,000	Stock	—	Do. Provisional Certificates (all paid)	64	67	103	103	..	..	..	..
250,000	10	2/6	Eastern Extension xd	17½	18	17½	18	3 17 9	Jan., Apr., July, Oct.	17⅞	17 5/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	129	125	129	3 2 4	February & August	128	..
£16,200	100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Deb. 1900 (reg.)	99	103	99	103	4 17 1	January and July	..	..
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	" "	101½	—
£35,100	100	5%	*Eastern and S. African 5 p.c. Mor. Deb., 1900 (reg.)	99	103	99	103	4 17 1	" "	..	—
£46,500	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	104	107	104	107	3 15 8	February & August	..	..
£300,000	25	4%	Do. 4% Mauritius Sub. Debs. (red.)	104%	107%	104%	107%	3 15 2	May and November	..	—
130,227	10	1/9	Globe Telegraph and Trust	12½	12¾	12½	12¾	4 0 9	Jan., Apr., July, Oct.	12⅞	12½
130,042	10	6%	Do. 6 per Cent. Preference	16¾	17¼	16¾	17¼	3 9 7	" "	16 13/16	—
150,000	10	5/0	Great Northern of Copenhagen	28½	29½	28½	29½	3 7 10	January, April, July	28½	..
£150,000	100	5%	* Do. 5 per Cent. Debs., 1883 Issue Series "B"	101	104	101	104	4 17 7	March & September	..	—
£97,800	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red)	100	103	100	103	4 7 5	June and December	..	—
17,000	25	12/6	Indo-European	56	53	57	60	4 3 4	May and November	59	—
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	109	112	109	112	5 7 7	March & September	..	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red)	104	107	104	107	3 14 9	June and December	—	
11,839	6	4/0	Reuter's	6½	7½	6½	7½	5 6 8	April and October	7⅜	6¾
3,381	£100 Cert.	6%	Submarine Cables Trust	134	139	134	139	4 6 9	" "	—	..
15,609	10	—	West African Telegraph	—		..		..	—	—	—
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	100	103	100	103	4 18 6	March & September	101½	—
30,008	2½	—	West Coast of America	½	1	½	1	—	—	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	102	105	102	105	3 16 2	June and December	103	..
88,321	10	1/6	West India and Panama	1⅞	2	1⅞	2	—	May and November	1⅞	1 13/16
34,563	10	6/0	Do. 6 per Cent. 1st Preference	10½	10¾	10½	10¾	5 11 7	" "	10⅝	10½
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	" "	9½	—
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	104	107	4 13 6	January and July	..	—
34,200	15	5/0	Western and Brazilian Ordinary	12½	12¾	12½	12¾	4 13 2	May and November	..	—
33,129	7½	3/9	Do. 5 per Cent. Preferred Ordinary	8	8½	8	8½	4 8 2	" "	—	—
33,129	7½	1/3	Do. Deferred Ordinary	4	4½	4	4½	—	" "	..	—
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	105	108	105	108	3 14 1	June and December	—	..
1,160,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	—		—		6 7 10	Feb., May, Aug., Nov.	—	—
£150,100	100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	98	103	98	103	5 16 6	March & September	..	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Jan. 11.		Price Wednesday, Jan. 18.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 18.	
								£ s. d.		Highest	Lowest
			TELEPHONES.								
£4,000	£5	4/0	Chili Telephone (fully paid)	2¼	3½	2¾	3½	6 3 1	August	–	–
224,850	10/0	1½d.	Consolidated Telephone Const. & Manufacturing	1/16	1/16	1/16	1/16	6 7 0	July	–	–
28,000	5	4/0	Monte Video Telephone 6 per Cent. Preference	..	..	–	–	–	October	–	–
490 000	5	3/0	National	5⅝	5⅞	5½	6	5 0 0	February & August	5 1/32	5 1/16
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	13	15	14	16	3 15 0	" "	15	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	13	15	13	15	4 0 0	" "	–	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	5⅜	5⅝	5½	5⅝	4 6 11	" "	5⅝	..
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	99	102	99	102	3 8 8	June and December	100	99½
171,504	1	0/4	Oriental	⅜	½	⅜	½	6 13 4	April and October	–	–
58,000	5	6/0	United River Plate	4½	5	4½	5½	5 14 3	July	–	–
£151,788	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	102	105	103	106	4 14 6	June and December	105	104
			ELECTRICITY SUPPLY COMPANIES.								
6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	11	11½	12½	12½	–	–	11⅜	..
6,000	10	4/3 1/10	Do. 4½ per Cent. Cumulative Pref.	10⅜	11½	10⅜	11½	4 4 0	–	10⅜	..
80,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	11½	12⅜	11½	12⅜	2 16 0	February & August	–	–
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6½	6	6½	3 9 3	" "	–	–
£34,000	5	2/6	Chelsea Electricity Supply Ordinary	9	10	8½	9½	3 3 2	March	9½	9
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	113	115	113	115	3 18 3	June and December	..	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red)	103	105	103	105	4 15 3	–	..	..
50,000	10	5/0	City of London Elec. Lighting Ord. 40,001 to 90,000	22	24	22	24	5 4 2	February & August	23 1/16	23⅛
10,000	10	1/9	Do. Ordinary 90,001 to 100,000	21	23	21	23	..	..	..	..
40,000	10	6%	Do. 6% Cumulative Pref.	15½	16½	15½	16½	3 13 9	January and July	–	–
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	125	130	125	130	3 16 11	June and December	–	..
30,000	10	..	County of London & Brush Prov. Ord. (1 to 30,000)	12	13	12½	13⅛	–	–	13 3/16	–
10,000	10	..	Do. (30,001 to 40,000)	11⅛	12½	12	13	..	–	12½	–
20,000	10	6/0	Do. 6% Cumulative Preference	14½	15⅜	14½	15½	4 0 0	March & September	15½	14⅝
15,660	5	2/6	House-to-House Electric Lighting Supply Ord.	9	10	9	10	2 0 0	–	9⅝	–
12,000	5	3/6	Do. 7 per Cent. Preference	9½	10½	9½	10½	3 6 8	March & September	–	–
15,000	5	10%	Kensington and Knightsbridge Ord.	13½	14½	13	14	3 18 7	..	..	–
10,000	5	6%	Do. 6% 1st Pref.	7⅞	8½	7⅞	8½	3 12 9	January and July	..	–
110,000	3	–	London Electric Supply Ordinary	3	3⅛	3	3⅛	–	–	3⅛	–
48,050	5	–	Do. Preference	6	6½	6½	6⅝	–	–	6½	6½
£100,000	Stock	..	Do. 4% 1st Mort. Deb.	102	104	102	104	3 16 11	Mch., June, Sept., Dec.	–	..
62 400	10	5/0	Metropolitan Electric Supply Ordinary	18	19	18½	19½	3 1 6	April and October	19½	18 3/16
27,500	10	–	Do. (£4 paid)	10⅞	11½	11½	12½	..	–	12	11½
£32 000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	115	119	115	119	3 15 8	June and Decemb	..	..
6,452	10	6/0	Notting Hill Electric Ordinary	17	18	17	18	3 6 8	March	–	–
10,000	5	–	Oxford Electric Ordinary	6	6½	6	6⅜	..	–	–	..
275,000	1	–	Rand Electric	⅜	1⅜	⅜	1⅜	..	..	..	..
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb	86	91	86	91	5 9 1	–	90½	–
150,000	$100	$2	Royal Electric Company of Montreal Shares	150	155	150	155	5 3 3	–	–	–
130,900	100	4½%	* Do. 4½% 1st Mort. Debs.	105	107	105	107	4 5 10	April and October	–	..
31,980	5	5/0	St. James and Pall Mall Electric Ordinary	17	18	17	18	4 9 0	February & August	17⅜	17⅜
20,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	" "	9½	9½
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.)	..	..	..	..	..	June and December	..	–
65,000	5	..	South London Electric Supply Ordinary (£3 paid)	3	3½	3	3½	..	..	3 3/16	3
79 900	5	5/0	Westminster Electric Supply Ordinary	15½	16½	13	17	3 16 6	March & September	16⅜	15⅜
18,848	5	5%	Yorkshire House-to-House	7½	8	..	..	..	February and July	–	–
18,626	5	5%	Do. (£4 paid)	5½	6½	–	..	..	February and July	–	–
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	2	1/2⅜	Brush Electrical Engineering	1⅝	2	1⅝	2	3 0 0	–	–	–
90,000	2	1/2⅜	Do. 6 per Cent. Pref. Non-Cumulative	2½	2⅝	2½	2⅝	5 1 1	–	–	–
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	111	115	111	115	3 19 0	February & August	–	–
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101	104	101	104	4 6 7	June and December	–	..
£20,000	5	5/0	Callender's Cable Construction	9½	10½	9½	10½	6 8 7	" "	10½	10½
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	110	113	110	113	3 19 8	November and May	..	–
300,000	1	9⅛	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	–	1 3/16	–
50,000	1	..	Chadburn's Ship Telegraph Ordinary	1⅛	1⅜	1⅛	1⅜	–	–	..	–
50,000	1	7½	Do. 6 per Cent. Cumulative Pref.	1	1⅛	1	1⅛	4 16 0	–	–	–
32,038	3	1/6	Crompton and Co. (Nos. 1 to 32,038) xd	2½	2⅝	2⅝	2⅝	5 9 1	–	2⅝	–
£82,850	100	5%	* Do. 5% First Mort. Deb. (red.)	89	94	91	96	5 4 2	January and July	–	–
99,261	5	2/1½	Edison and Swan United ("A" Shares) (£3 paid)	2½	3	2½	3	6 1 9	February & August	2 1/16	2⅞
17,189	5	3/1½	Do. (£5 paid)	4	5	4	5	6 0 0	–	–	–
£194,023	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	93	98	97	99	4 1 0	June and December	98	97⅛
17,400	5	5%	Edmundson's Electric Corporation Ord (fully paid)	5	5½	5	5½	4 10 11	Half-yearly	5½	–
112 100	2	1/2⅜	Electric Construction Co. (Limited)	2½	2⅝	2½	2⅝	4 12 0	January & July	2 1/16	2 1/16
25,000	2	2/9⅜	Do. 7 per Cent. Cumulative Pref.	2⅝	3⅛	3	3⅛	4 0 0	July	3 3/16	3⅛
£140,800	Stock	4%	Do. 4% First Mortgage Deb. (red.) xd	105	107	103	105	3 16 2	January and July	104⅜	–
91,196	1	–	Elmore's Patent Copper Depositing	⅛	⅜	⅛	⅜	..	–	–	–
12,500	10	8/0	Henley's Telegraph Works Ordinary	£22½	23½	23½	24⅛	5 6 1	February & August	24⅜	23½
8,000	10	7/0	Do. 7 per Cent. Preference	18	19	18	19	3 13 8	" "	18½	–
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 3	" "	11 4/16	..
40,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	4 8 11	" "	21⅜	21⅛
300,000	100	4%	Do. 4% First Mortgage Debentures (red.)	102	106	102	106	3 15 6	March & September	–	..
37,350	12	12/0	Telegraph Construction and Maintenance	37	41	37	41	4 6 2	March and July	4 1/16	39
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	..	..	..	..	..	January and July	..	..
12,400	5	..	Do. Manufacturing Ordinary	8	8½	8½	9½	–	–	–	–
13,410	5	..	Do. 5% Cum. Pref.	5½	6	5½	6	4 3 4	–	..	–
£20,000	5	4/0	Williams and Robinson Ordinary	8½	8½	8½	8½	4 11 5	April and October	8⅝	8½
£30,000	5	3/0	Do. 6% Cumulative Preference	6½	7½	6½	7½	4 2 9	" "	7⅛	–
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	106	108	108	108	3 18 8	May and November	107	–
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	..	Blackpool and Fleetwood Tramways	20	21	21	22	..	–	22	20
25,000	10	6%	Bristol Tramways and Carriage	£21½	22	21½	22	2 14 7	–	–	–
25,000	10	6%	Do. (£7. 10s. paid)	1 5/8	18⅞	18⅝	18⅞	1 14 1	–	–	–
£30,410	Stock	4%	Do. 4% Debenture	120	121	120	121	3 6 2	–	–	–
80,000	10	..	British Electric Traction Ordinary	16	17	17	18	..	–	18	17
10,000	10	2/4 7/10	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm.pd.)	13	13½	13	13½	4 8 11	–	13⅜	13½
£100,000	Stock	6/2 3	Do. 5% Perp. Deb.	119	121	119	121	–	–	120½	1 9⅜
40,000	5	..	Buenos Ayres & Belgrano 6% Cum. Pref. (£3 paid)	2½	3½	2½	3½	..	–	3 1/16	2⅝
27,500	5	..	Do. do. do. (fully paid)	3	3½	3½	4½	..	–	4	3½
£260,000	Stock	..	Do. do. 5% Deb.	100	105	100	105	4 15 3	..	103½	102½
£35,250	10	3/0	Central London Ordinary	9½	10½	9½	10½	2 18 6	June and December	10⅜	9⅝
178,303	10	1/9⅜	Do. (£8 paid)	5½	6½	7½	8½	2 13 2	" "	–	..
£339,000	Stock	2½%	City and South London Railway Con. Ordy.	67	69	68	70	2 17 6	January and July	70	69½
22,500	10	..	Do. Ordinary (£4 paid)	3½	4	3½	4	..	..	–	–
9,251	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	3 4 6	January and July	–	–
£137,701	Stock	4%	Do. 4% Perpetual Debenture	133	135	131	134	2 19 7	May and November	133½	–
20,000	10	6%	Imperial Tramways Ordinary (old £6 shares)	17½	17⅝	17½	18½	3 5 9	March & September	18½	17⅜
10,000	10	6%	Do. 6% Preference	15⅝	15⅝	15½	16⅛	3 16 2	" "	15⅝	15½
£70,000	Stock	4½%	Do. 4½% Debenture	117	118	118	119	3 15 8	..	119	118
37,500	10	3%	Liverpool Overhead Railway Ordinary	9 1/16	10 1/16	9⅜	10	3 5 0	February & August	–	–
10,000	10	5%	Do. 5% Preference	14⅜	15½	14⅜	15½	3 5 7	" "	–	–
125 000	Stock	4%	Do. 4% Debenture	106	108	106	108	3 14 1	January and July	–	–
20,000	5	3/3½	New General Traction 6% Cumulative Pref	4½	5½	4½	5½	5 14 3	–	–	–
£540,000	Stock	3%	Waterloo and City Ordinary	111	114	108	111	2 15 7	June and December	109	–

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

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CONTENTS OF THE CURRENT NUMBER.

NOTES	457	SOME ASPECTS OF BRITISH ELECTRICAL INDUSTRY	470
Meetings of Scientific Societies	459	Open Conduit Electric Traction at Washington. Illustrated	471
The Stanstad-Engelberg Electric Railway. Illustrated	460	High-Speed Engines. By J. H. Dales	478
The Post Office London-Birmingham Underground Telephone Cable. Illustrated	465	Correspondence	479
Induction Motor Diagrams. By C. C. Hawkins, M.A. Illus.	467	Legal Intelligence	479
Gravity-Electrolytic Processes for the Production of Caustic Soda. By G. H. Robertson, F.C.S.	468	Trade Notes and Notices	480
		Companies' Meetings & Reports	486
		New Companies, &c.	488
		City Notes	489
		Companies' Share List	490

NOTES.

IT may be hoped that the new Secretary to the Post Office will not be over much frightened by the *Daily Telegraph's* description of the Department to which he has been reluctantly transferred. Not only is the telegraph system of this country "the worst in the world," but the officials, both postal and telegraphic, are fossilised "in adamantine rules and regulations through which no glimmer of reasonable argument or common sense can penetrate." His task would be indeed stupendous if such statements were true; but seeing that the pages of this self-same journal only a few days before had overflowed with praises of the two most exalted of these official fossils on their retirement from the service, Mr. MURRAY need not take the *D. T.* too seriously. "A Day and Night Telegraph Service" may or may not be a good thing, according as it is or is not called for by local requirements; but that certain towns would like to have it and are not willing to pay for it, is no excuse for statements which are not only extravagant but altogether erroneous.

AFTER all has been said, the question is not wholly one of expense. It is to be noted that while every other kind of business has been tending latterly to shorten hours, and to lighten duty in the evenings, the tendency in the Post Office has been to prolong the hours for all classes of business further and further into the night-time; and this in deference to some real or fancied demand on the part of the public. No doubt further concessions will be made if there is a genuine call for them. But, reading between the lines, and from certain hints let fall here and there, we suspect that the ultimate object of this agitation is to obtain a considerable extension of hours on Sundays; and we doubt whether this is an alteration which the general public have the least desire to encourage. Lastly, as the Telegraph Service does not pay its way, the appeal to the tremendous profits earned by the Postal Service is not likely to have much weight with a Post Office Secretary.

THERE is no doubt that for telegraphic work the underground cable is in every way preferable to the overhead line, except so far as cost is concerned. The use of loose paper as a dielectric diminishes the electrostatic capacity which might otherwise impede long-distance high-speed signalling, and by giving access to the cable at a sufficient number of testing points, its inspection and the locating of faults are rendered almost as easy as on an overhead line. As will be gathered from the article on the London-Birmingham cable in another column, however, the cost of laying, apart from the price of the cable itself, must be considerably more than the sum spent on the erection of an equivalent number of overhead lines; and this may stand in the way of the general adoption of underground work for extensions. The cost, we think, could be considerably diminished by utilising an armoured cable laid directly in the ground, at all events in the country roads which form by far the greater part of the route of a long-distance cable. Such a line would still be less liable to disturbance than the existing overhead wires, and, in the rare event of a fault occurring, with the large engineering staff at the disposal of the telegraph department, the localisation and removal of the defect should take no longer than the withdrawal and replacement of a section of cable placed in iron pipe. One fact is certain, namely, that, except for short distances, paper is the insulation *par excellence* or underground telegraph cables, and it is only necessary to find a suitable waterproof, mechanically strong, and a sufficiently light protective covering, for this class of insulation to supersede gutta percha in submarine work as well as on land.

So far as telephony is concerned, paper or "air space" cable is now recognised as the most suitable for underground work, and in towns underground cables are given the preference over aërial lines. Whether in this case also underground cables will prove best for long distance work has still to be determined. In telephone work capacity plays a still more important part than in the sister service, and the majority of cables in use hitherto have capacities, although low, yet considerably in excess of those of overhead lines. It must be remembered, however, that by increasing the distances between the wires in the cable a great diminution

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of the capacity is possible, the only real deterrent being the increased diameter of the cable and consequent increased cost of the sheathing, and, in drawn-in systems, of the pipe-line.

THE time is now ripe for an investigation, confirmed by an actual experiment under practical working conditions, to determine the relative maximum permissible values of line resistance and capacity for distinct speech to be transmissible with modern telephonic apparatus. In cables with paper and air insulation, as now constructed, both the inductance and leakance are practically zero, the former being necessary to ensure immunity from external disturbance. When this has been determined, a second problem would be whether it would pay to use lower insulations at the expense of slightly higher capacities, by not carrying so far the drying process in the manufacture of the cable. If the efficiency of the cable for speech transmission were increased by this means, an increase in the conductor-resistance would be permissible, which would, again, lessen the cost. When numerical solutions are given to these problems it will be possible to compare exactly the merits and demerits, from an economical point of view, of overhead and underground long-distance telephone lines, and we shall also be clearer in regard to the distance to which submarine telephony may be economically extended.

CARLYLE once made sarcastic allusion to "the combined folly of a number of fools" being often mistaken for wisdom. It is the special brand of wisdom too frequently found among juries. On the 10th inst., as reported in our last issue, an engine driver was found dead on one of the electric locomotives of the City and South London Railway, and at the inquest a Dr. MORRIS attributed death to electric shock, as "there was nothing else to account for it." Mr. MCMAHON, the Company's chief engineer, gave evidence as to the physical impossibility of electric shock in the position in which the switches, &c., were found; while three medical men, Drs. LESLIE, HENRY and BELL, having made an autopsy, agreed that death was due to ordinary heart failure, that the condition of the heart would render the deceased liable to fainting attacks, and that there was no burning nor charring of the skin. The coroner, in summing up, pointed to the positive evidence that it was impossible for the deceased to receive an electric shock; yet a presumably intelligent body of twelve good men and true found that "death was due to syncope following an electric shock!"

MR. A. C. BROWN'S contribution to the recent discussion on the three Papers on induction telegraphy at the Institution of Electrical Engineers was not fully appreciated by his audience, chiefly, it must be confessed, owing to his being somewhat imperfectly heard. As will be seen by his letter in another column, he had something of considerable importance to say, although it related rather to earth-conduction than to induction telegraphy. The most sensitive current detectors are those responding to interrupted or alternating currents; but, on the other hand, Mr. BROWN had found experimentally that signals formed by short but continuous currents are transmitted by earth-conduction with more efficiency than are rapidly varying ones. In order to use these continuous-current signals in conjunction with a telephone or a relay requiring a high frequency, he interrupts the received instead of the transmitted current. This principle, it would appear, is the basis of his methods of telegraphing through bare wires and broken cables, and we shall be glad to hear that his efforts in this direction have been crowned with success.

Cable Interruption.—	Date of Interruption.
Para—Maranham	Nov. 15, 1898

Electrical Engineers (R.E.) Volunteers.—The first smoking concert of the corps of Electrical Engineers (R.E.) Volunteers will be held this evening at the Holborn Restaurant, London, at eight o'clock.

Royal Society.—Among the Papers down for reading yesterday was one by Mr. S. W. J. Smith, on "The Nature of Electro-Capillary Phenomena. I.—Their Relation to the Potential Differences between Solutions."

Personal.—In appreciation of his services as one of the two British representatives on the Superior Jury of the Brussels Exhibition, the King of the Belgians has appointed Mr. W. H. Massey an Officier de l'Ordre de Léopold.

The Rocent Fatal Accident at Southampton.—We have received a copy of Major Cardew's report of the inquiry he made into the recent fatal accident at Southampton. Owing to great pressure on our space we are unable to reprint it this week; but the report is of considerable importance, and we reserve our comments until its publication in full in our next issue.

A New Accumulator Switch.—In connection with our description of Messrs. Erlacher and Besso's accumulator switch in our last issue, Messrs. Verity's send us a copy of patent No. 8,048 of 1897, granted to Messrs. L. W. Heath and J. H. Field, which they state it is their opinion is infringed by Messrs. Erlacher and Besso's switch. They assert that the patent in question bears a date two months earlier than the Swiss inventors' patent. Messrs. Veritys add that they have the sole right to manufacture switches under the Heath and Field patent.

"The Archives of the Röntgen Ray."—We note that the November issue of this official journal of the Röntgen Society is under the joint editorship of Mr. Thomas Mcore, F.R.C.S., and Mr. Ernest Payne, M.A., assisted by an editorial committee. Mr. Sydney Rowland, who was the originator of the publication, and one of the first to bring the new photography prominently before the medical profession, has accepted a post on the staff of the *British Medical Journal*. Dr. W. S. Hedley also has vacated the editorial chair, but the services of both these individuals will be available on the editorial committee.

Sweating in the Post Office.—*Apropos* of the agitation in the *Daily Telegraph* for an extension of all-night telegraph service, the following advertisement, which appeared in *The Times* of 21st inst., throws some light on the duties, hours and remuneration attached to all-day offices:—

POST OFFICE.—WANTED, a PERSON, male or female, or married couple, to undertake the duties of a small country post and telegraph office. Must find and pay one messenger or more, as required. Hours 8 a.m. to 8 p.m. on week days, 8 to 11 a.m. on Sundays. Rent 2s. a week. Salary allowed by Government £15 per annum and small commission on postal orders and Telegrams. No holiday allowed in the year, except on paying a substitute approved by the head office. Apply by letter to P.O., Scripp's Advertising Office, 13, South Molton-street, Bond-street, London, W.

Telephone Statistics.—A considerable extension of the operations of the National Telephone Co. (Limited) has taken place during the past year. The figures given below (from "The Electrician" Electrical Trades' Directory and Handbook for 1899) show the progress made from Dec. 31, 1893, to Dec. 31, 1898:—

Year.	No. of exchanges.	Total No. of call offices.	No. of lines.
1893	540	1,283	60,041
1894	582	1,347	73,338
1895	629	1,334	82,089
1896	698	1,279	94,407
1897	782	1,384	106,188
1898	853	1,665	120,144

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Telephone Exchange at Auckland (N.Z.).—A telephone exchange was opened by the telegraph department last November, at Auckland, New Zealand. It was built by the Western Electric Co., and is on the multiple branching system, with self-restoring indicators, and pilot lamps to facilitate supervision. The present capacity of the switchboard is for 1,500 subscribers, but there is room for 4,900. The switchboard is divided into 15 sections, each served by one operator, who has, therefore, to attend to 100 subscribers' calls. Two sets of 3 storage batteries, charged by a gas engine and dynamo, furnish current for the operators' speaking circuits, the restoring circuits of the indicators, and the lamps.

Prizes Awarded by the Académie des Sciences.—The following are among the prizes awarded by the Académie des Sciences for the year 1898:—The Henry Wilde Prize to Dr. Charles A. Schott, in recognition of the value of his important work in connection with the terrestrial magnetic survey in the United States, published almost annually in the Annual Reports of the United States Coast and Geodetic Survey; the Gegner Prize to Madame Curie, for her investigations into the magnetic properties of commercial irons and steels, and her study of uranium and similar rays; the Houllevigue Prize to M. Edouard Branly, as already announced. There were only two essays sent in for the Kastner-Boursault Prize, awarded to the best work on diverse applications of electricity in the arts, industry and commerce. The first of these, on "Electric Traction on Railroads," by MM. A. Blondel and F. Paul Dubois, fills three volumes, and is a record of observations made during journeys in Europe and America, with a large amount of hitherto unpublished matter and much original work. M. Paul Janet was the other competitor for this prize, with a volume containing a *résumé* of his course on industrial electricity. The Commission having considered the two works of equal merit, the prize has been divided between them.

Lectures to Science Teachers.—By arrangement with the Technical Education Board of the London County Council, a course of lectures and laboratory demonstrations is being given by Dr. J. A. Fleming in the Pender Electrical Laboratory, University College, London, on Saturday mornings during the present Lent term, to about 20 or 25 head-masters, assistant masters, and science masters in London board schools and science schools. The subject is "Electromagnetism." The object of the course is, in the first place, to afford the teachers the advantage of seeing the best methods in lecture demonstrations, with the aim of improving their own teaching, and also giving them the opportunity to obtain experience in practical manipulation. The morning's work consists in the delivery of an experimental lecture by Dr. Fleming, followed by practical work in the laboratory. In the lecture course, such matters as the outlines of Maxwell's theory, Heaviside's system of rational units, and the processes of absolute measurement are being brought forward at an early stage; and methods of lantern projection, which has been a special study with Dr. Fleming, are fully illustrated and explained. In the laboratory, subsequently, the teachers, in groups of four, are taught to carry out quantitative exercises with simple, yet properly designed, apparatus, of a type which they can themselves subsequently use in their own teaching.

German Electric Tramway Statistics.—The *Elektrotechnische Zeitschrift* publishes, in its issue of January 5th, its usual statistical tables of the electric tramways in Germany. These are made up to September 1, 1898, and show that then 68 towns had electric tramways in operation. Since September 1st nine more electric tramway systems have been opened to the public, and the total of 77 may be compared with 61 at the end of the year 1897, and 44 at the end of 1896. In addition, 26 new lines are definitely projected or in course of construction, and in 35 places extensions are being laid down. The majority of these lines are on the overhead system, underground conduits being only used on some short lines in Berlin and Dresden. The "mixed" system, with overhead lines, and accumulators on the cars, is employed in Berlin, Dresden, Hagen (Westphalia) and Hanover, while the simple accumulator system has been adopted on one of the Berlin lines and at Hagen, Frankfort, Ludwigshaven and Türkheim, all these towns, with the exception of Ludwigshaven, being provided with either the overhead or "mixed" system as well. A line from Frankfort to Offenbach, 4½ miles long, opened in 1884, is still in operation, being one of the first experiments with electric tramways. The conductors are two slotted iron tubes, supported on poles, contact being made by means of four elliptical sliders pressed against the interior of the tube by flat springs. The following figures, all made up to Sept. 1, 1898, are interesting:—Total length of lines, 889 miles; total length of track, 1,205 miles; number of motor cars, 3,190; number of trailers, 2,128; capacity of generating plant, 33,333 kilowatts; capacity of power-house batteries, 5,118 kilowatts. Over 680 miles of line are in course of construction, corresponding to 830 miles of track.

Municipal Trading.—An important discussion on this topic is now taking place in the columns of *The Times*, and we extract the following from a letter which was contributed by Lord Wemyss on the 25th inst.:—

> Is it to the State or to municipalities that humanity is indebted for our marvellous progress in science, in invention, in material well-being? Assuredly not. It is to individuals and to private and commercial enterprise that all progress has been due. Thus, a great scientific discovery is made—take as an illustration the application of electricity to lighting, motor and other useful purposes. What happens? It is taken up by individuals who formed themselves into companies for the utilisation of electricity and its adaptation to our daily wants. This they did, not for the benefit of humanity, but in the hope and belief that it would pay. And, as in this, so in all inventions and discoveries that can be made available for the uses of society, and that, in the speculator's opinion, can be profitably worked. Had it not been for the hope and prospect of pecuniary benefit to be derived from the utilisation of scientific discoveries adaptable to the use of man, such discoveries would in many cases have been still-born, and assuredly would have so continued to be if the commercial speculator felt that as soon as his concern was seen to pay the State or municipality would take possession of his property and patent rights in the invention which he was, to use a current phrase, successfully running. Such action on the part of the State or municipalities tends necessarily to the checking of enterprise and to the arresting of human progress, for we may rest assured that, notwithstanding the wonders of scientific discovery in our time, we are ever on the threshold of further discoveries and inventions to be in their turn speculatively utilised for the benefit of man if private enterprise is left alone. I have referred to electricity. There we have conclusive evidence of the truth of the argument I have here advanced; for when Mr. Chamberlain carried through the House of Commons a Bill by which all electric companies might be compelled at the end of 14 years (extended in the Lords to 20 years) to part with their privileges and property to the State at the then estimated value of their plant, without reference to the market value of their property as a running concern, all advance in the utilisation of electricity for lighting and other purposes ceased. A committee of the House of Commons had to be appointed to consider the subject, and 40 years were substituted for the 20 in the Act as the time within which electric properties could not be acquired by the State. Let us then hope that we may see a joint committee of the two Houses of Parliament appointed and that it will put a stopper on municipal ambition and the speculating of municipal authorities with the ratepayers' money. Further, let them lay down, as a guide in such matters, the late M. Léon Say's wise axiom that "the action of the State should be so limited as not to interfere with private enterprise or limit personal responsibility."

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, January 27th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Agenda: (1) "On the Equivalent Resistance and Inductance of a Wire to an Oscillatory Discharge," by E. H. Barton; (2) Exhibition of (*a*) A Dephlegmator, (*b*) A Temperature Tell Tale, by R. Appleyard; (3) "On the Volume Changes accompanying Solution," by T. H. Littlewood.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Meeting at the Westminster Palace Hotel, when Prof. J. A. Ewing, F.R.S., will deliver a Lecture on "Measurement of Elasticity."

SATURDAY, January 28th.

INSTITUTION OF ELECTRICAL ENGINEERS.

10:15 a.m. Students' visit to the Works of the Electric Welding Co., Hindon-street, Pimlico. Meet at the Institution, 28, Victoria-street, at the time stated.

WEDNESDAY, February 1st.

INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Students' Meeting in the Library of the Institution. Paper to be read, "Safety Fuses," by Sidney Ransom.

SOCIETY OF ARTS.

8 p.m. Ordinary meeting. Paper to be read, "The Cost of Municipal Enterprise," by Dixon H. Davies.

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THE STANSSTAD-ENGELBERG ELECTRIC RAILWAY.

An order for the construction and working of a railway, connecting the village of Stansstad, on the Lake of Lucerne, with Engelberg, a favourite tourist resort 3,450ft. above sea level, was applied for and granted in October, 1890. It was not, however, until the autumn of the year 1896 that a company was formed with a capital of £80,000 for the purpose of building the projected line. As Stansstad is not connected with the Swiss railway system, the working of the line by steam would have been a very costly thing on account of the high carriage paid on fuel. It was, therefore, decided to build an electric railway, especially as an abundant water supply along the whole valley could easily and cheaply furnish the necessary motive power. The length of the proposed line being too great for an ordinary continuous current system, the polyphase system was chosen. The building of the line was commenced in May, 1897, and the railway was opened to traffic in October last. Messrs. Locher and Co., of Zürich, the well-known builders of the Pilatus Railway, were the contractors for the whole line, whilst the whole electrical equipment was supplied by Messrs. Brown, Boveri and Co., of Baden, in conjunction with the Société Suisse des Locomotives and the Société Industrielle Suisse of Neuhausen, who supplied the locomotives and rolling stock.

Map of Stansstad Engelberg Railway.

The line starts from the landing stage of the Steamship Company at Stansstad. Below we give a map of the line and a profile diagram. With a slight rise the line runs through Stans, and then, partly by the side of the road, with a maximum gradient of 2 per cent., to the village of Dallenwyl, where the river Aa is crossed by an iron girder bridge 115ft. long. The line then touches the village Wolfenschiessen Grafenort, from whence it follows the river, rising by means of a series of sharp curves, and a 5 per cent. gradient through a picturesque valley to Obermatt, where the power station is situated. From here a length of a mile is built on the rack system, ascending nearly 1,000ft., with a maximum gradient of 25 per cent. At one point the line is crossed by the road to Engelberg. The road being on a gradient, and lying slightly higher than the line, a draw bridge (shown in the illustration) had to be erected over which the road passes. The last portion of the line is mainly on the level, the rack ending about 1¼ miles below Engelberg. Room had to be made for the line in the last two miles by blasting away the rocks above the road, causing a series of sharp curves, the sharpest of which have a radius of 164ft.

Metre gauge (3ft.—3·4in.) is employed, the rails being of the ordinary Vignoles type, and weighing 26kg. per metre (52·3lbs. per yard). The length of each section of rail is 35ft., and there are 11 sleepers to the section. The sleepers are of rolled steel, and weigh 66lb. a piece. The rack is a so-called ladder rack, consisting of two parallel girders of rolled steel, into which the teeth are riveted. It weighs 105lbs. per yard, and is laid in 11½ft. sections. At the beginning and end of each steep gradient where a rack is employed, the end sections of the latter are left 7in. long, and have revolving teeth; these sections are supported at the ends on strong conical springs, so that the rack has here a certain amount of play, and the pinions can engage without rising out of it. The rails which form the third wire of the three-phase system are bonded at the joints by 8mm. Chicago bonds, being cross-connected at every fifth joint.

The stations are neat little brick and wood buildings, containing a booking-office, waiting-rooms and a goods shed. A carriage shed for eight cars, and a repairing shop, are situated at Stansstad. Both stations and repairing shops are lighted electrically, and the machine tools in the repairing shop are driven by a 5 H.P. induction motor, to which current is supplied from the trolley line through three step-down transformers.

Water-power for running the line is collected from a series of small springs which fill a reservoir of 660,000 gallons capacity, from whence a pipe line, 1,790 yards long, and buried in the ground, leads to the power station. The first 250 yards of the pipe line is of cast iron, with an inner diameter of 300mm. (11·8in.) and a thickness of 15mm. to 30mm. (0·59in. to 1·18in.). The remaining portion is of wrought iron with the same internal diameter, but a thickness of 7·5mm., 8mm., and 8·5mm. (0·295in. to 0·335in.). The available head is 1,280ft. A most suitable position has been chosen for the power station, viz., at Obermatt, at the foot of the rack, at the point where there is the greatest demand for power. The power-house, to which a locomotive shed is annexed, is built of brick, and contains space for three generating and two exciter sets. Two sets have been erected up to the present. The turbines built by Messrs. Bell and Co., of Kriens, are radial flow high-pressure Pelton wheels, with horizontal shafts. The output of each set is 180 H.P. at 650 revolutions, with a head of 1,250ft., and a flow of 11 gallons per second. The speed is controlled by Messrs. Bell and Co.'s patent high-pressure hydraulic governor. These turbines are directly coupled to three-phase generators of the revolving armature type, generating current at 750 volts and 32·5 revolutions per second. Shunt-wound dynamos of the Manchester type are used as exciters, each coupled to a 12 H.P. high-pressure turbine. They run at 1,700 revolutions per minute,

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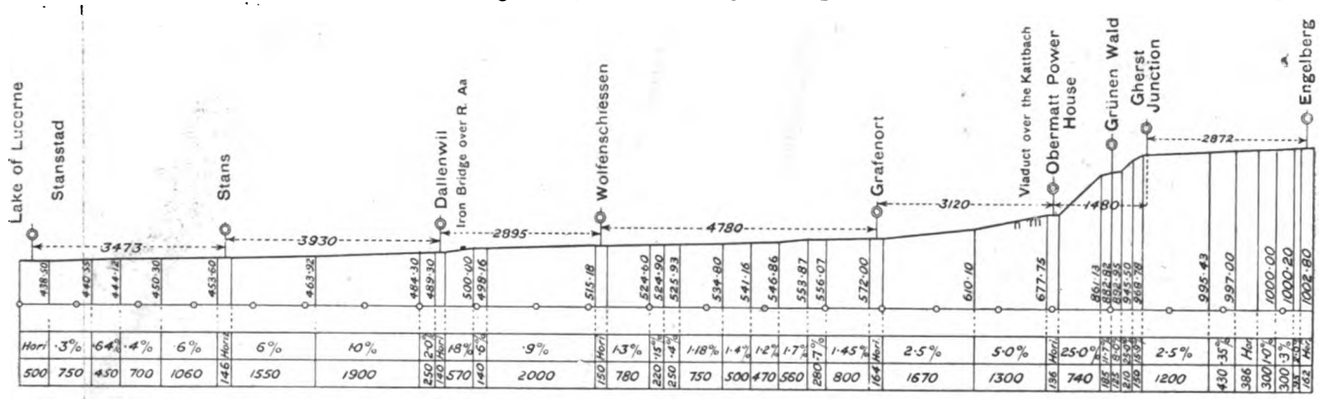
and their electrical pressure is 110 volts. The exciter turbines have no automatic speed regulators, and the exciting current is regulated by means of a rheostat in the field circuit of the main generators.

The switchboard, occupying one end of the machine room, is of white marble, mounted on an iron frame, and it is divided into three panels. The left-hand panel contains the field rheostat, and the exciter switches and measuring instruments.

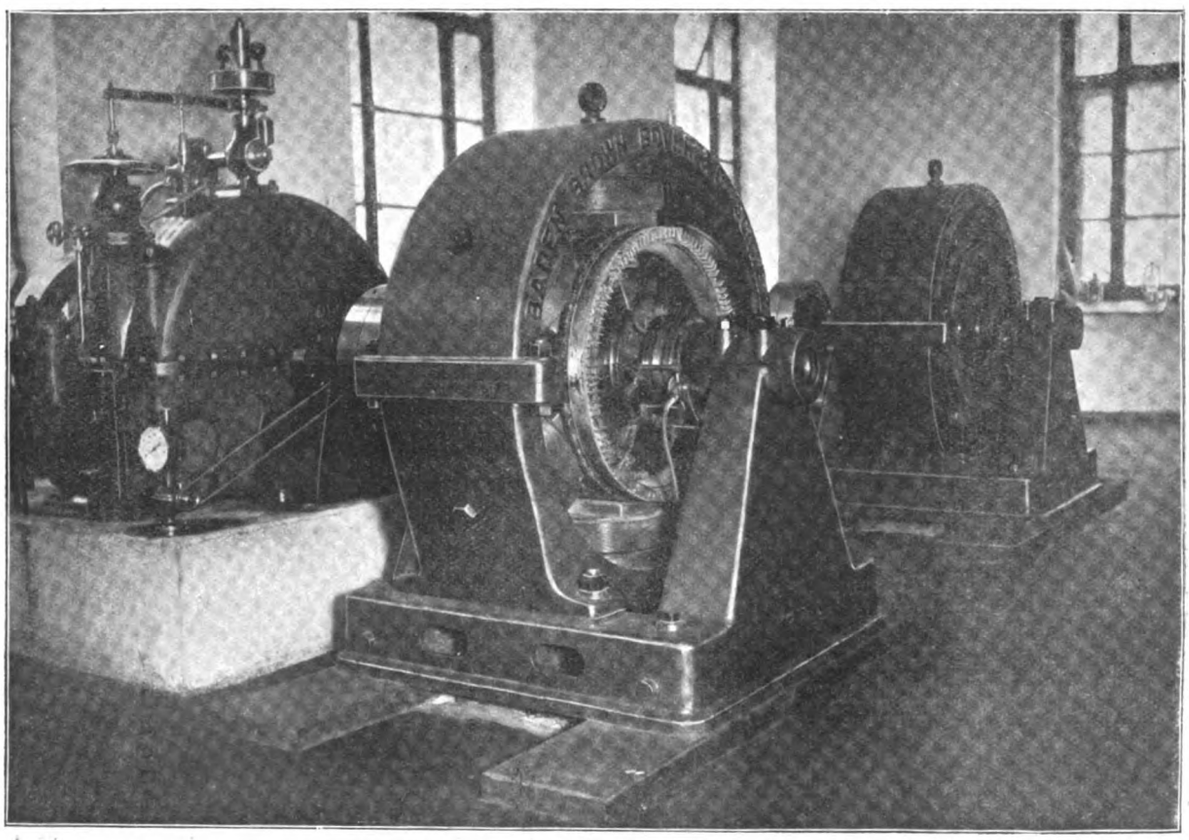


PROFILE OF STANSSTAD ENGELBERG RAILWAY.

NOTE.—The Dimensions are in Metres.

The two generator panels contain each a field rheostat, a three-pole switch, measuring instruments and synchronising lamps. At the top of the exciter panel is placed a three-pole switch for the step-up transformers, while the line and feeder switches are placed at the top of the generator panels. The generators run in parallel on three 'bus bars, and feed the trolley lines and feeders directly at 750 volts. On the back of the switchboard are placed the line fuses. The fuse is enclosed in a strong porcelain tube, at each end of which is a contact piece, so that it forms at the same time both fuse and switch. Behind the switchboard are placed three 30-kilowatt step-up transformers, raising the voltage from 750 to 5,200 volts. Here also is placed an automatic switch for interrupting the exciter current in case of an earth on the high-tension line. This was a stipulation made by the Federal Railway Department of Bern, as the high-tension line of 5,000 volts runs along the line for a distance of nearly seven miles.

The two trolley wires are of 7·5mm. hard-drawn copper wire suspended 8ft. 2in. apart and 13ft. 9½in. above the rails chiefly from span wires stretched between stout wooden poles. These poles also carry the low-tension feeder lines consisting of two 7·5mm. hard-drawn copper wires supported on double petticoated insulators. There are 2·6 miles of single feeders situated between Grafenort and the top of the rock, the section of the line where the power absorbed is greatest. The whole line is divided by section insulators into five insulated sections,



THREE-PHASE GENERATOR AND HIGH-PRESSURE TURBINES AT THE OBERMATT POWER STATION.

so that each section can be supplied with current independently of the rest of the line. At these points the contact lines are connected to the feeders by means of fuses of the same type as those used in the central station, the fuses being placed in watertight iron boxes screwed to the poles. As has been already stated, the high-tension line covers a length of

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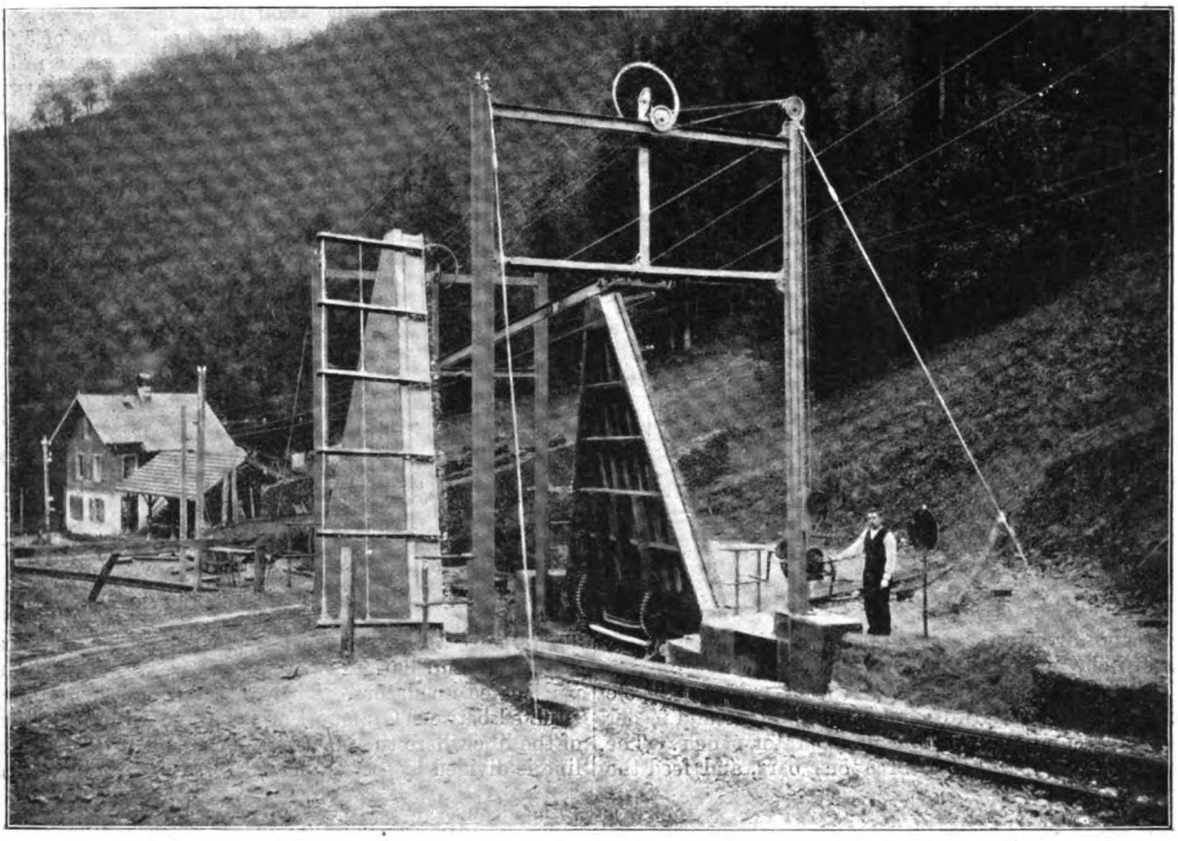
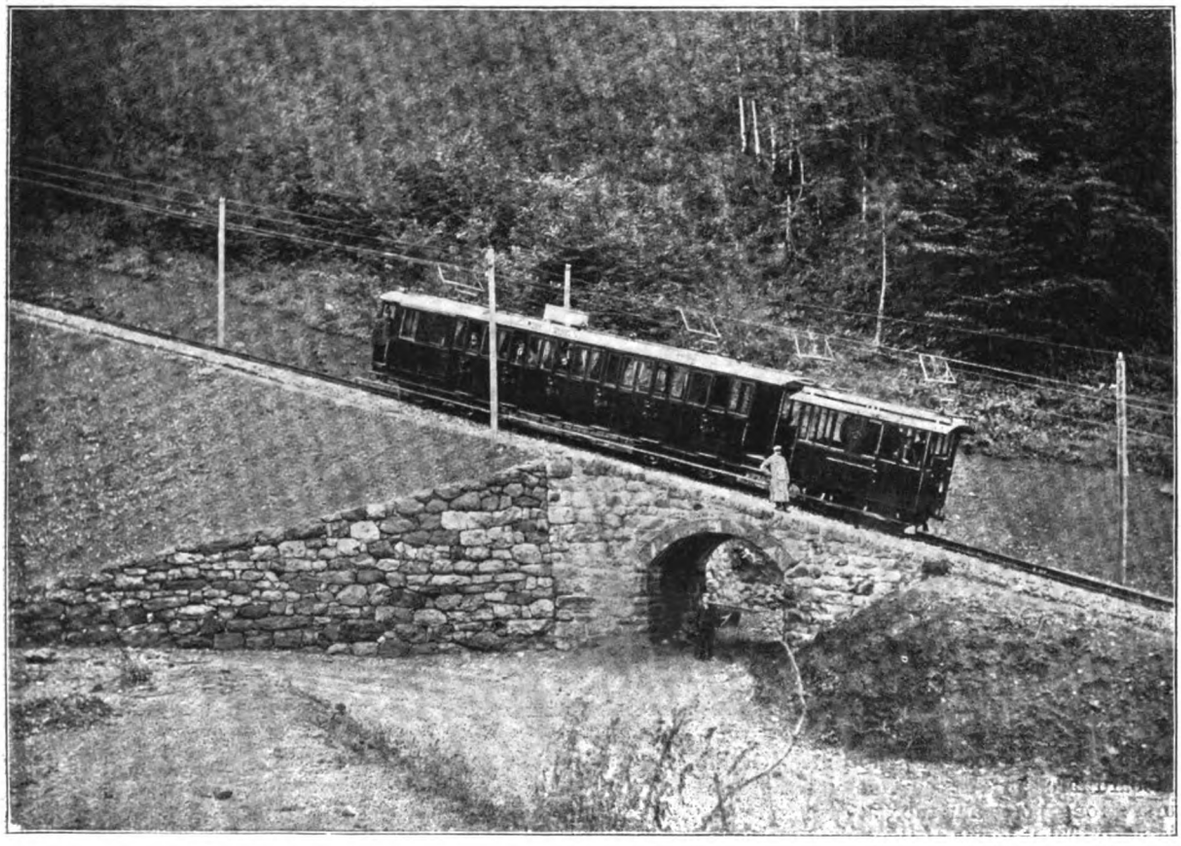


DRAWBRIDGE AT GRÜNENWALD.



TRAIN ON 25 PER CENT. GRADIENT.

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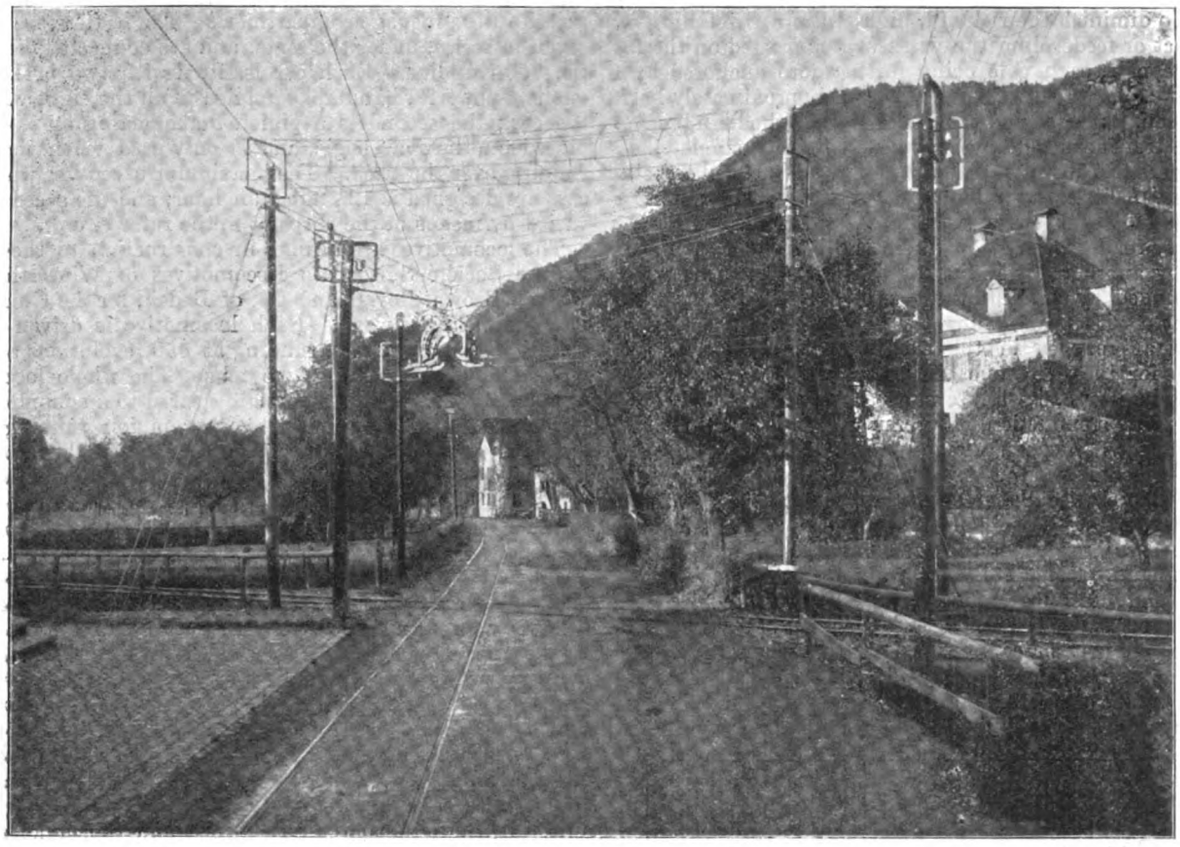
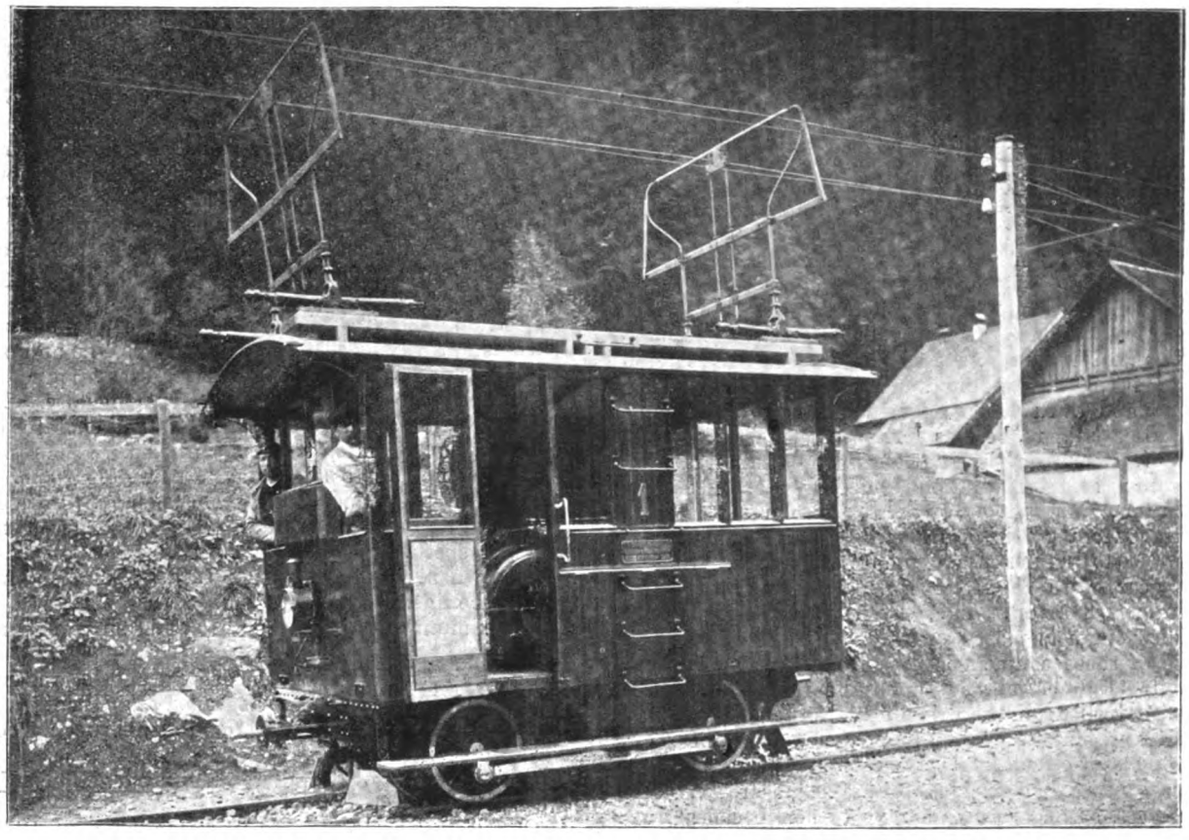


CROSSING OF RAILWAY BY THE STANSSTAD-STANS TRAMWAY.



VIEW OF LOCOMOTIVE.

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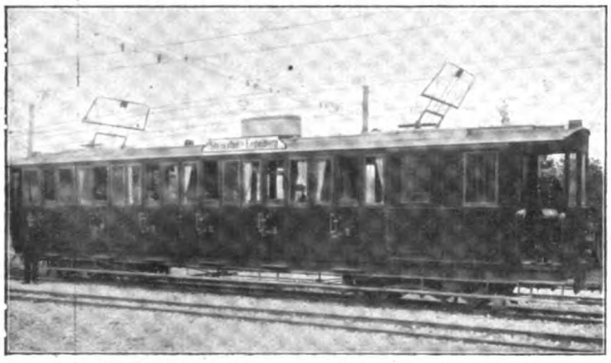
nearly seven miles. It is formed of three 3·5mm. hard-drawn copper wires, supported on separate poles along the track. To diminish the risk of a high-tension wire falling on the contact or feeder line the wires are supported on the far side of the pole, each pole being furthermore anchored by a stout iron cable. At Dallenwyl, a point approximately half-way between Stansstad and the power station, the high-tension current is transformed down by three 80-kilowatt, single-phase transformers to 750 volts, and the trolley wire is fed directly from these. A little tower built on the transformer chamber carries the high and low-pressure fuses.

At every road crossing, or where the high-tension line is crossed by another power line or telephone line, the wires are surrounded by a wide mesh net of galvanised iron wire, to prevent a wire from falling to the ground. The trolley-line poles are capped in the cast iron discs, carrying two insulators for the telephone circuit, which is a loop line of 2mm. silicium-bronze wire, crossed every 100 metres (109 yards) to prevent induction disturbances. It has been found that, so long as the insulation of the line is good, the telephone is nearly free from any induction noises. The State telephone line between Engelberg and Stansstad runs through the greater part of the valley parallel to the railway, divided from it by the breadth of the road only. It is only on wet days, when the leakage is naturally large, that a slight buzzing sound is heard; for the rest no more than the ordinary noises common to long distance telephony are noticeable. Great precautions had to be taken to protect the line against lightning discharges. The 750-volt lines are protected by Wurts patent lightning arresters, made by the Westinghouse Company, the high-pressure line by forked



Motor-Car on Stansstad Engelberg Railway.

lightning arresters placed at each end of the line, and each telephone by fuses and a short-gap lightning arrester. A point of interest on the line is the crossing with an existing continuous-current tram line near Stans, shown in the illustration.

The rolling stock consists at present of five motor-cars and two locomotives. The former, built by the Société Industrielle Suisse of Neuhausen, are four-axle bogie cars, having a length of 46ft., and weighing, unloaded, 14 tons. They have second and third-class compartments, and are capable of seating 46 passengers, besides having a luggage and mail compartment. The front bogie carries two 35 h.p. induction motors, running at 480 revolutions and 750 volts, and weighing about a ton. These motors are suspended by two double helical springs from the bogie frame, half the weight resting by means of two bearings on the driving axle. Single-reduction gear, with cast-steel wheels, is used, the gear running immersed in oil. The current is collected by two double sliding contacts placed on the roof of the car. The spring-base of these contacts is so arranged as to allow the sliding contacts to be laid flat upon the roof. The stator current is controlled on the driver's platform by a two-way switch under which are placed four enclosed high-tension fuses for the stator circuit of both motors. The third end of the stator winding is connected to the bogie frame. The rotor current is collected by double carbon brushes from the slip-rings, from whence it passes to the rotor resistance placed on the roof. The resistance is worked by a lever placed above the controller on the driver's platform.

The cars are heated and lighted electrically, current for the lighting being supplied at 100 volts by a small transformer placed in the luggage compartment. The heaters are placed, seven in series, under the seats, and are connected directly to the 750-volt line. Each car is fitted with two brakes: the one is a powerful handbrake applied to all the eight wheels of the car; the second is a pinion brake, acting on the pinion placed on the rear bogie, and is only used when the car is running over the rack. The maximum speed for which the cars are designed is 12½ miles an hour, and the speed is only varied by means of the rheostat in the rotor circuit.

The locomotives are similar in construction to those built by the Société Suisse des Locomotives of Winterther and Messrs. Brown, Boveri and Co. of Baden, for the Gornergrat and Jungfrau Railway.* Each locomotive is driven by two 75 h.p. induction motors, running at 650 revolutions and 750 volts, and each weighing two tons. The whole locomotive weighs 12 tons. Both motors are geared to a common shaft, which is again geared to the driving pinion running in the rack. The gearing is so dimensioned as to give the locomotive a speed of 3·1 miles an hour on the rack. By means of a friction coupling and connecting rod the motors can be geared to the driving wheel, making it possible to run the locomotive at a speed of 7½ miles an hour on the adhesion line. The rotors are controlled by a reversing switch in the stator-circuit and a common resistance in the rotor circuit. Three independent brakes are in use. The first is a hand-brake acting on the driving wheels. The second is a hand-brake, acting by means of four gunmetal shoes pressed on two wheels keyed to the driving pinion. The third is an automatic brake, which acts as soon as the speed of the locomotive exceeds 4¼ miles an hour on the rack. It consists in the main of a centrifugal governor keyed to the motor-shaft, which on acting releases a catch. By means of a falling weight the switch in the stator circuit is opened and the brake spindle coupled to the motor-shaft, so tightening the brake shoes on the driving pinion and on a pinion placed loose on the rear axle of the truck. By means of this brake it is possible to stop a train weighing 28½ tons and going at a speed of three miles an hour on the 25 per cent. gradient in a distance of 20ft.

The method adopted for working the line is as follows:—The motor-cars, which are designed of sufficient power to draw a trailer (a total weight of 26½ tons) up to a gradient of 2·3 per cent., run as far as the foot of the rack at Obermatt at a speed of 12½ miles an hour. From Obermatt the car is pushed up the rack, at a speed of 3·1 miles an hour, by one of the locomotives, and from the end of the rack the train runs on to Engelberg at the maximum speed and without the assistance of the locomotive. The down-coming train is coupled at the head of the rack to the locomotive, the coupling being released as soon as the train is on the 25 per cent. gradient, so as to be able to stop the car in a case of emergency independently of the locomotive. As the weight of the down-coming train tends to raise the speed of the motors above synchronism, so giving current back into the line and causing the turbines to run unloaded at an increasing speed, it was found necessary to load the generators artificially. This is done by inserting a water resistance in the generator circuit as soon as a down-coming train is signalled. This resistance is so dimensioned as to absorb a little more than the power given back into the line, so that the generators are loaded with a small surplus to enable the turbine regulator to keep the proper speed. The insertion of this resistance is only necessary when the down-coming train is the only moving object on the line.

The maximum capacity of the power station at present is as follows:—

1. One train, consisting of a loaded car and locomotive, *i.e.*, 28½ tons, on the rack between Obermatt and Ghent.
2. One loaded car, weighing 16½ tons, between Obermatt and Grafenort.
3. One loaded car and trailer, weighing together 26½ tons, between Grafenort and Stans.
4. One loaded car, weighing 16½ tons, between Stansstad and Stans.

* See *The Electrician*, Vol. XLI., p. 708.

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To be able to meet the large traffic during the summer season, it is contemplated to enlarge the capacity of the power station to a maximum of 600 H.P., and to order three more motor-cars and one locomotive. The demand for facilities for transporting goods is increasing, and five goods cars are at present under construction, bringing the total up to nine.

In conclusion, our thanks are due to Herr H. Hänsler, who superintended the construction of the line for Messrs. Locher and Co., and who kindly supplied our representative with much of the information contained in this article.

THE POST OFFICE LONDON-BIRMINGHAM UNDERGROUND TELEPHONE CABLE.

Somewhat over a year ago* we notified the fact that the Post Office was laying an underground cable from London to Birmingham to supplement the existing overhead telegraph and telephone lines. We gave then a brief description of the cable, but by the courtesy of Mr. W. H. Preece, and with the assistance of Mr. G. W. Hook, who has charge of the laying of the cable, we are now able to publish further particulars and details, and to describe the methods employed for laying and jointing. The cable employed at first was a 76-wire cable, the separate wires being laid up in fours, but, after the first 20 or 30 miles had been laid, a 76 wire cable with wires laid-up in pairs was employed in preference. The remainder of the cable may, therefore, be described as follows:—

Copper conductors, 97 mils. diameter, weighing 150lbs. per mile, and with a resistance not greater than 5·852 ohms per mile at 60°F. Each conductor is insulated with a longitudinal wrapping of paper, and laid up in pairs, there being a strip of paper dividing the two wires of each pair. The "lay" in twisting the pairs is 1½in. The pairs are cabled in layers of 1, 6, 12 and 19 to make up the complete 38-pair cable, and between each layer and between the last layer and the lead sheathing is a lapping of paper tape. It is a noteworthy feature that no cotton is employed in the cable, in fact, no insulation of any sort except dry paper and air. After the cable has been thoroughly dried it is lead-covered, the lead sheathing having a thickness of 160 mils., and the diameter over all is slightly over 2½in. The whole of the cable is of the British Insulated Wire Co"s manufacture. Under the specification the capacity must be less than 0·065 microfarads per mile, and the insulation resistance above 10,000 megohms per mile; but, as a matter of fact, the insulation resistance is greatly in excess of the latter figure, some tests on laid and jointed cable having given 28,000 megohms per mile. Such a high insulation resistance is not by any means exceptional for paper-insulated telephone cables, but that it should have been maintained on a length of several miles of cable reflects great credit on the manner the jointing has been carried out.

The route along which the cable is laid is as follows:—Leaving London by the Edgware-road, which it meets at Cricklewood, it runs to Watford, entering the telegraph office there, thence through King's Langley and Hemel Hempstead to Leighton Buzzard, from which place also the lines can be used. Continuing, the line passes Fenny Stratford, Stony Stratford, Towcester, Weedon, Southam, Leamington, Warwick, and Hockley Heath, entering Birmingham by the Old Stratford Road. Besides Watford and Leighton Buzzard, there are stations at Fenny Stratford, Weedon and Leamington. At these places the cable from both sides ends in cast-iron cable-heads, whence it is brought to test-boards, where the wires can either be connected through or, by means of paraffined cotton wires, to the operating room.

FIG. 1.—CABLE READY FOR DRAWING-IN, SHOWING CLIP.

Three-inch cast-iron socket pipes carry the cable. These are laid in 9ft. lengths, and jointed with lead in the usual way. The cable being in 152-yard lengths, of which one yard is left over at each end for jointing and slack, a discontinuity in the pipe 4ft. 2in. long is left at the end of each 150-yard section of the route. This is afterwards bridged by a cast-iron sleeve, as will be explained. The pipes are laid at a depth of 2ft. under the footways and 2ft. 6in. under the roadways, with a wire for drawing in the pulling rope. In the event of a breakage in the wire, or a similar mishap, sweeps' rods are used to thread the pipe.

The whole line between London and Birmingham (about 112 miles) has not yet been completed. The pipes have been

The Electrician, Vol XXXIX., p. 596.

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laid as far as Leamington, and the work of laying them between Leamington and the Birmingham Post Office is progressing, being divided in three sections. Cable has been drawn in up to three miles north of Weedon, and jointed completely up to two miles south of Weedon, *i.e.*, about 78 miles from London. Between London and Fenny Stratford, where some important road-lines meet, it is already working, and it has proved of considerable assistance as a reserve

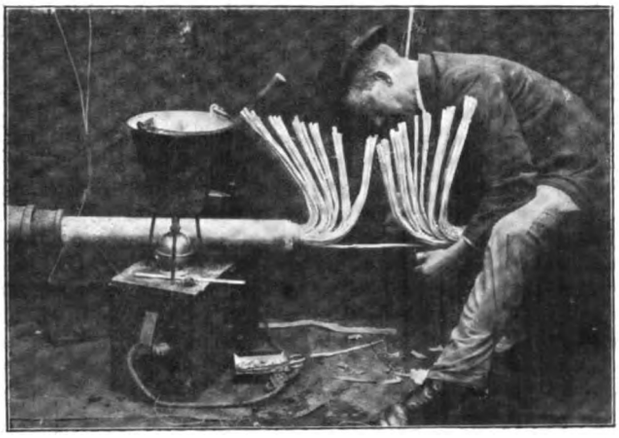

FIG. 2.—JOINTING THE FIRST PAIR.

during the recent gales. By the middle of next month it will be in working order as far as Weedon, where the route crosses the West Coast land-lines.

A very thorough system of jointing is in use, all the details having been carefully thought out by the engineering staff of the Post Office. The cable is drawn in by a rope attached to a clip, seen in Fig. 1, which is screwed on to the cable end.

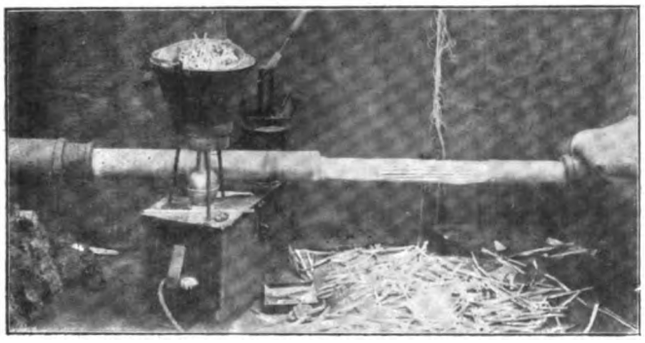

FIG. 3.—WIRE-JOINTS COMPLETED.

After having been drawn in, the end on which the clip was fastened is cut off, and the cable immediately sealed with a lead disc. This is done on account of the highly hygroscopic nature of the dielectric, the cable having to be sealed from access of the air from before it leaves the factory to the moment the joints are to be made. Before commencing the joint, a sleeve of 8in. 7lb. lead soil pipe is passed over the

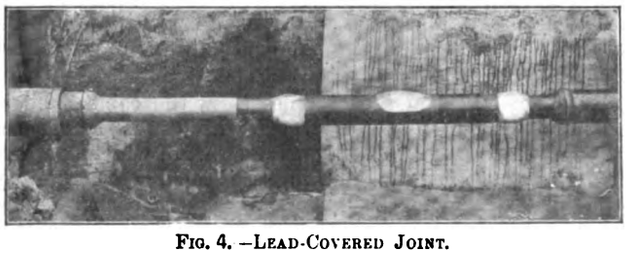

FIG. 4.—LEAD-COVERED JOINT.

cable, and a cast-iron sleeve over the iron pipe sufficiently long to bridge the gap after the cable-joint has been completed. The ends of the cables are then opened and separated, and the conductors jointed in the usual manner, wire by wire, pair by pair, and layer by layer. Before each copper joint is made, a paper sleeve is passed over one of the two wires and this is drawn over the completed joint. Fig. 2 shows the joint in process of construction. The sleeves are kept dry until wanted, by being placed in a tin in a bucket (seen in the illustration) which is heated by a spirit lamp. After all the wires have

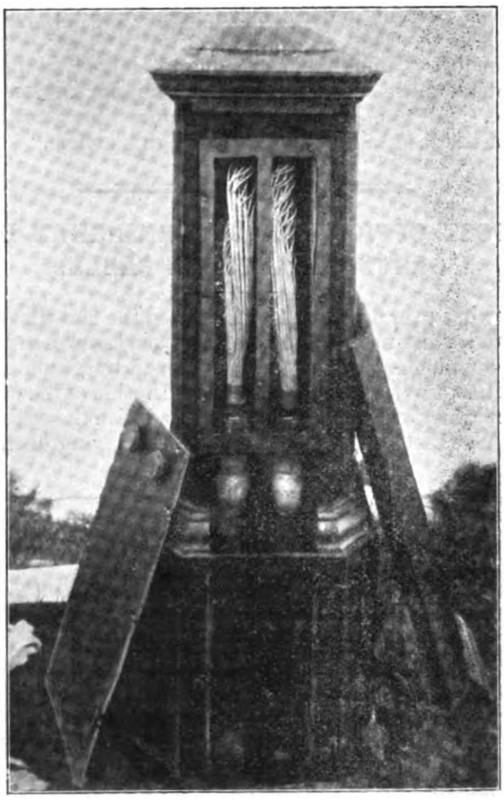

FIG. 5.—TEST-PILLAR (BACK).

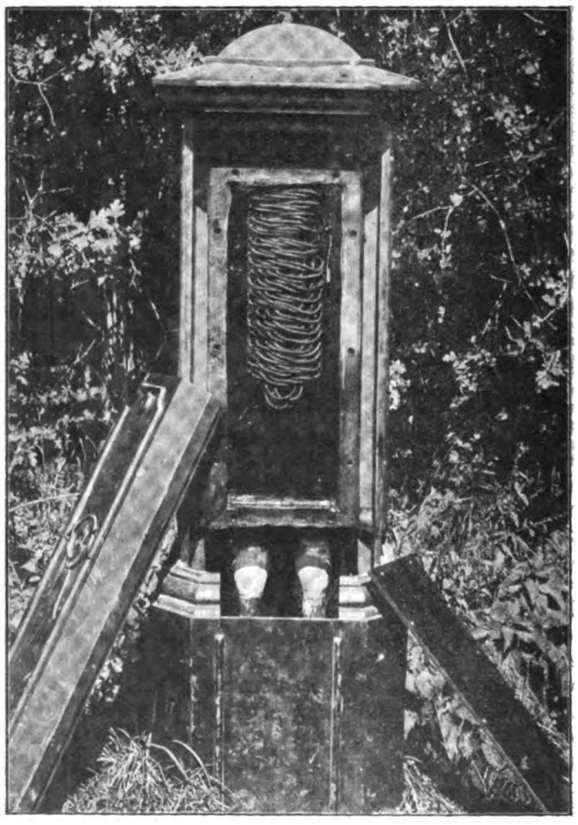

FIG. 6.—TEST-PILLAR (FRONT).

been dealt with, the joint presents the appearance shown in Fig. 3. It is then covered with a layer of paper tape and dried by heating it with a charcoal brazier until a piece of looking glass held over it indicates that no more moisture is coming off. The

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time required for this drying process varies, of course, with the state of the weather. On a fine, dry day an hour is sufficient. The lead sleeve is then drawn over and jointed to the lead cable on each side by a plumber's joint. There is a small slit on the top of the lead sleeve, so that if necessary the joint can again be dried before this slit is sealed by another "wiped" joint. The completed joint is seen in Fig. 3. The iron sleeve is then pulled over it and jointed to the iron pipe on either side by a yarn and lead joint, just as the pipe itself.

After each day's work a test is made by the foreman to see that the wires are jointed properly in pairs, and a rough insulation test is made with a horizontal galvanometer and a 450-volt portable battery. If any indication of leakage is obtained on the galvanometer, the slit in the lead sleeve is reopened and the joint dried further. About every week a mirror galvanometer test of the insulation resistance is made.

There are test pillars placed at intervals of five miles along the route. As seen in Figs. 5 and 6, these resemble ordinary pillar boxes in outward appearance. Fig. 5 shows the back of the cable-head, where the cables are brought in, and Fig. 6 the front, where cross-connections are made. The cables are brought through brass sleeves in the cable-heads, and jointed to them by plumber's joints in the usual manner, the covers of the cable-heads also making an air-tight joint. Vulcanised rubber wire is used for the connections on the front of the cable-head. Up to the present no necessity has been found for utilising the dry air circulation method of drying the joints. If it is found that faults develop, however, arrangements will be made for pumping dry air through the cable at these testing-points. It has been found by experiment that air can be pumped through three miles of the cable, with a pressure of 36lb. per square inch.

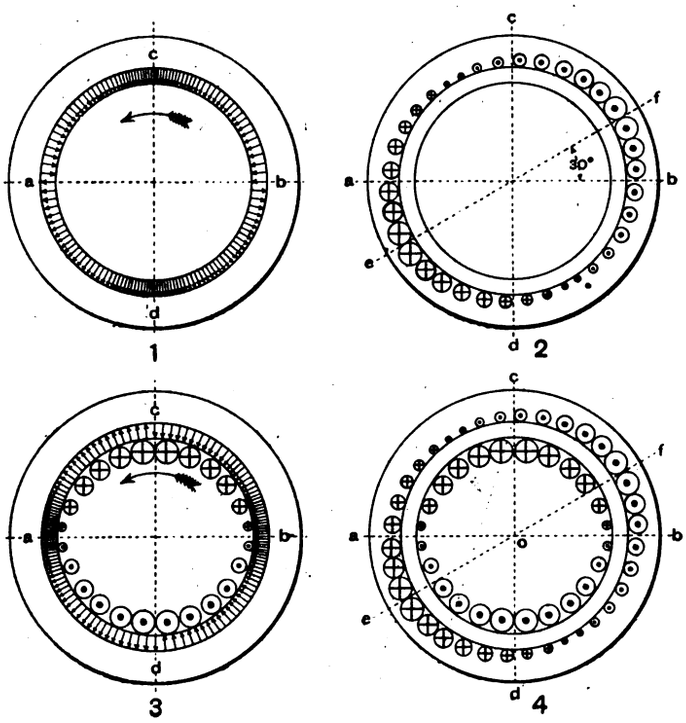
INDUCTION MOTOR DIAGRAMS.

BY C. C. HAWKINS, M.A.

Although the numerical quantities involved in induction motors are of such different magnitude that it is difficult to obtain exact determination in practical cases by means of diagrams, yet the graphical method remains the best means of gaining a clear insight into their working. The analysis of the induction motor by this method follows the same lines as the analysis of the transformer; the chief difference being that the magnetising current in the motor must be much greater than in the transformer, owing to the necessary air-gap in the magnetic circuit of the motor. Both cases have been treated at length by Mr. Steinmetz in "Alternating-Current Phenomena," and in England Mr. Atkinson's recent Paper before the Institution of Civil Engineers has again directed attention to the graphics of the induction motor. Yet with these exceptions (and the present writer acknowledges his indebtedness to them in particular), the graphical method has seldom been fully described, so that a more detailed building-up of its principles, accompanied by numerical illustrations, may still find a place.

(1) *Load Diagrams without Magnetic Leakage.*

For the sake of simplicity we assume at the outset that all magnetic lines due to the primary or field-winding pass through the secondary or armature-winding, and, similarly, that if the secondary were converted into a primary and excited, all its lines would pass through the original primary; in other words, magnetic leakage is assumed to be absent. The actual field present in the interspace between field-magnet and armature is due to the difference of potential at each point, which results from the magnetomotive forces of the field and armature ampere-turns. Let Fig. 1 represent a resultant two-pole field, such as would exist in an induction motor, at any one moment, as it rotates round the armature in the direction shown by the arrow. Then the instantaneous currents induced in a squirrel-cage armature are as shown in Fig. 3, where the relative strength of the currents at different positions are indicated by the size of the circles. The secondary ampere-turns so obtained would, if acting alone, produce a magnetic field of which the line of maximum induction, *a b* (Fig. 3), would be at right angles to the line of the maximum induction, *c d*, of the resultant field at the same moment. Evidently, therefore, the impressed ampere-turns of the primary must be of such strength and so placed that at each moment they not only balance the secondary ampere-turns, and so annul the field that these latter would produce, but leave a surplus of magnetising turns which actually produce the resultant field of Fig. 1. The ampere-turns in each case may be mentally regarded as concentrated in a plane coinciding with their line of maximum strength. Thus, in Fig. 3, the secondary ampere-turns may be grouped together in a vertical plane, *c d*, while at the same moment the magnetising ampere-turns which produce the field of Fig. 1 must be symmetrically placed on a plane, *a b*, at right angles to *c d*. In Fig. 5 let OX_μ represent the magnetising ampere-turns required to produce the actual field, and OX_s the secondary ampere-turns at right angles to OX_μ, while OX'_s are the primary ampere-turns required to cancel out OX_s. The completed parallelogram $OX'_sX_pX_\mu$ shows that in order to give the ampere-turns OX'_s, and, further, to leave a net sum of magnetising turns OX_μ, the primary ampere-turns must have the strength and position OX_p, their angle to OX_μ depending on the strength of the secondary



FIGS. 1, 2, 3 and 4.

ampere-turns (in the diagram 30°). Transferring this to a diagram similar to Figs. 1 and 3, we obtain Fig. 2, which shows the general disposition of the primary ampere-turns which must be produced by the several phases of current in the field-winding.* These cannot produce their full effect at right angles to *e f*, owing to the interaction of the secondary turns, and, as Fig. 5 shows, the general effect of the armature currents is to shift the line of maximum induction more nearly towards the line of maximum primary ampere-turns, and to reduce the strength of field everywhere below that which would be produced by the field-winding if acting alone.

If both sets of ampere-turns are filled in as in Fig. 4, one sees more plainly how the secondary ampere-turns are counterbalanced by the field-turns, and in order to fulfil more nearly the condition of no magnetic leakage, the air-gap should be reduced to a mere line, so that the layers of opposing currents clearly overlap each other. Thus Fig. 6 shows a pair of poles of a multipolar two-phase motor, equivalent to Fig. 4 split open along *d d*, with one circuit (shown by the full

* The actual currents in a two- or three-phase motor will not vary so gradually as shown, but the combined effect of the two or more phases must be the equivalent of the field-currents shown. Cp. Figs. 4 and 6.

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circles) carrying the maximum current, while the other circuit (shown dotted) carries zero current; the phase angles are marked in terms of a complete period, and the diminishing or increasing sizes of the armature wires indicate the rise or fall of the current according to their position on the sine curve of the field in which they are immersed.

Fig. 5, like Fig. 4, was drawn to represent diagrammatically the complete system of a motor at some one moment, and, starting from this point, if Fig. 5 or the wires of Fig. 4 be rotated at the speed of the rotating field, they will still give a true representation of the condition of the motor at any other

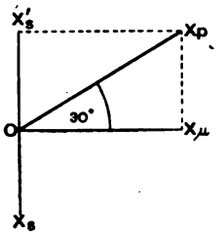

Fig. 5.

moment. But Fig. 5 can also be read as a clock diagram for the whole motor, applicable to a certain fixed diameter; if the lines OX_p, OX_μ and OX_s be regarded as rotating round O in the direction of the rotating field, *i.e.*, positively or counter-clockwise, and at its speed, their projections upon the vertical axis represent the instantaneous strengths of the primary, resultant and secondary ampere turns along any one diameter or line joining two poles in the armature, *e.g.*, as drawn in Fig. 5 along the vertical diameter *c d* of Fig. 1. The field due to OX_μ has such a direction across the armature that when OX_μ at any point is passing through zero

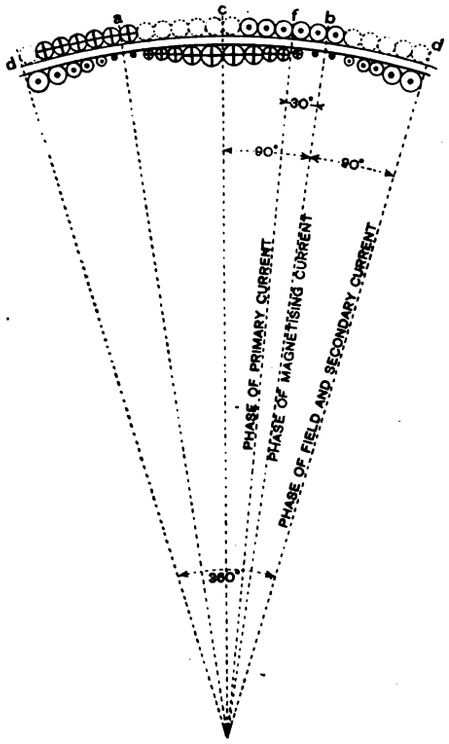

Fig. 6.

from a – to a + value, the current in the secondary wire at that point is passing through a – maximum to zero; hence OX_s lags 90deg. *behind* OX_μ, and the component OX'_s must, therefore, be ahead of OX_p. When so interpreted, the instantaneous values of OX_μ, OX_p and OX_s no longer remain constant, but vary after a sine law.

So far the representation in both cases is independent of the number of phases in the field or armature. We are, however, not so much concerned with either the spacial position of the total ampere-turns in the motor or with their instantaneous strength along any one fixed diameter; the coils of any one phase or circuit of the field are indeed fixed, but what we require to know is the current and voltage in them separately, and not the general effect of all the phases. In order to pass from the motor as a whole to one out of the two or more phases it is only necessary to alter the scale of Fig. 5 and interpret it as follows: If the length of the rotating line OX_μ represents the maximum strength of the magnetising current in one phase which, together with the simultaneous magnetising currents in the other phases, gives the resultant field, then the projection of OX_μ upon the vertical will give the share at any moment which the one phase of the field-winding takes in magnetising; *e.g.*, in a two-phase motor, when the projection of OX_μ on the vertical is zero in one phase, the field is due to the other phase and is still proportional to OX_μ. Similarly, OX'_s must be drawn to represent the maximum value in one phase of the current component by virtue of which that phase develops its proportionate share of the horse-power. The phases of OX_μ and of the field so far as it is due to OX_μ alone would coincide in point of time, but when OX_μ in one phase is zero the resultant field is acting, and OX'_s in the same phase is a maximum; it must therefore be plotted, as before, 90 deg. ahead of OX_μ. The rotating resultant field remains uniform as a whole, but since its distribution is assumed to be sinusoidal, and it has the same periodic time as the primary current, it induces in the coils, both of the field and armature, a sine wave of E.M.F. which has a phase and lags 90deg. behind OX_μ. As this E.M.F. in the field-winding is in the negative direction or is a counter E.M.F., it must be balanced by a component of the impressed E.M.F. in the positive direction, and this component will hereafter be called the "back" E.M.F., since it is required to balance the actual back E.M.F. induced in the field-winding. Thus Fig. 5 equally well represents the instantaneous strengths of current in any one phase of the field-winding.

Finally, as we only require to know the *relative phases* of the various current- and voltage- components, since these remain unchanged so long as the load remains constant, a single diagram suffices for each load, and it is permissible to plot either the maxima or the effective values of the components. It now remains to consider how the graphical diagram for one phase or circuit of a motor with no magnetic leakage is to be drawn for any load; and at the outset it must be pointed out that, owing to hysteresis, the preceding statement that the phases of OX_μ and the field due to it coincide is not absolutely true, although for a preliminary general explanation it is sufficiently accurate.

(*To be continued.*)

GRAVITY-ELECTROLYTIC PROCESSES FOR THE PRODUCTION OF CAUSTIC SODA.

BY G. H. ROBERTSON, F.C.S.

Processes for the production of bleach and caustic soda by the electrolysis of a solution of common salt are exceedingly numerous, but it is evident from the attention which the matter still receives at the hands of inventors that a thoroughly satisfactory solution of the problems involved in conducting this operation on a commercial scale has not yet been obtained. In the early days, effort was mainly directed to obtaining a satisfactory diaphragm which should keep the anions and cations, separated by the current, from recombining. Then the anodes were thought to contain the key to the situation, and much ingenuity was expended in endeavouring to cheapen the cost of their production, and render them less destructible by the products of electrolysis. But it was realised at last that what was wanted was some method for removing the anions and the cations from the bulk of the solution as fast as they were separated by electrolysis, and in order to effect this Kellner introduced his well-known process in which a moving mercury cathode combines with the alkali metal as soon as it is released, and transfers it to a second vessel containing water, in which the metal forms caustic

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soda, while the E.M.F. due to this reaction goes to aid the E.M.F. which is required to decompose the salt solution. Other processes of this kind have been introduced, but mercury is costly, and there are other objections to its use, so attempts have been made to devise processes in which the continuous separation of the anions and cations should be effected by the force of gravity instead of that of chemical combination. The latest of these is that which has been recently introduced by the Oesterreichischer Verein für Chemische und Metallurgische Produktion, in Bohemia. Before describing it, it may be as well to give a short account of the principal processes of the kind which have preceded it, and the disadvantages from which they are alleged to suffer.

The earliest of these was that devised by Cuttens in 1892. He employed a pump to remove the chlorine as soon as it was formed, while the caustic solution which is formed round the walls of the cell (cathode) was allowed to sink to the bottom by its own gravity, from whence it could be drawn off at intervals. During this process, strong salt solution is forced into the lower part of the cell at a point below the cylinder which surrounds the anode, and ascending this, it leaves the upper part of the cell to be strengthened by passing over rock salt. In this process the layer formation of the electrolyte due to the difference in density between the anions and the cations is destroyed, owing to the disposition of the anodes, and the way in which the electrolyte is fed in, and the projection of the anodes contracts the space in which the layers can be formed.

Four processes were introduced in 1893. G. Baily and M. Guthrie suggested a process in which a pair of very porous screens were interposed between the anode and cathode so as to enclose a space into which the electrolyte was fed continuously, and overflows were arranged near to or behind the electrodes. The electrolyte was intended to flow from the centre to the electrodes at such a rate as to prevent diffusion, but there was a difficulty in effecting this, and the solutions of different density into which the liquid was separated by electrolysis would not maintain a vertical position, but tended to form horizontal layers with consequent intermixture.

Hurter, Auers and Muspratt introduced a density process, but the apparatus hinders the formation of layers, as, owing to the position of the anodes and the use of the whole of the cell wall as cathode, the evolution of gas from anode and cathode must generate movement of the liquid which will destroy layer formation. Moreover, the process was primarily devised for discontinuous working, and no means were provided for introducing fresh electrolyte into the closed anode compartment, so that if the process were worked continuously with the apparatus described, fresh electrolyte would have to be introduced into the open cathode compartments, which would of necessity break up the layer formation, while the liquid in the anode compartments would become poorer and poorer, with the result that secondary decomposition of water would take place with useless consumption of current.

Richardson, in order to overcome the disturbance of the electrolyte caused by the escape of chlorine gas generated near the bottom of the anodes, proposed to interpose horizontally between the electrodes a screen of slips of glass which overlapped like the slats of a Venetian blind, leaving spaces between them for the passage of the current. The caustic solution collects near the cathodes at the bottom of the cell, and as the process is not arranged for continuous working, the whole of the alkali formed cannot be removed before fresh solution is run in.

Dr. W. Bein brought out a discontinuous process, and arranged the anodes and cathodes side by side in special divisions of the decomposing trough, which communicated under the surface of the liquid. By means of a device the two layers of liquid can be separated, and the operation stopped when the electrolysis has proceeded so far that the cathode liquid is about to enter the anode compartment. The process requires careful supervision, and, moreover, the complication of the apparatus involves technical difficulties. In 1897 this process was rendered continuous by substituting means for continuously supplying fresh electrolyte to the cell at the place where in the older apparatus the valve was situated which maintained the separation of the liquid into layers, and in this way a separating layer is maintained between the anode and cathode liquids. Moreover, the electrolyte thus introduced caused the anode and cathode liquids to move to their respective outlets at a rate proportional to its flow. The advantage which it was hoped to attain by this apparatus—*i.e.*, a continuous working—is not realised, since the admission of fresh electrolyte into the space between the anode and cathode is not favourable for the formation of layers, and it is impossible in practice to so regulate the efflux from the anode and cathode compartments that the quantity flowing away from each shall be in constant proportion, and, in consequence, the working is very irregular. If the influx into the anode compartment be restricted, the liquid therein soon becomes so dilute that secondary decomposition of water ensues, and there is useless consumption of current.

In 1894, Carmichael designed an apparatus based on much the same principle. He employed a specially designed diaphragm which afforded a free communication between the anode and cathode compartments, and the fresh electrolyte was fed in between the anode and the diaphragm so that the alkaline solution passed through to the upper part of the diaphragm, and flowed back through the communication in the diaphragm into the cathode compartment, and thence to the outlet. In addition to the disadvantage occasioned by the use of diaphragms, this process suffers from the defect that the introduction of the electrolyte into the space between the electrodes destroys the layers formed by the separation of the electrolyte into solutions of different density, and the impoverishment of the anode liquid and the consequent waste of current are not avoided.

It is claimed that the new density process, which has been recently introduced by the Oesterreichischer Verein differs from those already described, and avoids their disadvantages. Now when an alkaline solution, particularly a chloride of an alkali, undergoes electrolysis, there is a constant passage of hydroxyl ions towards the anode compartment, while the product of the reaction of the cations with the water collects as an alkaline solution around the cathode, and gradually spreads to the anode compartment; and if the electrolysis is carried too far, the alkali formed around the cathode spreads to the anode liquid, and chlorate is formed which gives rise to injurious secondary reactions. When the alkaline solution has a higher density than that of the electrolyte, and than that of the liquid in the anode compartment, it is obvious that the anode should be arranged at a higher level than the cathode, whereby full use is made of the difference of density between the anode and cathode liquids for separating them, and with them, of course, the products of the electrolysis. By the introduction of fresh electrolyte above the anode, and the consequent circulation of the electrolyte in a direction opposite to that of the migration of the hydroxyl ions, the layer formation is not interfered with, and the alkaline liquid can be withdrawn from an overflow pipe. These principles are embodied in the new apparatus in which the electrodes are placed side by side, and if necessary, at different levels. The anode is covered by a bell which extends below it, and fresh electrolyte is fed into this compartment continuously, while the alkaline lye produced is continuously removed from the cathode compartment, and the layer formation of the anode and cathode liquids is maintained without the use of a diaphragm, so that the products formed at the electrodes are continuously separated. How far the anticipations formed of the new process will be verified in practice remains to be seen.

American Government Cable Steamer.—Orders have been issued by the War Department for the purchase at once of an iron ship of from 1,000 to 1,200 tons burden to lay cables to connect the islands of the Philippines. The Department has already ordered 166 miles of cable for this purpose, which will take about 6,500 cubic ft. for coiling. The cable ship must accommodate on the forward deck, says the *Electrical Engineer* of New York, the "giving out" machinery, which will weigh from 15 to 20 tons, and the accessories, weighing from 5 to 10 tons. The ship is to be kept on station as a cable steamer, or will, if necessary, be used as a transport.

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SOME ASPECTS OF BRITISH ELECTRICAL INDUSTRY.

We publish as a supplement this week our annual Table of the Electric Railways and Tramways of the United Kingdom, giving particulars to date of the lines in Operation, in Progress of construction and Projected. It will be seen that there are 34 lines in operation, 27 under construction, and no less than 93 projected, making a total of 154 lines of all descriptions. At the end of 1897 the numbers were 23 lines in operation, 25 in progress, and 83 projected. Thus there has been an increase of 48 per cent. in the number of working lines, and of 90 per cent. in the total number of lines of all classes. Again, whereas the gross mileage of the lines in operation at the end of 1897 was 140 miles, the mileage of working tramways and railways to-day exceeds 240 miles, showing an increase of 71 per cent. in twelve months. A careful examination of the data afforded by this year's table, and a comparison of these data with the corresponding data for previous years, will show that the British electrical manufacturer and contractor is gradually awaking to the importance of electric traction as an opening for trade, and is receiving a steadily increasing share of this class of work in the United Kingdom. From the first, two or three leading electrical firms have undertaken important contracts, chiefly for the heavier class of lines represented by the City and South London Railway and the Liverpool Overhead Railway, but there is no denying that for some time the foreign manufacturer had it nearly all his own way with street tramway electrical equipment. We have long insisted upon the necessity for the British manufacturer to standardise his electrical equipment in order that he might be able to market his goods at a price that could compete with the highly-standardised American products. It is gratifying to notice that this is now extensively being done by all the leading firms who

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manufacture electric traction plant. There were two obstacles formerly in the way, viz., the lack of experience on the part of the manufacturer as to the best designs to adopt for standardisation, and, secondly, the insistence of each individual consulting engineer on the adoption of the special designs evolved in his own office. The British custom of entrusting the details of an engineering specification to a consulting engineer has many good points, and we do not wish to see it abolished; but there is no doubt that it often possesses features which might advantageously be eliminated. One of these is the free hand the consultant possesses of introducing his own pet ideas—often very costly fads—into the design of the plant to be supplied. The unhappy contractor is thereby put to unnecessary expense, either in submitting two alternative tenders, one including the fads and the other based on common practice, or else in altering the patterns of his plant to suit the innovation. We repeat, we are glad to see very marked indications that all the principal British manufacturers who are making traction plant are standardising sizes and designs; and we regard this as a prelude to a very considerable increase in the volume of British home trade in this class of manufactures. It is also pleasing to observe that the vigorous tone of British trade in traction plant is but one phase of an all-round expansion of British electrical engineering industry. We have alluded on previous occasions to the great activity that prevails in the engineering workshops of the country; and we are assured, in many quarters, that there are indications of a general and permanent expansion of this department of industry. If home electrical industry be any index of the general conditions, these indications, indeed, are not misleading.

Turning now from the home aspect of British electrical industry, let us consider some of the points which have been brought before the public of late in regard to our foreign trade. We may notice, in the first place, the instructive, if somewhat curious, array of consular opinions on the subject recently displayed by our esteemed contemporary, the *Daily Chronicle*. A whole column of that newspaper was filled with extracts from the latest reports from Her Majesty's consuls in various parts of the world. Some 200 reports were searched, and 37 extracts were given, our contemporary remarking in its prefatory paragraph that "the extracts . . . . are by no means exhaustive; there are plenty more to be had of the same tenor." The general tone of these extracts is sufficiently indicated by the following samples:—

Argentine Republic.—Continental merchants are always more willing to meet their customers' wants than British, who will endeavour to foist their ideas and their stock on their customers, without sufficiently heeding the latter's needs. Cases of goods should be marked in kilos and metres. (8648-66, p. 10.)

Brazil (Rio de Janeiro).—The conservative system of British manufacturers often prevents them making new patterns to meet the needs of foreign markets. (8648-80.)

France (Cherbourg).—Notwithstanding the reputation for good make still enjoyed by Great Britain, the difficulty of procuring British-made goods suitable to local tastes, the impossibility of unravelling the mysteries of British price lists, and the absence of all flexibility in British commercial custom, almost close the half-shut door to British imports. (8648-57, p. 5.)

Germany (Dusseldorf).—British commercial men still labour under the old delusion that English weights, measures, classes of goods, tools, implements, and so on, which meet with English requirements and tastes, will work all over the world (8648-68, p. 7.)

Japan (Nagasaki).—English producers have queer notions of enterprise. The English manufacturer, as a general rule, will take no risk. (9044-6, p. 10.)

Netherlands (Amsterdam).—British manufacturers must accommodate themselves more to the needs of their foreign customers. The use of the metric system is imperative. (8648-76, p. 9.)

Norway.—British goods might find more ready sale if manufacturers would take pains to cultivate the market. There are about seven German commercial travellers to one English. (8648-141, p. 15.)

United States (California).—In electro-plate and silver, the stubbornness of the English manufacturers in ignoring the particular requirements of the American market handicaps the sale of English goods. (8648-174, p. 21.)

Broadly speaking, two principal complaints pervade these extracts: firstly, as to the non-adoption of metric currency and measures to suit local trading; and, secondly, as to a certain stiff-necked disregard for local requirements in the class of goods supplied. Where these complaints hit the British electrical manufacturer, we feel sure he will pay attention to the matter; but we do not think there is any ground for the second complaint, at any rate, as regards the generality of these firms. Indeed, through the exceptional willingness of the British contractor to adapt his patterns and designs to the local and special requirements of his customer, he is placed in an especially favourable position to compete in colonial and foreign markets. Thus, while standardisation is desirable at home—to meet the uniformity of home conditions—abroad, the variety, and even heterogeneity, in the conditions places at an immense advantage the manufacturer who is willing to adopt special and local types of design in his manufactures. And, as a matter of fact, the British electrical manufacturer—whether from this cause alone, or, as we suspect, from the general superiority of his wares—still holds the bulk of the colonial contracting work, especially in South Africa. Our contemporary reflects that, notwithstanding the sadness on the consular brow, "we are making wealth at an appalling rate." While not ourselves "appalled," we are willing to concede that the wealth derived from our colonial and foreign engineering trade is rapidly on the increase; and we regard this fact as an indication of the persistent suitability of British machinery—including, of course, every description of electrical plant—to meet local and national conditions in all parts of the world.

OPEN CONDUIT ELECTRIC TRACTION AT WASHINGTON.

Washington, the capital of the United States, has afforded many interesting lessons in tramway traction. The whole of the district of Columbia, which is controlled by the City Council, is well served by tramways, but many years ago the authorities decided to prohibit the overhead trolley system within this territory. Consequently the cable haulage system and the electric conduit system have been very extensively developed there. Indeed, more has been learned in Washington in regard to the construction and working of electric conduits for tramways than in any other part of the world, and the success of the system ultimately evolved has led to its adoption in other American cities, notably in New York. Many of the Washington lines extend beyond the district of Columbia into Maryland and West Virginia, in which two States the overhead trolley is permitted. At the boundary lines these tramways change from the conduit to the trolley system, and thus ample experience has been gained as to the working of such composite systems. It will be remembered that similar composite systems have on several occasions been proposed for British cities, where the tramway systems extend to the rural districts.

One of the most important traction concerns in Washington is the Capital Traction Co., which in 1897 had 36 miles of track, of which 21½ miles were worked by cable haulage and 14½ miles by electric conduit. The gauge is 4ft. 8½in., and the tracks were laid with 50lb. and 80lb. rails. There were 450 cars, of which 25 were electric motor cars, 98 cable grip cars, and 327 trailers. At the power station, the location of which is shown in the map accompanying this article, there was station plant aggregating 1,600 H.P. On September 29, 1897, the whole of this station was destroyed by fire, and the entire cable and electric system was thrown out of gear, the cars having to be temporarily run by horses. Within four days of the fire the directors decided definitely to adopt the underground conduit system for their lines, which had previously

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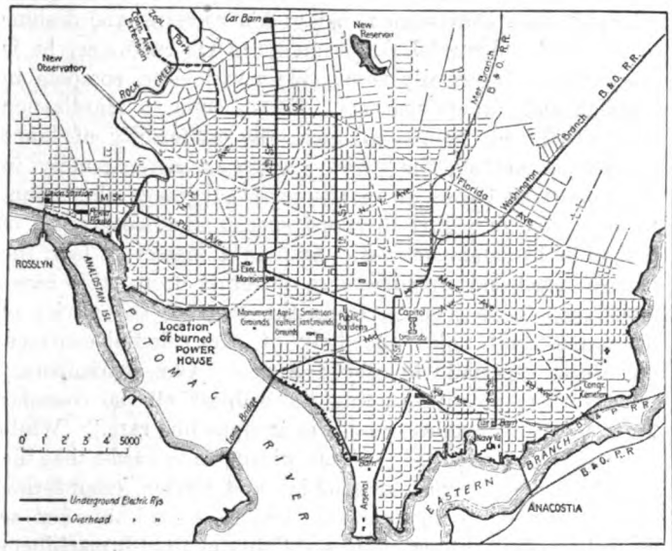
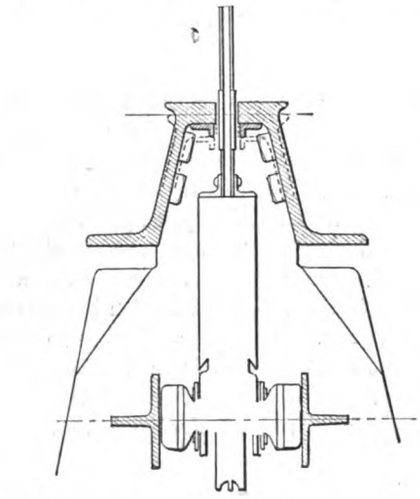
been worked by cable haulage, and thus to work the whole of their system by electricity. Particulars of the electric construction work, both in converting the old cable conduits to the electric system and in the construction of the new power house, have recently appeared in the *Electrical World*, of New York, to which we are indebted for the following details, as also for the illustrations which accompany this article :—

Reconstruction of the Tracks.—The track system adopted was the same as that in use by the Metropolitan Railroad Co.

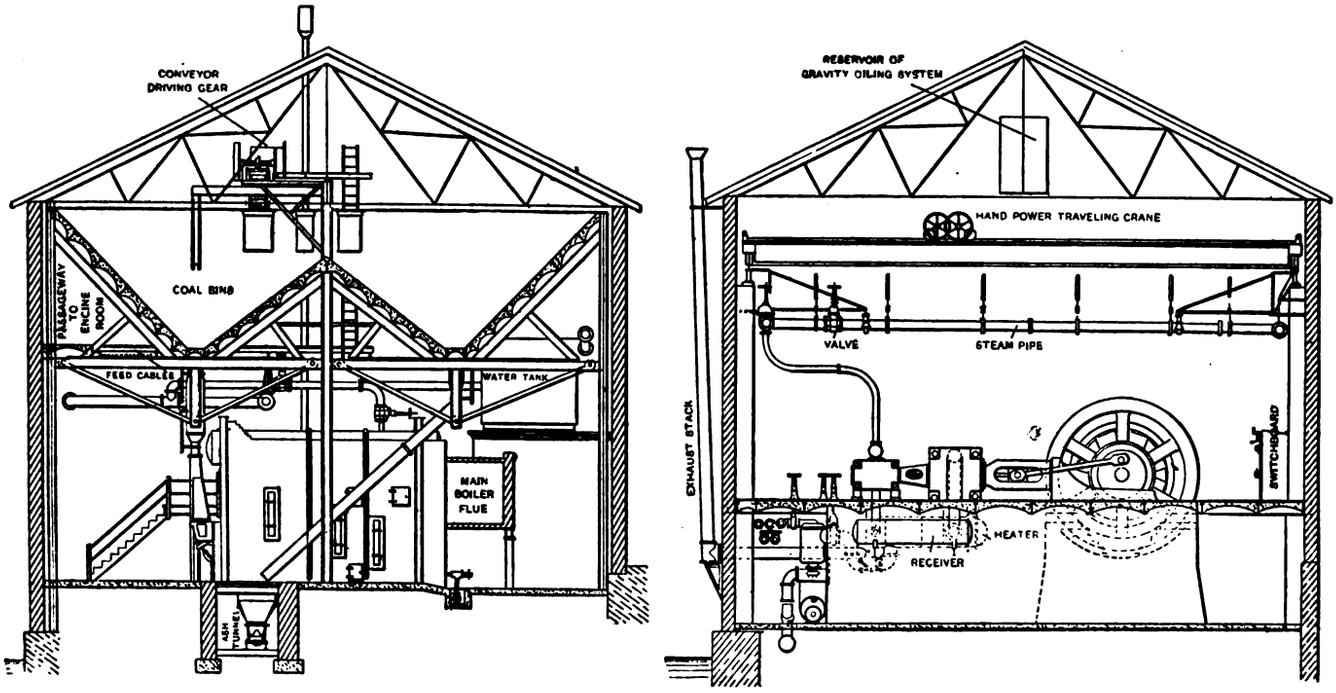


MAP OF THE CAPITAL TRACTION COMPANY'S SYSTEM AT WASHINGTON.

in Washington, and by the Metropolitan Street Railway Co. in New York City, with such changes as were necessary to adapt it to the existing cable tracks. Twenty-two miles of track have been changed over, including the Seventh-street line, which was kept in operation by cable while the change was being made; the Love conduit system on U-street will later be rendered uniform with the rest. A 24-way conduit for the electrical cables was laid midway between the two tracks, except where deflected by existing pipes and ducts, the material used being vitrified clay pipes, and wrought-iron cement-lined pipes are laid in concrete in the ordinary way. Temporary tracks were laid down for the horse cars on Pennsylvania-avenue and Fourteenth-street, so that the track work could be carried on without interruption. The cable conduit—18in. wide by 38in. deep—was fortunately made of concrete, plaster-lined, and without any inside metal sheathing. Entrance to it was obtained by means of manholes at intervals of 31½ft., running from the slot rail to the outer track rail. The conductor rails for the new electrical work are of steel, T-shaped, 4in. by 2in., weighing 23lbs. to the yard, and having the conductivity of 300,000 circular mils. of copper. They were cut into 31ft. 6in. sections to span the distance between these manholes in which the insulating supports for the outer rail were placed. To hold the other conductor rail a small handhole was put in immediately across the slot from the manhole, and to give an intermediate support at the middle of the rail length a pair of similar handholes was put in midway between manholes. The conductor rails were inserted through slot hatches which were placed at intervals of about 800ft. The porcelain insulators are supported by cast-iron caps with ears, which are bolted to the foot flanges of the slot rails. The holes for these bolts were made by punching machines as soon as the excavations for the handholes had been made. The two holes in the web of the slot rail for the attachment of each cast-iron handhole frame were made by a specially designed drill let into the excavation and backed up against the track rail. Knock-down frames were then placed



SECTION SHOWING SLOT-RAILS, CONDUCTOR RAILS AND CONDUCTOR PLOUGH.



VERTICAL SECTIONS THROUGH POWER STATION AT BOILER HOUSE AND AT MACHINERY ROOM.

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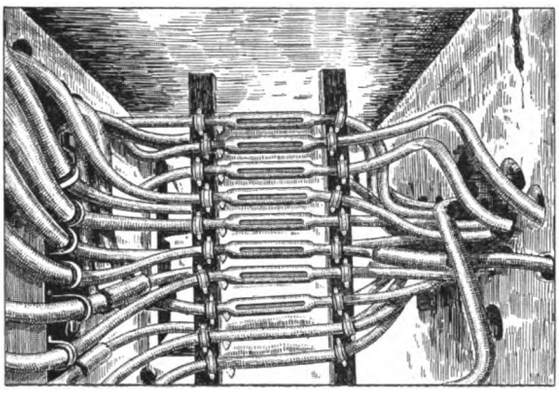
in the excavations, making an inside form for the concrete shells of the handholes, which are 5in. in thickness, internally plastered with cement mortar.

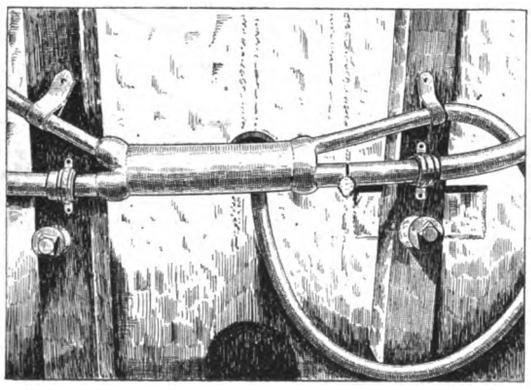
To prevent the water entering the slot from trickling down the sides and dripping over the conductor rails, which are 6in. apart, the upper flange of the slot rails in such a road must be fitted with a downwardly projecting lip, from which all water will drip off and fall between the conductor rails to the bottom of the conduit. There was, of course, no such lip on the old cable rails, and rather than replace them, bedded as they were in good asphalt paving, it was decided to rivet inch steel angle sections to them in the manner clearly shown in the sectional elevation. The angles were let down through the slot and held up against the lower face of the slot-rail head



Feeder Splices.

by a specially designed tool, and rivet holes were drilled through both at intervals of about 4ft. The holes are countersunk from the top and the rivet heads finished flush with the surface.

The old track-rail ends were badly dropped, and it was decided to bring them up by the cast-welding process. The fishplates were removed, the rail ends cleaned by hand, no power being available, for a distance of about 10in. back from the joint, and the splice-bar bolt holes in the rails were plugged, the iron plugs projecting about an inch on each side of the web so as to become bedded firmly in the casting.

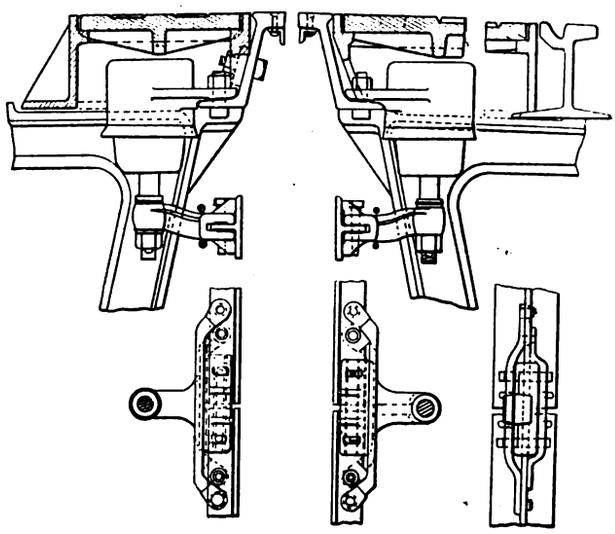


Splice of the Branches from the Feeder Cables.

Strips of iron of the rail section were driven between the abutting ends, making the joints tight. The flattened rail of each joint was shimmed up a trifle higher than the other, and the usual cast-iron mould was clamped about the hole and filled with molten iron poured from a portable furnace. The heating of the steel was found to bend the ends upward to just about a true bearing, a smooth joint being assured by finishing the surface by hand filling. The joints now ride very smoothly, but few of them being perceptible.

The conversion of the Seventh-street line, which was kept in operation by cable, except during a few hours of each night, was still more difficult. The laying of the ducts and the setting of handhole castings and insulators were done in the daytime. At night the workmen entered the conduits and secured the conductor rails to the clips of the insulating supports. The cast welding of the rail joints on this section was done several years ago. Drip angles were only put on the slot rails in the valleys.

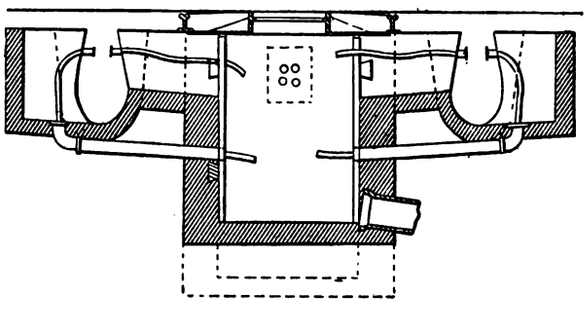
After the electric roads had been in operation about six months the Company decided to put down heavier and higher rails at the curves. Excavations were made between the yokes at all the curves, in which cast-iron chairs, weighing about 100lb. each, were set with concrete packed around them. This



Section of Track Showing Insulating Support and Bond for Conductor Rail.

work was done in the daytime, and at night after traffic was suspended the old rails were taken up, the rail seats on the yokes broken off, and the new rails put down and secured to the rail chairs. Courses of scoria block are laid on each side of the rails at the curves, the crevices between the bricks being filled with asphaltum.

As a ground return is not used, both the positive and negative feeders are insulated. There are thus 20 lead-covered cables for the 10 feeders, each with a cross-section of copper of 1,000,000 circular mils., insulated by saturated paper $\frac{3}{16}$in. in thickness, and protected by a $\frac{1}{8}$in. lead sheath. They are drawn in through manholes running across the two tracks, spaced at intervals of about 400ft. At points determined by



Draw-In Manhole, Showing Taps to the Conductor Rails and Method of Draining.

traffic conditions the feeders are tapped in the manholes with two branches from the one splice to the conductor rails, to which they are attached by clamps. Those going to the outboard rails pass down through a duct from the handholes to the manhole. One pair of cables is held in reserve as an emergency feeder, being provided with blind taps ready to be cut in at any point at any time it may be needed. In all there are about 66 miles of cables in place.

The Power House.—The work on the new power house was necessarily very much rushed, and had to be carried on almost while the drawings were being made; nevertheless, the plant evidences a surprising amount of ingenious design to overcome the difficulties involved. The work was begun about

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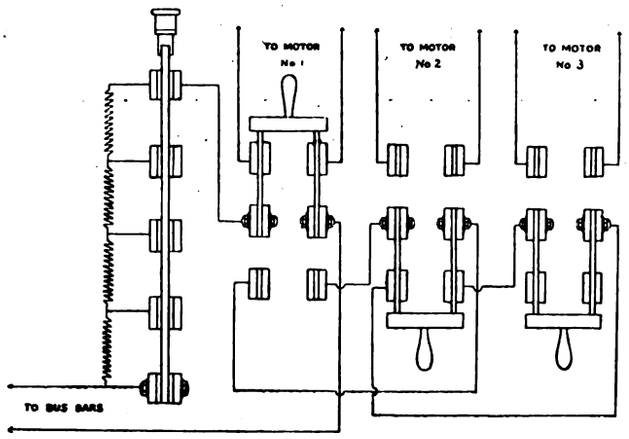
December 1, 1897, and early in April, 1898, power was on. Old material was used to a certain extent, the good bricks of the partition walls, which had to be taken down, being used in the engine foundations, the new crane runways being made of the I-beams of the old floors, &c. The building is located on the Chesapeake and Ohio Canal. It is a long, narrow structure, which did not admit of the standard practice of placing the boilers in a row along one side of a division wall and the engines nearly in a parallel row along the other side. This building required a division midway of its length, one half being the boiler and the other half the engine room. Fortunately, solid rock was but 2ft. or 3ft. below the basement floor, so that all foundations, even to those of the auxiliary pumps, are carried clear to rock.

One of the most interesting parts of the equipment is the coal-conveying apparatus. Bituminous coal is brought directly to the plant on canal boats, holding about 120 tons each. Standing apart from the main building, towards the west, is the coal-unloading tower of steel frame construction, covered with corrugated iron sheathing. This tower has a boom projecting over the canal, by which tubs holding 1,000lb. each take the coal up from the canal boats and dump it into a receiving hopper, which, in turn, dumps it into the weighing hopper, from which it passes down into the crushing equipment. The bucket hoist and crusher are both driven by one 30 H.P. 500 volt motor. From the crusher the coal is dropped into the buckets of a pan and bucket conveyor. The driving mechanism consists of a 15 H.P. motor geared down through triple reduction gears to the heavy sprocket wheel, under which run the cables, the clamps on which fit into pockets in



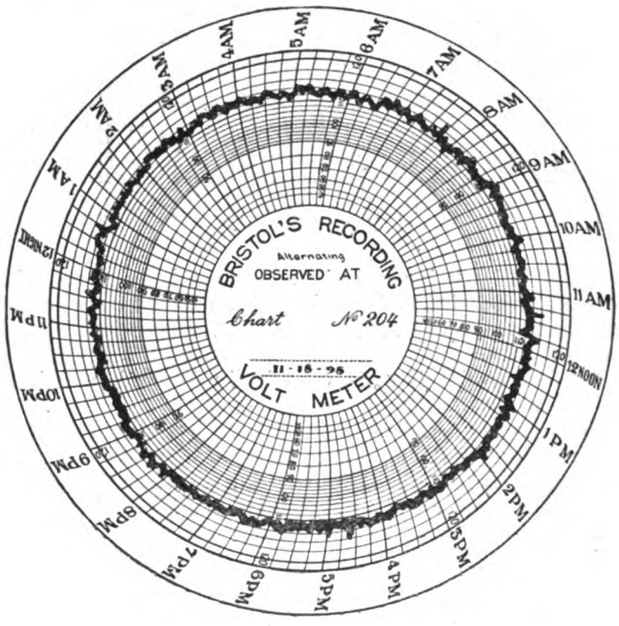
CONNECTIONS FOR THE BOOSTER STARTING RHEOSTAT.

the wheel rim, the teeth adjacent to these pockets insuring an absolute drive. The conveyor dumps the coal into bins over the boiler room.

There are four batteries of boilers in place—one battery on the west of the stack and three to the east of it. The space in front of the stack is occupied by filters, and the space to the west of the boiler room is reserved in case increased boiler power is wanted. Each battery consists of two Babcock-Wilcox boilers, each boiler being nominally of 350 H.P. The boilers are fitted with the latest type of mechanical stokers, driven by three small Westinghouse engines worm-geared to the shafts.

The piping system of this station has been the subject of unusual study, and is worked out in a very complete manner. Water for boiler feed and condensing purposes is taken from the canal through a 24-in. intake below the ice level, through two screens of half-inch mesh into a concrete settling tank or basin in the engine-room basement. From this five 8-in. pipes, with foot valves and strainers, rise and run to the five independent jet condensers of the five main units. In this way the condensers cannot interfere with or rob each other, and the choking of any one pipe does not shut down the whole plant. The exhaust of each engine passes first through a feed water heater and thence through its own jet condenser and its own independent 14-in. exhaust stack of spiral-riveted pipe. Three valve standards on the floor above at the head of each engine control respectively the valves of the steam supply, water supply, and exhaust steam supply of each condenser pump. An automatic atmospheric valve in the pipe running to each exhaust stack is fitted so that when it opens its valve stem projects upward above the floor of the engine room and stays there until forcibly pushed down by the engineer.

The feed water is handled by three pumps in one end of the boiler room, one of which, the tank pump, is arranged to lift the water from the well above mentioned to a 4,000-gallon tank over the toilet room to the rear of the boilers. A gravity pump governor controls this pump. The tank may also be supplied from the city mains through a meter at times when the canal is emptied for repairs, and an automatic float valve is installed for control under these circumstances. From the tank the water normally passes to two filters, and thence through one of two direct-acting duplex feed pumps, which in turn deliver it through any one or more of the heaters attached to the engines and then through the supplementary heater in the boiler room, thence to the feed line and to the boilers. The supplementary heater takes the exhaust of all the auxiliary engines. Finally, two injectors are installed connected with an entirely independent feed line running along the rear of the boiler steam drums.



STATION PRESSURE RECORD.

The main steam pipe is run on the ring system and is all of extra heavy piping designed for 200lb. steam pressure, although the pressure at present carried is 140lb. The main header is run along one side of the boiler room and continued along the same side of the engine room and into it all the boilers feed and from it all the engines take steam. This header is 12in. in diameter, its terminals being connected around to the opposite side of the building, to a 10in. auxiliary main. These two mains are cross-connected near the division wall by an 8in. equalising main, giving a sort of figure 8 arrangement. Over the boilers the main header is supported on gas-pipe stands with ball and socket bases to allow for expansion, and at other points it is hung by adjustable rods from brackets and stayed against vibration by sliding attachments to the pilasters. Both the main header and the auxiliary main are anchored where they pass through the wall between the engine and the boiler rooms, and the expansion—which amounts to a movement of about 8in. at the extreme ends—is taken up without slip joints or copper bends. This is done by giving each boiler and engine branch a horizontal run with a vertical turn at each end, so joined that the flanges give the proper flexibility. There is a gate valve in the main header between each battery of boilers and between each engine, so that any part of the main can be cut out without shutting down more than one battery or one engine at a time.

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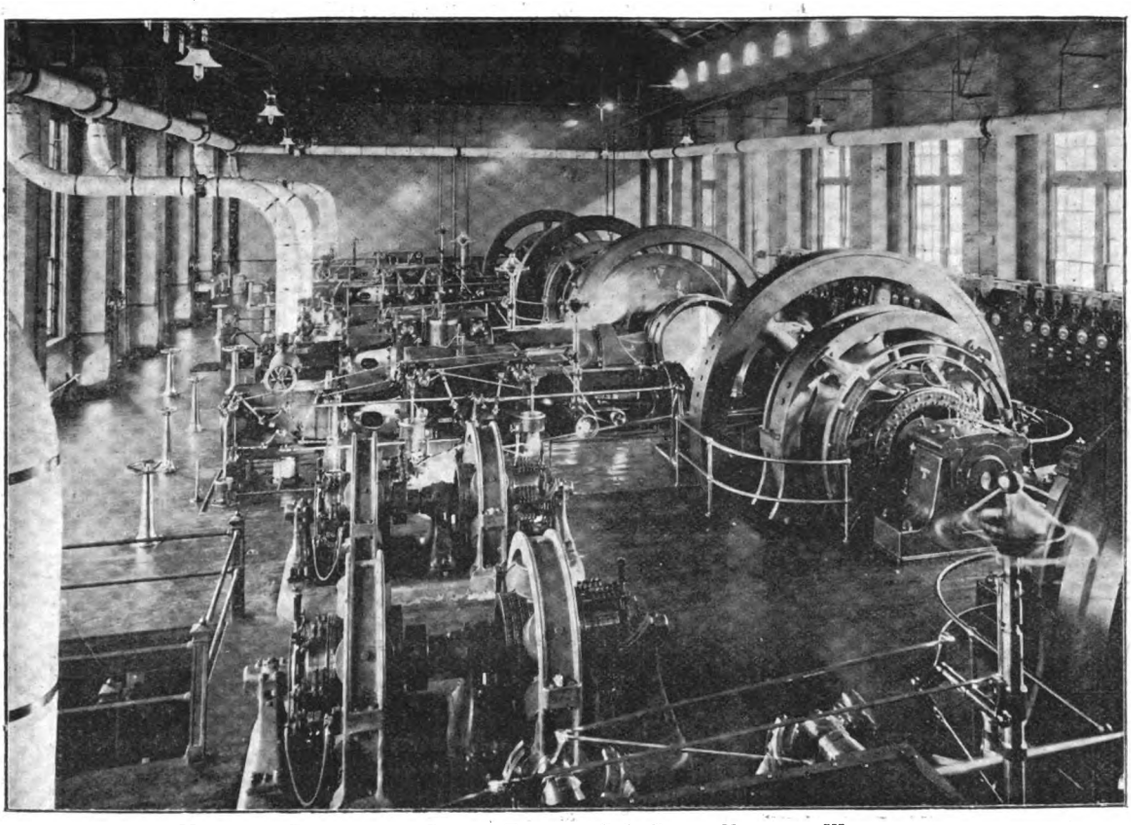
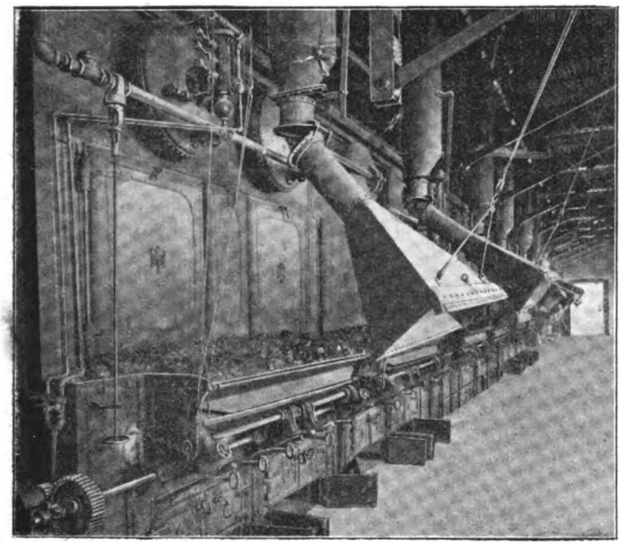
The cross or equalising main allows the steam to be fed viâ any one of several routes, thus giving a surety of operation even with simultaneous accidents to more than one part of the system. Steam for all auxiliaries is taken off from the middle of the equalising main, which it can reach by



MACHINERY ROOM OF THE CAPITAL TRACTION CO.'S POWER HOUSE, AT WASHINGTON.

either the main header or the auxiliary main. The steam is dried by two separators, one in each of the two steam mains near the points where they pass through the boiler room wall, the entrainment from these separators being returned to the boilers by gravity through the blow-off connections. There are no separators near the engines and the



INTERIOR OF THE BOILER HOUSE.

tees for the engine branches open downward, but there is absolutely no water knocking in the cylinders. The main header has no slope one way or the other, but the auxiliary main slopes from both directions toward its separator.

The main engine room is noticeable for the ample provision of light. A 15 ton hand crane spans the room. Ten enclosed arc lights are supported from the craneways on hinged gas-pipe brackets. There are five main Allis-Corliss tandem-compound 800 H.P. engines, with the standard and well-known features of this design, the 1890 frame. Four of these are arranged in right and left-hand pairs on two heavy brick foundations carried down to rock and capped with cast-iron oil pans. Each engine is coupled to a standard 600-volt generator, and fitted with a 16-ft. 25-ton cast-iron flywheel. Between these engines there are to be three motor-driven boosters, two of which are now installed, each with a capacity of 550 amperes and 180 volts, with a straight characteristic up to 100 volts when running at 600 revolutions per minute. These are 100 kilowatt 6-pole three-bearing machines with a coupling, fitted under the overhanging barrel, winding at the motor end. The dynamo ends are series wound.

The switchboard is of standard General Electric construction with a few peculiarities. The five panels at the left-hand end are standard 1,000-ampere generator panels, with current indicators; the next panel contains two totalising output instruments, one an 8,000-ammeter and the other a 5,000-ampere integrating wattmeter, and beyond these come the feeder panels, of which two are required for each feeder, one positive and one negative with throw-over switches, by which the polarity of the sections fed may be reversed when desired. This is to provide against a ground on the west rail of one section, for example, and the east rail of another, short-circuiting the 'buses. By reversing the polarity of either one of the two feeders, the two grounds can be brought on one side of the system and the same can be done with any number of grounds provided no two of them are on opposite sides of one section. On account of the 600 volts difference between adjacent feeder panels, the circuit breakers at the tops are separated by wooden barriers.

The controlling arrangements of the boosters are novel and very interesting. But one motor-starting rheostat is used for all the machines, and this is of the single-switch type, the different clips which grasp the knife blade at different positions cutting out the different sections. This is connected, in to the line feeding the various motors through a number of double-pole double-throw switches, one for each motor, connected up as shown in the diagram. Tracing out the lines, it will be seen that any switch thrown up cuts the rheostat in to

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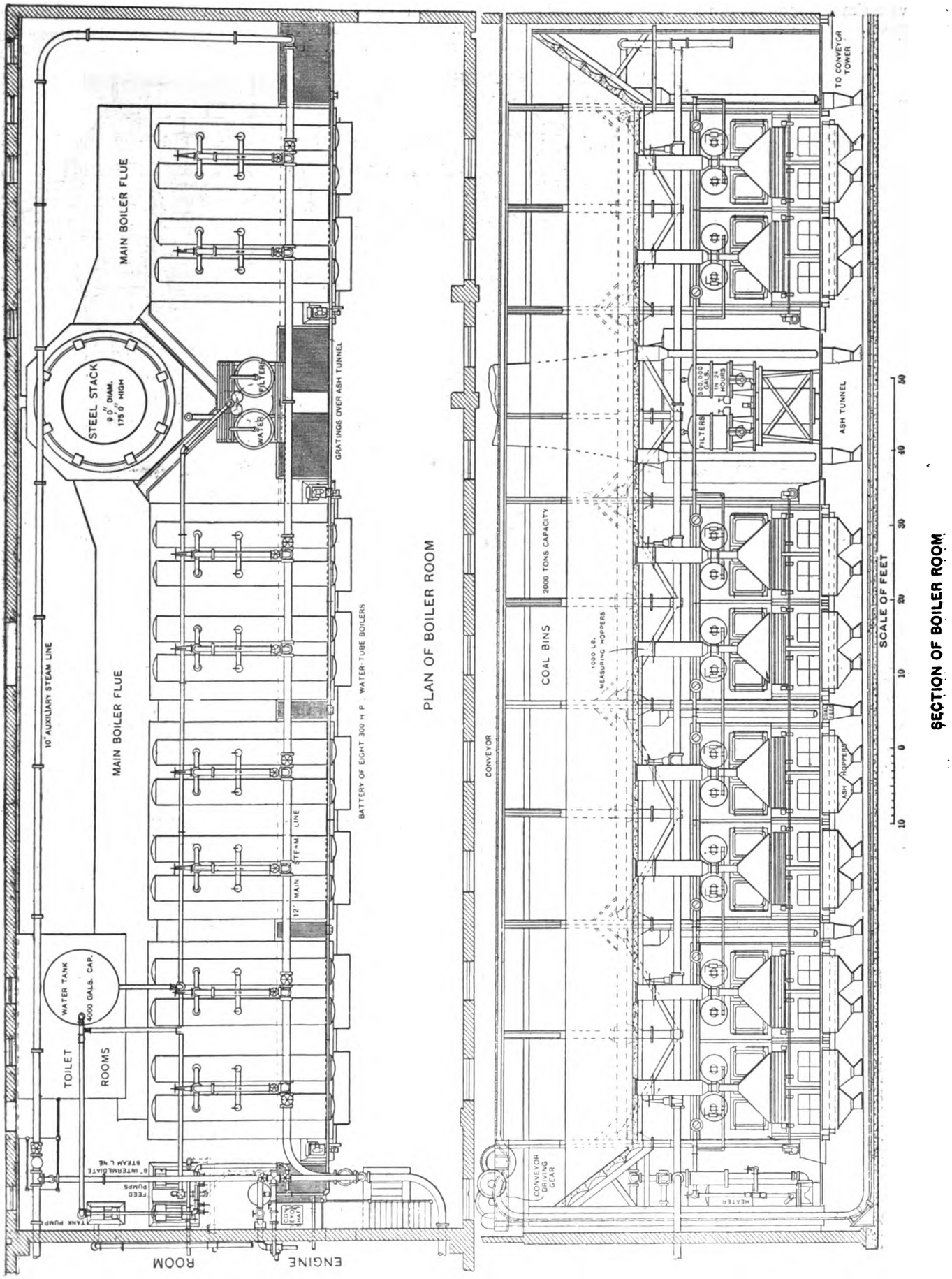

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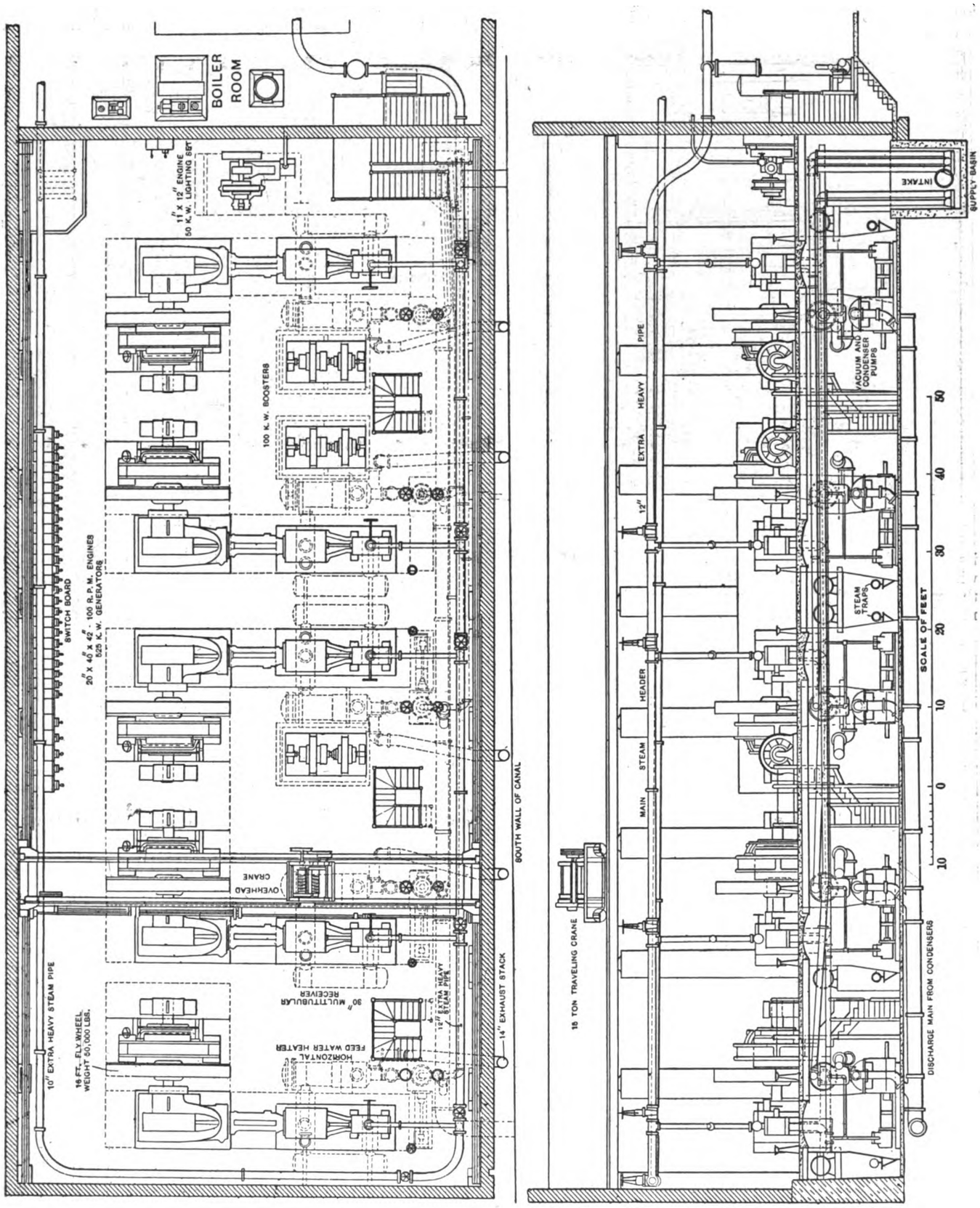
the corresponding motor, and absolutely cuts it out from any of the others. Another interesting detail is the protective device designed to cut the series-wound booster generator out when for any reason the circuit breaker of the motor opens, energised, closes the circuit of a fine wire winding on the booster-generator circuit breaker, which operates the trigger to open the breaker, and immediately thereafter opens the circuit of this same fine-wire winding, and also opens the



PLAN AND ELEVATION OF THE MACHINERY ROOM.

under which circumstance the generator would tend to run away as a series motor. The circuit breaker of the booster motor is provided with the ordinary tell-tale connected into a battery circuit, which in turn energises the magnet of a specially designed relay. This relay, when its magnet is battery circuit to prevent waste of battery power. This does not connect the boosted feeders over on to the 'bus-bars, but leaves them on open circuit. There are two long feeders for which the boosters are intended, the board being so arranged that each of these feeders may be thrown in series with its own

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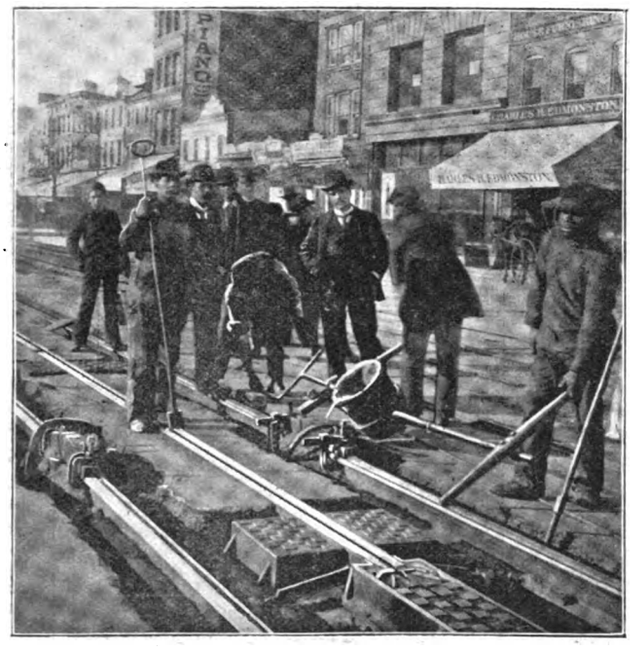
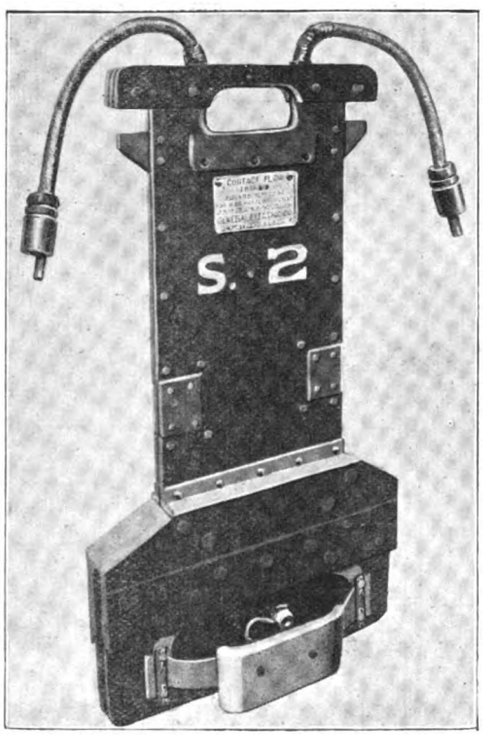
booster, the third booster being arranged to be thrown on either of the two feeders, or either feeder may be thrown directly to the 600 volt 'bus. At the right-hand end of the board, the next to the last panel is fitted with a water rheostat, which may be connected between either 'bus and ground,



CAST-WELDING THE OLD RAIL JOINTS.

its purpose being to burn out grounds on the line by a current which may be thrown on through and adjusted by means of the water rheostat. The last panel controls the auxiliary motors and 600 volt lighting lines.



COLLECTOR PLOUGH FOR THE CONDUIT SYSTEM.

Rolling Stock.—About 60 motor cars are run, and both trucks and bodies are new. Short cars with bodies only 16ft. long are used, and run with trailers. The collector plough, a view of which is shown, consists of the usual steel plate enclosing copper straps and running down through the ¾in. slot with an enlarged wooden section carrying on outward-bearing springs the cast-iron shoes. The shoes are bevelled at the ends to prevent their catching on the joints in conductor bars and on parts of the switch gear. The plough-hanger in the truck is ingeniously arranged, so that in case of derailment or a misplaced switch the plough will fall off after travelling part way across to the side frames of the truck, and

DRILLING THE SLOT RAIL FOR THE DRIP ANGLE LIPS.

drop into the conduit sufficiently to clear the motors. This prevents, in case of such an accident, the plough from becoming wedged and twisted in the slot, which requires its cutting out by cold chisels and the shutting down of the line for some time.

HIGH-SPEED ENGINES.*

BY J. H. DALES.

In applying provisions for eliminating knock in double-acting engines, the author had found that the ordinary rates of rotation could, with practical immunity from overheating, and an absolute freedom from seizure of bearings, be exceeded to the extent of 30 per cent. to 50 per cent. This had been effected by providing a close-up, and at the same time expansible, adjustment of bearing brasses, and so reducing the production of heat to only that caused by the rotation of a shaft as distinguished from the usual cause of seizure—namely, the expansive force of the metal of both journal and brasses. At moderate rates of rotation, say, 300 revolutions per minute, an audible knock took place with a $\frac{1}{500}$in. clearance in the bearings of double-acting engines, and a rise of temperature of 20°F. or 30°F., which almost always took place in practice, would expand the bearings more than that amount of clearance, and, therefore, an engine, if fitted with fixed brasses, was always liable, with little or no warning, to become overheated, and to seize in its bearings. The provisions which were made for avoiding the usual consequences of heating were very simple, and consisted of a small ram of the hydraulic pressure type, which was made to bear on the adjustable brass of a bearing. On the alternative stroke of an engine, when the working pressure was not on the adjustable brass, the ram was forced through its packing by a spring of sufficient strength to overcome the friction and the inertia of the ram and parts, and in such manner placed the adjustable brass close on its journal. This action caused a slight clearance in the ram cylinder, which was instantly filled by liquid from a reservoir which entered by a back-pressure valve. The shock of the working stroke of the engine acting upon the liquid inside the ram cylinder instantly shut the back-pressure valve and confined the liquid as a packing at the back of the ram, and so maintained the adjustment of the brass which had been made by the spring. Similar fittings were provided on all the reciprocating bearings of an engine which were usually subject to knock.

The value of close governing had been very much underrated. It could be shown that by running to within 1 per cent. or 1½ per

* Abstract of a Paper read before the Institution of Civil Engineers, January 10, 1899.

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cent. total variation in the speed of an engine, an increase over ordinary results in the quantity of work could be produced, which in many cases amounted in value to more than the whole of the coal bill. The possibilities of close governing by the various types of governor in common use had been investigated, and it had been found that dead-weight loaded governors of the ordinary type, even when compensated for change of position, could not be moved by any less variation of speed than about 2 per cent. from the normal, or a total variation of 4 per cent., taking no account of any work to be performed in the way of moving throttle or expansion apparatus. Spring-load governors with angular arms pivoted, as in the former case, on plain pins, could be moved with a variation of 1½ per cent. from the normal, or a total of 3 per cent., taking no account of the performance of any governing functions. Spring-load governors, fitted in all joints with ball bearings and designed with small relative inertia and high speed, had been made to work auxiliary apparatus with as little variation of speed as 1½ per cent. total, and had governed engines within those limits.

Perfect governing could be obtained when (1st) the direction of the strains of centrifugal force were not diverted; (2nd) such strains were directly radial; (3rd) the friction and inertia of the centrifugal generating parts were reduced to a minimum; (4th) the mechanical relations of the governing parts were constant; (5th) the inertia of the centrifugal generating parts, whilst very small relatively to the centrifugal forces, were as far as possible in excess of the driven parts of the governing apparatus. These points were embodied in a fly-wheel governor dealt with, in which the load springs were arranged radially, as also were the spring-boxes and guides belonging thereto, so that the centrifugal forces caused no cross strains. The springs formed a large part of the centrifugal weights, and had a peculiar effect upon themselves which was illustrated by a diagram. The motion of the governor, in performing its functions, was transmitted to the expansion eccentric by means of a spur-wheel mounted on a sleeve which was solid with the eccentric, and was actuated by means of rack teeth formed in the spring-box slides, giving a practically constant mechanical effect in the action between the governor and the expansion eccentric. The inertia of the governor was in excess of the driven parts as about 3 to 1, while the centrifugal weights were about 2 per cent. of the total spring-load. The total average centrifugal force of the governor was about 3,000lb., and the only cross strains on the spring-box slides were those brought about by driving the cut-off eccentric, and those strains were relatively very small, as the cut-off valve was worked by a rocking shaft and twisting spindle in order to avoid the friction of a pulling spindle and the effects of the steam pressure on the same. The arrangement could be adjusted so as to govern an engine to 1 per cent. total variation throughout the whole steam range of the expansion gear, which was about ⅝ cut-off from zero, and without racing. The expansion motion was reversible with the same set of parts.

CORRESPONDENCE.

WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In Mr. Evershed's reply to my remarks in the discussion of his most able paper on "Telegraphy by Magnetic induction," he rather attributed to me a meaning I did not intend to convey. I did not wish to state that the difference in the energy received in the receiving circuit at Mr. Preece's Lavernock Flat Holm system, when a simple permanent current was put on the primary or transmitting circuit, and when the primary current was rapidly made and broken, was due to absorption. I am not concerned at all with the name of the phenomenon, but simply wished to indicate that, since such difference *does* exist, a better way of signalling is available, viz., by taking advantage of the stronger, but slower varying currents produced in the receiving circuit of such systems when steady currents, broken only by the signalling key, or other currents of low frequency, are sent over the transmitting circuit. A telephone, coherer, or other extremely sensitive receiver which may require a high or harmonic frequency can still be used in the receiving circuit. This is to be done (as described in my Patent Specification, No. 30,123 of 1896) by splitting up the *received* current into rapid pulsations immediately next the telephone or other receiver itself, by means of a rapid make and break applied to the receiving circuit. I use for this purpose a light, rapid, trembling bell motion, with an additional insulated contact spring moved by the vibrating armature and operating to rapidly open and close the *receiving* line circuit, without producing any current therein, care being, of course, taken to twist together the leads bringing the local current. The transmitting circuit then contains nothing but the battery or generator and signalling key, connected to the pair of earth plates. If a coherer, with its usual set of accessories, is employed as a receiver, it is placed as a shunt across an electro-magnet or induction coil, the extra currents from the latter, when the received current, however faint, is made and broken in this way, being found to actuate the coherer very effectively. Under many conditions (as, for instance, in my proposed bare wire cables, on which tests have been made) this appears to be the best way of working.

I would add that where, in any of these receiving circuits, it is desirable to operate a vibrating relay of definite rate, such as the exquisitely sensitive one designed by Mr. Evershed, this can be done by simply adjusting the rate of the local vibrator in the receiving circuit to that of the relay. Earth currents can usually be stopped by means of a condenser, which may generally be of very small capacity, and yet be sufficient to allow of the proper reception of the signalling currents. This method of working appears to extend the possible limits of this class of telegraphy.—Yours, &c.

A. C. BROWN.

LEGAL INTELLIGENCE.

Postmaster-General v. Edinburgh Town Council.

In the Edinburgh Sheriff's Court, on Tuesday, Sheriff Rutherford heard an application by the Postmaster-General for an order upon the Lord Provost, Magistrates, and Council of Edinburgh requiring them to give their consent to the placing and maintaining of a certain line or lines of underground telegraphs. The Council oppose the application on the ground that the wires were intended for the use of the National Telephone Co. as part of their undertaking, and the Council object to giving any rights in the streets to private or commercial undertakings whether applied for directly or through the medium of the Post Office.

Mr. F. T. COOPER (for the Council) held that the application was not made in good faith by the Postmaster-General for the purpose of the Post Office, but was intended to facilitate communication between one exchange of the National Company and another, to put the exchanges in connection with the trunk system of the country, which is in the control of the Postmaster-General. If consent were given they reserved their right even to interdict the Postmaster-General. The Postmaster-General had ample conduits for public telegraph and telephone purposes. If the consent sought were given, he did not see where it was to end. He admitted that the initial outlay might be the Government's, but the company would bear the cost ultimately. He did not anticipate that any expense would fall upon the Council, except the loss of valuable ground, which might be required for other purposes.

Mr. FLEMING (for the Post Office) submitted that a telephone had been declared to be a telegraph under the Telegraph Acts. In 1868 the Postmaster-General obtained the exclusive privilege to send telegraphic messages throughout the country, which meant that he had also the same privilege in regard to the telephone. He could start a telephone system anywhere by virtue of this privilege. Not being in the position to do the work himself the Postmaster-General issued licences to companies for local work, but retained the trunk wires in his own control. There was now only one telephone exchange company in the country. The wires the Post Office desired to lay down were to be trunk wires, connecting centre and centre, which privilege was the exclusive monopoly of the Postmaster-General.

The DEAN OF FACULTY (for the Council) asked where the Postmaster-General got the title to lay conduits on the private property of anybody? Why should the Post Office (and the National Telephone Co. through the Post Office) be entitled to do something which they could not do of themselves, and upon terms which they could not themselves obtain? If the National Company could not touch the streets of Edinburgh by applying to the Council, why should they be able to do so through the Post Office? He disputed that the Postmaster-General might, regardless of the prospective requirements of the city, claim the right to do so. The Council possessed an express statutory prohibition against anybody interfering with the streets.

The SOLICITOR-GENERAL (for the Post Office) said it was the fact that there had been no previous experience of an application of this kind in Scotland, but there had been a dozen in England. In this case he contended all that was required was that the consent of the Council should be asked, and if it was not given, that notice should be served upon them. It was then for the Council to state a relevant objection. In answer to the objection that this was not a Post Office purpose, he said it was quite true he did not show any connection with the Post Office, but the reason for that was easily explained. The Edinburgh Council had already permitted the Post Office to connect the Central telephone exchange with the Edinburgh post office by underground wires, and the result of that was that all the local exchanges, when they had to communicate with the

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post office, had first to go through the Central exchange, and then the central exchange communicated with the post office. One of the chief causes of the unsatisfactory working of the telephone was overhead wires, which were apt to get disarranged by storms, and the Telephone Company were anxious that the wires connecting the local exchanges should be placed underground. Was it possible to represent as not being a good Post Office service that the means of allowing the public to use the trunk lines should be improved? He failed to extract any meaning from the contention that the wires were not required for Post Office purposes, because the position of the licensee was this—he was in the shoes of the Postmaster-General, with all the powers the latter had except the one power of opening the streets without special consent, but he was bound to pay the Postmaster-General 10 per cent. of everything he took. Therefore, everything the Postmaster-General did that would result or not result in increasing the income of the licensee was a Post Office purpose. If the Corporation could have said that from side to side and from top to bottom the solum was so packed with tubes and drains and pipes that they could not get another one in, that would have been a good objection ; but it was an averment that could not possibly be made. He maintained that there was no ground for the Corporation not granting its consent, and that his Lordship should grant decree in terms of the notice.

Sheriff Rutherford reserved his decision.

African Direct Telegraph Co. (Limited) v. Webb.

At the Lord Mayor's Court, on Monday, before the Recorder and a Common Jury, the African Direct Telegraph Co. sued the defendant to recover damages for breach of contract. Mr. Glyn appeared for plaintiffs, the defendant not being present or represented.

Mr. GLYN stated that on June 6, 1896, an agreement was entered into between the parties, under which defendant agreed to serve plaintiffs as an operator for a period of five years, at a salary of £72 per annum. At the end of five years the engagement was terminable by three months' notice on either side. The defendant was sent out at an increased salary to the Gold Coast, West Africa, but he left the plaintiff company's employment in June, 1898, without notice, caused loss to the plaintiffs, as they were compelled to send out another operator, and there was a claim for damages. Plaintiffs considered it necessary that where operators left their employment without notice the company should claim damages for breach of the agreement, as otherwise the whole telegraphic service must be seriously inconvenienced. In the present case the plaintiffs were obliged to send someone over from England almost at a moment's notice, and they actually incurred expenses amounting to £60. 3s. 4d.

Mr. H. E. PLANK, secretary to the plaintiff company, gave evidence in support of the claim, and stated that, in addition to paying £26 for the passage of the second operator, the plaintiffs paid £34. 3s. 4d. as his wages for a month during the passage.

The RECORDER said it was intolerable that agreements of a binding character should be broken in the manner proved by the plaintiffs, as such conduct caused the greatest possible inconvenience. He thought the plaintiff company had acted very fairly in not pressing for exemplary damages.

The jury found for the plaintiffs, and judgment was given for £60. 3s. 4d. and costs.

Stegmann v. O'Connor.

This case (reported last week) was resumed in the Queen's Bench on Tuesday. At the conclusion of the arguments of counsel their lordships intimated that they would give judgment in a few days, as the case might have to go back to the official referee.

At the Marylebone (London) Police Court, last week, Messrs. Allingham and Fennell, electrical engineers, were summoned for connecting up a supply of electric current in the area of the Hampstead Vestry without the consent of the Lighting committee of the Vestry. Mr. A. P. Johnson, solicitor to the Vestry, said defendants were electric wiring contractors, and had orders to wire the house of a resident in Lyndhurst-road, Hampstead. The act required that the fittings should be tested before the connection was made, as a safeguard against fire. An appointment was made for the test to be carried out, but defendants did not keep it, and afterwards wrote saying that they would communicate when they were ready. About three weeks later one of the Vestry officials passed the house, and saw that the connection had been made without the knowledge or consent of the Vestry, and that all the parts of the house were illuminated. There was no meter fixed, but the occupier, who was an innocent party, had arranged to pay an agreed sum. A plea of "Guilty" having been recorded, the magistrate imposed a fine of £3 and £1. 3s. costs.

At Hampstead (London) the above defendants were summoned for making a similar connection to another house in the same district without the Hampstead Vestry's sanction. When the meter fixer employed by the Vestry went to connect the electric lighting wires of the house on to the Vestry's main, he found that defendants had already made the connection. To do this they had to break open the Vestry's fuse-box, which was sealed. This temporary connection had been made for a week, and when the installation was tested it was found to be defective, and the connection was cut off. It was a very bad case, and there was danger of fire through it. By the action of the contractors the consumer of the light was also rendered liable to prosecution, but the Vestry were not taking proceedings against him. Mr. Allingham (one of the defendants) said the light had been put on for only a short time, in order to test the lamps in the house. He denied that the fuse-box was sealed. The Bench imposed a fine of £3. 3s. and £1. 3s. costs.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London :—

NOW READY.

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. The Author hopes that, besides Telegraph and Telephone Engineers, it may, perhaps, also prove of service to those in charge of cables for the transmission of light and power. The localisation of faults has been very fully investigated, including the different degrees in which the various methods are affected by the presence of a second fault or of general leakage.—*Extract from Preface.* Demy 8vo, fully illustrated. 10s. 6d., post free ; abroad 11s.

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"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition now ready.*

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"WIRELESS TELEGRAPHY: SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES."—By Dr. O. J. Lodge, with many original illustrations. *Enlarged Edition*, 2s. 6d. net, 2s. 9d. post free.

"ELECTRIC MOTIVE POWER," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free ; abroad, 11s.

"LABORATORY NOTES AND FORMS."—With the above title we have ready the New Edition of a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net ; in sets of any three, 1s. net ; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net ; or in handy portfolio, price 12s. net ; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

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"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free ; cloth, 2s. 9d. Single Primers, 3d. each, post free.

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"ARMATURE WINDINGS OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

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"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free; abroad 13s. 6d. Prospectus post free.

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"THE ELECTRIC ARC."—By Mrs. Ayrton.

"THE MANUFACTURE OF CARBONS FOR ALL ELECTRICAL PURPOSES."—By Francis Jehl.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. Vol. II.

"SECONDARY BATTERIES, THEIR DESIGN AND MANUFACTURE."—By E. J. Wade.

"PRIMARY BATTERIES: THEIR CONSTRUCTION AND USE."—By W. R. Cooper.

"PRACTICAL TELEPHONY."—By Dane Sinclair and F. C. Raphael.

"'THE ELECTRICIAN' WIREMAN'S POCKET-BOOK."

"The Electrician" Electrical Trades' Directory and Handbook.—An important announcement in connection with the 1899 issue of the "Big Blue Book" will be found in an advertisement on another page of the present issue, to which our readers will please refer.

TENDERS INVITED.

The *Leyton* District Council invite tenders for a motor generator and the necessary switch gear. Specifications, conditions, &c., can be obtained from the electrical engineer (Mr. H. Collings Bishop), Cathall-road, Leytonstone. An advertisement contains additional particulars, and tenders must be sent in to the clerk to the council (Mr. R. Vincent), Town Hall, Leyton, by Monday, Feb. 6.

The Corporation of *West Hartlepool* invite tenders for feeders, mains, arc light leads and road work. Further particulars are given in an advertisement, and copies of specifications, forms of tender, &c., can be obtained from the town clerk, Mr. Higson Simpson. Specifications and drawings can be seen at, but not obtained from, the offices of Prof. Alex. B. W. Kennedy, 17, Victoria-street, London, S.W. Tenders to Mr Simpson, by Monday, the 13th Feb.

The Gas committee of the *Nelson* Corporation invite tenders for the supply and erection of the following plant:—(*a*) steam dynamo, ejector condensers, &c., (*b*) switchboard, (*c*) alterations to accumulators, (*d*) overhead crane. Additional particulars are given in an advertisement, and plans, specifications, &c., may be obtained at the office of the engineer (Mr. Wm. Foster). Tenders must be sent to the town clerk (Mr. R. M. Prescott), Town Hall, Nelson, not later than noon on Tuesday, Feb. 14.

As announced in an advertisement, the Electricity committee of the *Belfast* Corporation invite tenders for the supply of the following:—Cast iron pipes, cast iron frames and covers, earthenware conduits, insulated cable, and Lancashire boilers. Specifications and conditions of contract may be obtained from Mr. Victor A. H. M'Cowen, city electrical engineer. Tenders must be lodged with the town clerk (Sir Samuel Black), City Hall, Belfast, by Thursday, Feb. 2.

The *Glasgow* Corporation invite tenders for the reconstruction of the tramways in Crown-street and Cathcart-road. Specifications, with forms of tender, can be obtained on application to the general manager (Mr. John Young), 88, Renfield-street, Glasgow, and tenders must be lodged with the town clerk (Sir J. D. Marwick), City Chambers, Glasgow, by 10 a.m. of Monday, 6th prox. Further particulars are set out in an advertisement.

As announced in our advertisement columns, the Corporation of *Harwich* invite offers for the transfer of their provisional order. Tenders must be sent in by May 17 next to the town clerk (Mr. A. J. H. Ward), Harwich.

The governors of the District Asylum of *Enniscorthy* (Ireland) invite tenders for the installation of electric tell-tale clocks. Particulars can be had from the resident medical superintendent, and tenders must be sent in by the 8th prox. See advertisement.

The Corporation of *Lowestoft* invite tenders for the supply and erection of the following plant:—(*a*) boilers and fittings, economisers, feed pumps, &c.; (*b*) pipe work, &c., for engine and boiler house; (*c*) steam dynamos and motor boosters; (*d*) storage batteries; (*e*) main switchboard and connections; (*f*) overhead travelling crane; (*g*) underground mains and conduits, road work, &c.; (*h*) arc lamps and posts; (*i*) station lighting. Tenders to Town Clerk, 115, High-street, Lowestoft, by noon, Feb. 6.

The *Buxton* District Council invite tenders for the supply of feeders, mains and arc light heads. Tenders to Mr. Josiah Taylor, Town Hall, Buxton, by Monday, Feb. 6.

The *Burton-on-Trent* Corporation invite tenders for the supply and erection of three steel Lancashire boilers at the electric light Tenders to the town clerk (Mr. T. N. Whitehead) by 10 a.m., 28th inst.

The *London* County Council invite tenders for four continuous-current dynamos, one motor generator, two switch-boards with switches, measuring instruments and other work required for the proposed Victoria Embankment electric generating station. Tenders to Mr. C. J. Stewart, County Hall, Spring-gardens, S.W., by 10 a.m. Jan. 31.

Tenders are invited for the wiring and fitting of the library premises, Whimple-street, *Plymouth*. Tenders by Feb. 8 to the borough electrical engineer East-street, Plymouth.

The *Edinburgh* Town Council invite tenders for iron and steel work at the M'Donald-road electricity station. Tenders to the town clerk by Feb. 3.

The *Fulham* (London) Vestry require tenders for electric motors for driving pumps. Tenders to the clerk by Feb. 8.

The *Kingston-on-Thames* Guardians invite tenders for private telephone communication between the various workhouse buildings. Tenders to clerk, Union offices, Kingston-on-Thames, by Feb. 14.

The municipal authorities of *San Severa* (Italy) require tenders for the electric lighting of the town. Tenders by Feb. 25 to el Municipio de San Severa (Foggia), Italy.

The *Austrian* Post and Telegraph Authorities require tenders for the supply of telegraph and telephone materials, including 950 tons of wire, required during 1899. Tenders to die K. K. Post Oekonomie Verwaltung, Vienna.

TENDERS RECEIVED AND ACCEPTED.

The Tudor Accumulator Co. has received an order for a battery having a capacity of 490 kilowatt hours, from the City and South London Railway Co.

The Watford Corporation have accepted the tender of the Reason Manufacturing Co. for cut-outs, and that of Messrs. Venner and Co. for electricity meters (Hookham).

The Exeter City Council have placed an order with Messrs. Mather and Platt for a 30-kilowatt dynamo, at £686.

APPOINTMENTS VACANT AND FILLED.

The Lee District Board of Works require for one year the services of a consulting electrical engineer. Remuneration £100. Applications by 3 p.m. of Wednesday, Feb. 8, to the clerk to the Board (Mr. George Whale), Old Charlton. See advertisement.

The Torquay Corporation require a mains electrician for their electricity department. Applications must be sent in by Saturday, 28th inst., to the Corporation electrical engineer (Mr. P. Storey), Electricity Works, Torquay. See advertisement.

The Tramways committee of the Manchester Corporation require an assistant tramway engineer. An advertisement contains additional particulars, and applications must be sent to the chairman of the committee, Town Hall, Manchester, by Saturday, Feb. 4.

The Littleborough District Council require a consulting electrical engineer. Applications to the clerk to the Council by Feb. 14.

The Governors of the Paisley Technical School require a Principal. Salary £300 per annum. Applications to the Secretary by Feb. 13.

The St. Ann's District Council received 53 applications for the position of electrical engineer, and the Electric Lighting committee reduced this number to three, viz.:—Messrs. J. Pilling (chief assistant at the Bolton Electricity Works), R. Birkett (chief assistant at Burnley), and Mr. Tiddeman (engineer to the Pontypool Electric Lighting Co.). Mr. Tiddeman was ultimately selected.

Mr. C. M. Johnston has been appointed borough electrical engineer at Shrewsbury. Mr. Johnston has been for some time electrical engineer to the Lancaster Corporation.

BUSINESS NOTICE.

The British Aron Meter Co. notify that the company's business, having been acquired by the Aron Electricity Meter (Limited), all debts due to or owing by the former company will be received and discharged by the latter.

Messrs. John Drury, Frederick Drury and James Francis Drury (trading as Drury Bros.), electric bell founders, &c., Stock Orchard-street, Holloway, London, N., have dissolved partnership. Debts by J. and J. F. Drury, who continue under the old title.

Mr. W. H. Walton, late electrical engineer to the Drapers' Company, having joined the firm of Newsome, Pinching and Co., the style of the firm has been altered to Newsome, Pinching and Walton, 1, Crutched-friars, London, E.C.

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Holophane (Limited) has removed to Wardrobe Chambers, 146, Queen Victoria-street, London, E.C.

The address of the Institution of Mechanical Engineers will in future be Storey's Gate, St. James's Park, London, S.W.

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting of the shareholders of the Fowler, Lancaster Co. (Limited) will be held at Albert Works, Graham-street, Birmingham, on Feb. 20, to receive an account of the winding-up. Mr. W. Hands is liquidator.

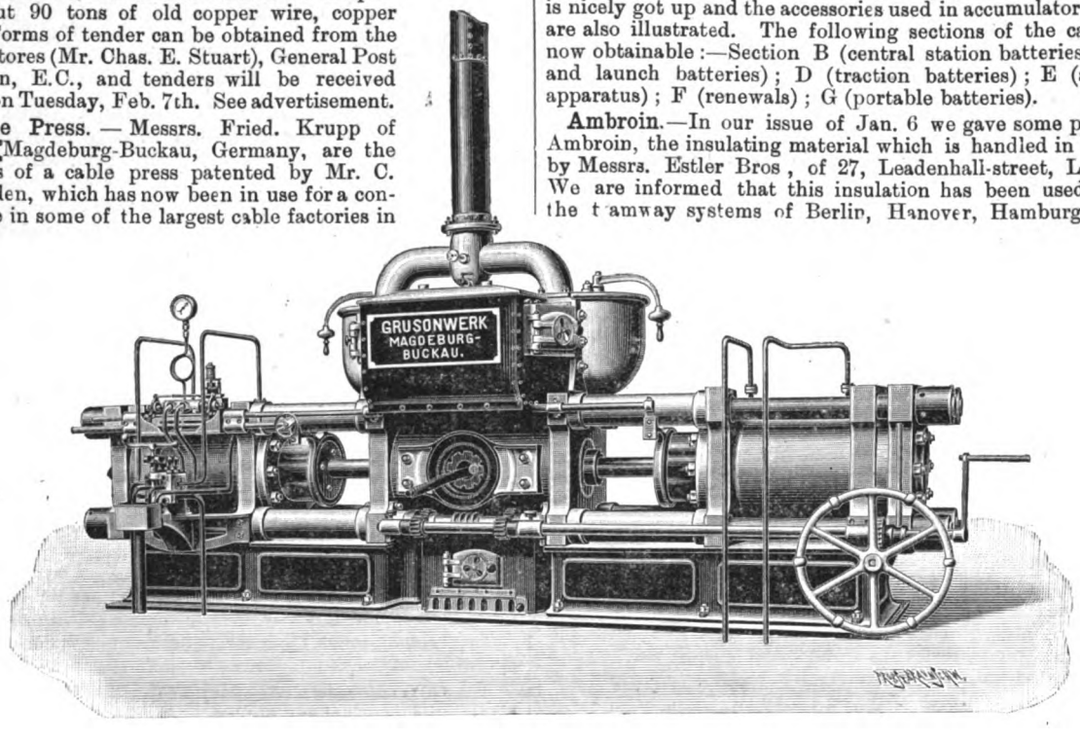
The proceedings at the two meetings of creditors of Messrs. L. V. Riley and Co. have been previously reported. Since the last meeting Mr. Seagrave, accountant, 31, Selby-road, Anerley, acting for his client and the creditors, has found funds enabling him to offer a composition of 7s. 6d. in the £, which has been accepted by the creditors in many instances.

The creditors of the London and Hampstead Battery Co., Limited, (in liquidation) must send particulars of their claims by March 1 to Mr. H. P. Spottiswoode, Donington House, Norfolk-street, London, W.C.

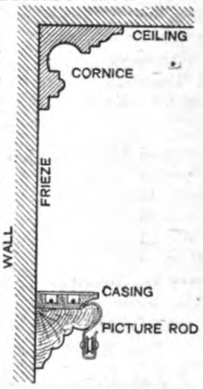
For Sale.—As announced in an advertisement, Messrs. Wheatley Kirk, Price and Goulty, Albert Chambers, Albert-square, Manchester, have for disposal electric lighting plant with a capacity of 500 16 c.p. lights.

The Postmaster-General invites tenders for the purchase of about 90 tons of old copper wire, copper plates, &c. Forms of tender can be obtained from the controller of stores (Mr. Chas. E. Stuart), General Post Office, London, E.C., and tenders will be received until 10 a.m. on Tuesday, Feb. 7th. See advertisement.

Lead Cable Press. — Messrs. Fried. Krupp of Grusonwerk, Magdeburg-Buckau, Germany, are the manufacturers of a cable press patented by Mr. C. Huber, of Baden, which has now been in use for a considerable time in some of the largest cable factories in this country and on the Continent, and which is claimed to have given satisfactory results. This press differs in many points from others on the market. It is provided with two hydraulic cylinders which work opposite one another and between which is placed the receiver containing the lead charge. Two steel rams attached to the pistons of the hydraulic cylinders pass into the bore of the receiver; on moving forward, these press the lead charge towards the matrix. The cable to be covered enters the press at one side, passes through the matrix placed in the centre of the receiver, and leaves the press on the other side. As the lead is forced towards the receiver from both ends, it is necessary that the movement of the rams shall be absolutely uniform, and this result has been obtained by means of an arrangement which regulates the velocity of the rams automatically, by altering the size of the opening, admitting water to the cylinder of that piston which is moving too fast and enlarging the opening of the other cylinder. This arrangement assures the pressure on the lead charge being perfectly uniform. An advantage claimed for this type of press is the adjusting arrangement of the matrix, by means of which a casing of absolutely uniform thickness can be turned out. By means of this arrangement the thickness of the lead casing can be made true to any fraction of a millimetre for a cable of any length. The hollow mandrels through which the cables are passed, as well as the matrices, can be quickly and easily changed. The press is made for cables from 3mm. to 60mm. in diameter. If the arrangement for centralising the cables is dispensed with, cables up to 95mm. in diameter may be covered. The melting pot placed above the receiver may be heated by coal or oil. All parts are readily accessible. The hydraulic cylinders are made of cast steel with copper lining, the rams are of chilled cast iron, the receiver of special forged Krupp steel. Messrs. Krupp's representative in this country is Mr. W. Stamm, 62, Cannon-street, London, E.C.



Combined Electric Wire Casing and Picture Rod.—The accompanying illustration shows a patent combined electric wire casing and picture rod, manufactured by Messrs. Skegg and Co., of 231, Oldfield-road, Salford, Manchester, for which we understand there is considerable demand where bracket lighting is required. The casing, as shown, is fixed upon the wall below the cornice to form a frieze, and leaves the wires easy of access. We are informed by Messrs. Skegg and Co. that this combined casing has been approved by the Phœnix Fire Office. A moulding hook or picture-holder is manufactured by the same firm, and is shown in the illustration attached to the picture rod. It will be seen that the complete arrangement is very effective and simple.



Chloride Batteries.—The Chloride Electrical Storage Syndicate (Limited) have now completed Section A of their complete catalogue, this section dealing with lighting batteries. The catalogue is nicely got up and the accessories used in accumulator installation are also illustrated. The following sections of the catalogue are now obtainable:—Section B (central station batteries); C (yacht and launch batteries); D (traction batteries); E (accumulator apparatus); F (renewals); G (portable batteries).

Ambroin.—In our issue of Jan. 6 we gave some particulars of Ambroin, the insulating material which is handled in this country by Messrs. Estler Bros, of 27, Leadenhall-street, London, E.C. We are informed that this insulation has been used largely on the tramway systems of Berlin, Hanover, Hamburg, Augsburg, Czernowitz, Leghorn, Nîmes, &c., and in smaller quantities on many other lines, including some in this country.

Electric Mining Machinery—Messrs. John Davis and Son have just issued a comprehensive catalogue of electric mining plant, apparatus and accessories. Attention is called to the considerable advance which has taken place in the design and construction of machines for the economic working of mines, particularly in the use of armoured concentric cables, more substantial switching and regulating apparatus, and the introduction of junction boxes to avoid the use of jointing wires. A large variety of haulage and pumping plant, motors, protector fittings, &c., is included in the new list.

Fire.—We are glad to announce that the fire which occurred on the premises of the General Electric Co. (Limited), 69-71, Queen Victoria-street, London, E.C., on Friday last, and which at one time promised to be serious, was extinguished by the brigade in less than an hour, enabling the company to continue their business as usual.

Roentgen Rays.—Mr. Geo. Stegmann has just issued an illustrated pamphlet and price list of Roentgen ray apparatus, for which he is agent in this country. A fully-equipped Roentgen laboratory is kept up at Mr. Stegmann's premises, 45, St. John's-hill, Clapham Junction, S.W.

"Engineering Times."—We have to acknowledge receipt of No. 2 of the "Engineering Times," a well-got-up monthly engi-

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neering magazine, which claims to be "every bit English." Both the first and second numbers of this magazine have been very creditable productions, and there should be room for such a publication, if the high character of the early issues is maintained.

Labour Protection Association.—Any of our readers seeking information concerning the Labour Protection Association and its past year's work can obtain copies of the second annual report of the Association, and a pamphlet, entitled "The Law Relating to Picketing," as laid down by recent judgments, together with other information, at the offices, 7, Victoria-street, London, S.W. The report states that the Association has rendered good service in a number of strikes and labour disputes during the past year.

The Past Year.—Messrs. Willans and Robinson (Limited) again report a very prosperous year for 1898, the orders booked having amounted to over 53,700 H.P.. There were several noticeable features in the year's trade. The first is the great extension which is taking place in municipal and public company electricity stations, over 41,000 H P. of the company's output being for this class of work. Among the more important orders were the following :—

Liverpool Corporation	10,000	H.P.
Edinburgh Corporation	7,920	,,
Nottingham Corporation	3,565	,,
Brighton Corporation	1,650	,,
Chelsea Electricity Supply Co.	1,400	,,
Bristol Corporation	1,400	,,
Norwich Electricity Co.	1,300	,,
Hampstead Vestry	1,150	,,
St. Helens Corporation	1,080	,,
Westminster Electric Supply Corporation	1,080	,,

Repeat orders amounted to 43,900 H.P., and afford striking evidence, not only of the prosperity of the various undertakings, but also of continued confidence in the Willans engine. The shops have, in fact, been nearly filled with work for old customers. This, of course, resulted in many new orders being lost, on account of the impossibility of giving delivery. A third characteristic of the year's orders was the increase in the size of the units ordered. Until comparatively recently, 350 H.P. was the most usual size employed in lighting stations, and although some few of larger size were ordered, it was not until 1898 that the custom became general. During the year just ended the company has received orders for 13 engines of 1,200 H.P., two of 825, eleven of 700, six of 575, three of 450, besides some 45 ranging between 250 and 350 H.P. The tendency seems to be still upwards, as there are many inquiries for still larger sizes. Electric lighting continues to be the principal employment of the engines, orders for this work amounting to 36,700 H.P. ; but electric traction is now beginning to be of great importance also, and 14,000 H.P. were booked for this purpose, the principal customers being :—

Liverpool Corporation	10,000	H.P.
Bradford Corporation	1,400	,,
St. Helens Corporation	1,080	,,
City and South London Railway Co.	1,150	,,

The company have been making large additions to their plant to meet increasing business, and are now in a position to deal with very large quantities of work.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Jan. 18 to Jan. 24, with the ports of destination :—

Argentina—Buenos Ayres, £482 (telegraph material). ***Australasia***—Auckland, £223 ; Invercargill, £56 ; Lyttelton, £32 ; Melbourne, £145 ; Sydney, £81 ; Wellington, £1,649 (including £909 telegraph material). *Belgium*—Ostend, £5. *Canada*—Montreal, £11. *Ceylon*—Colombo, £69. *China*—Shanghai, £81. *Denmark*—Copenhagen, £192 (including £178 telegraph cable) ; Kolding, £259 (telegraph cable) ; Odense, £28 (telegraph material). *Eyypt*—Alexandria, £55. *Germany*—Hamburg, £110 (telegraph material). *Holland*—Amsterdam, £125 ; Flushing, £11. *India*—Calcutta, £1,698. *Japan*—Yokohama, £740. *Madeira*, £15. *Norway*—Christiania, £100. *Russia*—Reval, £66. *South Africa*—Cape Town, £845 ; Delagoa Bay, £279 ; Durban, £166 (including £68 telegraph material) ; East London, £1,268 ; Port Elizabeth, £1,416. *Straits Settlements*—Singapore, £115. *Sweden*—Gothenburg, £148 ; Stockholm, £533 (telegraph material). *Turkey*—Constantinople, £195 (telegraph cable). Total £11,198, against £15,321 in the corresponding week last year (Jan. 20 to Jan. 26).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Bradford.—Mr. A. H. Gibbings has presented a report in which he states that, owing to the continued increase in the demand for current, considerable extensions of the plant and mains will have to be made during the present year. The Committee have already placed orders for two 300 H P. sets, which it is expected will be delivered by the middle of September, but in order to meet all demands Mr. Gibbings advises that two additional 600 H P. sets should be ordered. The following is a summary of the work it is proposed should be carried out during 1899 :—

Machinery : Two 300 H.P. engines and dynamos, £4 500 ; two switchboards, £250 ; two condensing plants, £3,500 ; one motor generator for balancing, £800 ; one induced draught boiler, £1,800 ; one grinding machine for commutator, £50 ; motors and gearing for travelling crane, £150 ; two feed water heaters, £250 ; one feed pump, electrical (new works), £150 ; one lathe, £200 ; one drilling machine, £90 ; one shaping machine, £60 ; one screwing machine for pipes, £20 ; one feed pump, electrical (old works), £120. *Condensing reservoirs :* Extensions of existing condensing reservoirs for increased load at new works, estimated cost £3,000. *Cables :* For ordinary extensions to various districts, £10,000. *Batteries :* One additional battery of 1,500 ampere-hours capacity, to give 250 volts when discharged 50 per cent. £2,000 ; switchboard and connections for above, £250. *Buildings :* Additions to Bolton-road Works : one new floor in present battery room (principally of wood), £150 ; one new floor in old boiler shed, £200. Total cost, £27,540.

Mr. Gibbings further advises that the question of the extension of the electricity supply station buildings be considered, as when the additional machinery is put down there will be no further room for extensions.

Barnsley.—The Local Government Board has sanctioned the borrowing of £25,000 for electric lighting purposes.

Cable to Honolulu.—The House Commerce committee of the United States Parliament has reported in favour of a bill granting a charter to the Pacific Cable Co. to lay a cable from San Francisco to Honolulu. The bill proposes that the United States Government shall pay the company an annual subsidy of $100,000 for 20 years.

Croydon.—The County Council are extending the arc lighting. Seventy-nine arcs are to be erected at once, to be eventually increased to 100. £22,000 is to be borrowed for carrying out this work.

Depot Lighting.—The Midland Railway Co. have recently made a clearance of a number of ramshackle tenement buildings in Pancras-road, London, N., and, upon the site, have erected one of the most imposing coal depôts in the world. The depôt is on two levels, the lower of which has to be always artificially lighted. In order to effectively illuminate a building which covers an area of some 20,000 square yards, the company have erected what is likely to develop into the largest electricity generating station for railway purposes in the country. The Midland Co. has, from the first, been foremost in the use of electricity, wherever possible, at its various termini, depôts, and similar centres of railway activity, and the policy has been adopted to the full in connection with the arrangements made at the newest of the company's depôts. The new generating station is situated at Kentish Town, and the plant installed is intended to supersede the isolated plants at the Midland Hotel, St. Pancras, and at the Somers Town goods depot, at the latter of which current for lighting the St. Pancras passenger and goods station and the Somers Town goods depôt is generated. The plant at Kentish Town consists of four 300 H.P. Lancashire boilers, duplicate pumps, economiser, and exhaust feed heater. In the engine room are three Parker 200kw. steam dynamos coupled to Willans engines. Two exciters with a set of accumulator cells and the usual switchboard equipments complete the present plant. Space is available for extensions, and the offices comprise workshop, messroom, store room and residential engineer's office. The continuous-current system is adopted, as current for both power and lighing is required. The current is generated at from 2,000 to 2,300 volts, and conducted by armoured concentric lead-covered cables. The transformer rooms are situate at Kentish Town station (now in hand), St. Pancras goods station, and St. Pancras passenger station. The cables are in duplicate, and are chiefly underground with railway sleepers placed over them for protection from platelayers' picks. The installation will also be utilised to operate a large fan for the better ventilation of the Midland portion of the "Underground" connection of the railway ; and traversers and cranes for the new locomotion shed and works, which are about to be built. Although, when designed, the generating plant was intended to provide for a spare unit, the many applications for lighting and power already indicated will practically absorb the entire capacity, and additions are already in contemplation. At present 400 arcs and nearly 2,000 incandescents are in operation.

Dorking.—Mr. W. H. Trentham has been appointed consulting electrical engineer to the Council.

Electric Power Schemes.—At Manchester on Tuesday a meeting was held of the Executive committee of the Municipal Corporations in Lancashire and Cheshire opposed to the Lancashire and Cheshire and the South Lancashire and Cheshire Electric Power schemes. Resolutions were adopted that communications should be made with all the municipal corporations in the area of the conference urging them to adopt resolutions for opposing the second reading of the electric power bills.

German Cable to the United States.—A *Daily News* telegram states that a joint stock company has been founded at Cologne with a capital of half a million sterling, to lay a direct cable from Germany to the United States.

Glasgow.—Mr. John Young, general manager of the Tramways, has prepared a draft scheme for the extension of the overhead system to the various routes in the city. The next section recom-

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mended to be converted is the main east and west route, from Whiteinch to London-road and Dalmarnock, *via* Bridgeton Cross. Mr. Young advises that the work on this route should be begun immediately, and that the others should be taken up in the following order :—Overnewton to Crosshills and Langside, Pollokshaws and Shawlands, and Pollokshields routes from Eglinton Toll outwards. These routes might be joined, for a time at least with the Springburn system, thus avoiding the turning of cars in Mitchell-street. The estimated expenditure providing additional car sheds at Coplawhill, is £25,000, and of equipping the three routes £54,000, in addition to £61,000, the cost of renewing the lines in ordinary course. Mr. Young suggests that the Parkhead and Paisley-road route might then be undertaken, and the Maryhill and Mount Florida, Dennistoun and Kelvinside, Woodlands-road, and Possilpark and Govan lines dealt in the order most practicable. The Tramways Committee have endorsed Mr. Young's recommendation.

Grays (Essex).—The District Council have adopted Mr. A. H. Preece's scheme for the erection of electricity supply works.

Hammersmith (London).—Electric lighting extensions are to be carried out in this district, at an estimated cost of about £13,000. On the recommendation of Mr. G. G. Bell, the electrical engineer, the vestry have decided to engage a staff for the laying of mains.

Increased Discounts.—The St. James' and Pall Mall Electric Lighting Co. announce the allowance of a special discount of 8 per cent. on all accounts under the current scale of charging. The new discount comes into force as from 1st inst.

Inquest.—The adjourned inquest on the engine driver Pugh, who was found dead on his engine on the City and South London Co.'s line on the 10th inst., was resumed on Friday last, when it was announced that a second post-mortem examination of the body had been made in the presence of a number of medical men, including Drs. William Murray-Leslie, Morriss, Henry and Bell. The former medical man, a specialist, stated that the cause of death was syncope from ordinary heart failure. This was confirmed by Dr. Henry and by Dr. Bell. Dr. Morriss, however, adhered to the view that death resulted from electric shock. A fellow driver deposed that he had seen deceased on several occasions go into a dead faint. On that and other evidence the coroner (Mr. Walter Shröder), in summing up, remarked that the jury would have no difficulty in coming to a conclusion that death was not the result of electric shock. The coroner's views, however, had no weight with the jury, who returned a verdict that deceased was killed by an electric shock, but whether the shock was sustained accidentally or otherwise the jury declined to decide.

Lancaster.—A Local Government Board inquiry was held here last week into the application of the Town Council to borrow, amongst other sums, £10,000 for extensions at the electricity supply works. The Town Clerk stated that the demand for electric current rendered the extension of the plant and mains absolutely necessary. There was no opposition.

Light Railways.—The Board of Trade on Wednesday considered the objections of the Worcestershire County Council and the Stourbridge District Council to the confirmation of the order of the Light Railway Commissioners for the construction of an electric railway between Stourbridge and Kinver. Mr. Sydney Morse represented the promoters (the British Electric Traction Co.). After discussion an agreement was arrived at. After hearing an objection by the Kinver Council as to the width of the roadway, Sir Courtenay Boyle intimated that he could not alter the order as drafted by the Commissioners, and he should report to the Board of Trade accordingly.

London County Council.—At Tuesday's meeting it was announced that £11,020 had been loaned to Hammersmith Vestry and £20,000 to Newington (part of £50,000). Islington is to borrow a further £15,000. All these borrowings are for electric lighting extensions.

It was decided to refuse consent to the erection of additions to the works of the Western Electric Co., at North Woolwich, of 250,000 cubic feet extent, and to disapprove of the application of the Blackheath and Greenwich District Electric Light Co. to construct generating works on a site at East Greenwich on the ground that it was undesirable to sanction the construction of a wood and iron temporary enclosure in any part of the building.

Lieut.-Col. Ford has given notice of the following motion :—

"That in face of the application recently made by the Council to Her Majesty's Postmaster-General, with a view to a London municipal telephone service, and in face of the report of the Committee of the House of Commons last session, this Council views with grave concern the aims of the National Telephone Co. as contained in its bills now before Parliament, and accordingly refers it to the Parliamentary Committee to consider, after conference with the Highways Committee, the desirability of petitioning against the said bills, which appear to aim at a grosser and perpetual form of monopoly than that already enjoyed by the company, to the serious injury of the trade and business of the metropolis, which monopoly already deprives the ratepayers of London of a legitimate source of public revenue."

London Telephone Service.—At the conference at the Guildhall of the City of London, on Feb. 1, to consider the question of applying for a licence to establish a telephone service in conjunction with the London County Council and other local authorities within the London telephone area, the following resolutions will be proposed :—"(1) That this conference of delegates, representing the London County Council, the Corporation of London, and the other local authorities within the London telephone area, is of opinion that a joint application should be made for a telephone licence for the London telephone area, in accordance with the resolution passed by the Court of Common Council on Nov. 17, 1898—viz., 'That application be made for a licence to establish a telephone service in conjunction with the London County Council and other local authorities within the London telephone area.' (2) That this conference is of opinion that the London telephone service should be managed by the London County Council and the Corporation of London. (3) That this conference recommends a joint application to the Postmaster-General for the telephone licence, in accordance with the foregoing regulations. (4) That these regulations be submitted to the various authorities represented at this conference for their confirmation."—*Times*.

Manchester.—At a meeting of the Tramways committee, on Tuesday, it was decided to recommend the Corporation to adopt the overhead trolley system throughout the whole of the tramways in the city.

Museum Lighting.—The Trustees of the Natural History Museum, Cromwell-road, London, are making arrangements for introducing the electric light. The work will be executed in sections, and the electric light will be gradually introduced into the various parts of the extensive building—first of all, into the offices and studies of the staff and the workshops in the basement, and then into the various public galleries.

Newcastle-on-Tyne.—After full investigation and mature deliberation the Tramways committee decided, on Wednesday, by 15 votes to 2, to report to the Council in favour of equipping the whole of the old and new tramways of the city on the overhead trolley system. The committee are to consult with the Lighting committee as to the advisability of lighting the streets by means of arc lamps suspended from the trolley posts. A consulting engineer is to be at once appointed to supervise the whole of the work.

Peterborough.—Electric lighting matters seem at last to be making some progress in Peterborough, after the delays occasioned by local opposition. A suitable site has been secured near the river for the Corporation electric lighting station. Dr. J. A. Fleming, F.R.S., consulting engineer to the Corporation, and Mr. J. C. Gill, the borough engineer, are engaged on the plans and specifications. The system to be adopted is the three-wire continuous current, with batteries.

Parliamentary Bills.—The Vestry of St. Margaret and St. John, Westminster (London), invites the co-operation of London local authorities in opposing the bills before Parliament dealing with the construction of underground electric railways. The Vestry suggest that the extension of this class of undertaking should only be permitted when a comprehensive scheme, serving all districts, is presented for parliamentary consideration, such scheme to provide for the convergence of traffic to fixed points, where accommodation would be provided for passengers desiring to travel from one extreme point of London to another.

A petition has been presented to the Vestry of St. James's, Westminster, against the bill of the St. James' and Pall Mall Co. seeking powers to extend their electricity works in Carnaby-street.

The Vestry of Battersea (London) is in communication with other London local authorities as to the advisability of opposing the bill to be introduced by the County of London and Brush Provincial Co. seeking powers to connect up their various areas of supply in London. The Parliamentary committee of the Vestry recommend that the bill should be strongly opposed and seek the assistance of other local authorities in connection with this opposition. The London County Council is to be invited to co-operate.

A Bill has been deposited at the Private Bill office for powers to construct a ferry running on a submerged railway across the river Thames between Greenwich and Milwall. The railway will be worked by electricity, and the ferry will be available for vehicles, foot passengers, animals and general traffic. The gauge of the submerged rails will be 30ft., or such other gauge as the Board of Trade may approve. The capital of the Company will be £250,000, with borrowing powers to the extent of £83,300. The promoters are Mr. H. P. Hussey, Mr. A. F. Hills (Thames Ironworks Co.) and Mr. E. D. Lennox Harvey.

The Lancashire Electric Power Co.'s bill has not passed the examiner of private bills, owing to non-compliance with the Standing Orders. It is stated that the promoters of the two Lancashire electric power schemes intend to ask the assent of the Standing Orders Committee to the suspension of the orders.

Mr. Thoms, one of the examiners of private bills, has held that certain of the allegations of non-compliance with the rules of Par-

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liament by the promoters of the Leicestershire and Warwickshire Electric Supply Bill have been sustained, and the non-compliance will be referred to the Select Committee on Standing Orders.

Memorials presented against the National Telephone Co.'s Bills through the Standing Orders stage allege that the notices given by the Company of their intended application to Parliament were defective, insufficient, vague, and misleading. It is alleged that the notices were not published in the manner prescribed by the Standing Orders in newspapers circulating in the cities and districts affected by the Bills, whilst the notices that were given in the London, Edinburgh, and Dublin *Gazettes* contained no intimation of some of the principal provisions in the Bills.

St. Giles (London, W.C.).—The Board of Works have finally approved the arrangements made by the Board of Trade in regard to the supply of electrical energy in this district by the Charing Cross and Strand Electricity Supply Corporation under their Holborn and St. Giles Electric Lighting Order, 1895.

Salford.—On Wednesday the Borough Council resumed the discussion on the report of the Electric Lighting committee, recommending the appointment of Messrs. Lacey, Clirehugh and Sillar as consulting engineers. Eventually an amendment that Messrs. Lacey, Clirehugh and Sillar should be appointed consulting engineers, provided that the committee gave the Council an undertaking to set aside the present specifications and start *de novo* was passed.

Scholarship Examinations.—The Board of Control of the Electrical Standardizing, Testing and Training Institution, have made the following awards:—A Maxwell Scholarship of 50 guineas to Mr. Gerald Adamson Hopkins, tenable for two years; an exhibition of 30 guineas to Mr. Thomas Gregory Smith, of Blackheath School, tenable for two years; a prize of 20 guineas to Mr. Leonard Roseveare, of Dunheved College, Launceston.

Southport.—A Local Government Board inquiry was held on Tuesday into the appplication of the Town Council to borrow £3,500 for electric lighting purposes.

Telephone Span Wires.—The National Telephone Co., in its application to the Islington (London) Vestry for permission to work certain overhead wires in spans exceeding the distance allowed by the London Overhead Wires Act, points out that every effort is being made to reduce the length of spans where such have exceeded the limits allowed by the act. It is intimated, however, that it is impossible to undertake to shorten these spans unless the company is granted compulsory powers. If the company cannot obtain from the Vestry an extension of the six months allowed some time back for altering the spans, it is intimated that these lines will have to be taken down and the subscribers disconnected.

Windsor Castle.—Electric current is to be taken from the mains of the Windsor Electric Installation Co. for the lighting of Windsor Castle. Hitherto current has been generated at an independent station under the north terrace opposite the royal library. The work is to be completed before Her Majesty's return from Osborne.

Workhouse Lighting.—The Ecclesall (Sheffield) Board of Guardians are ascertaining the cost of lighting the new hospital and administrative block electrically.

Electro-Harmonic Society.—A smoking concert will be given at the St. James's Hall Restaurant, Regent-street, W., this (Friday) evening at eight o'clock.

Staff Dinner.—On Saturday last the staffs of the London and Belvedere offices of Callender's Cable and Construction Co. (Limited) held their first annual dinner at the Bridge House Hotel, London Bridge, Mr. Manning (secretary) occupying the chair and Mr. Johnston (manager at Belvedere) the vice chair. A large company enjoyed a pleasant evening.

BOOKS RECEIVED.

"Die Ankerwicklungen und Ankerkonstruktionen der Gleichstrom-Dynamomaschinen." By E. Arnold. Third edition. (Berlin: Julius Springer.)

"Lockwood's Builders' Price Book" for 1899. Edited by Francis T. W. Miller. (London: Crosby Lockwood and Sons. Price 4s.)

"Lezioni di Elettrotecnica," by Galileo Ferraris. (Turin: Roux, Frassati and Co.)

"*Proceedings* of the Royal Society," No. 406, Vol. LXIV. (London: Harrison and Sons.) Price 2s. 6d.

"Continuous-Current Dynamos, in Theory and Practice," by J. Fisher-Hinnen. (London: Biggs and Co.) Price 10s. 6d.

"The Official Gazette of the United States Patent Office." No. 2. Vol. LXXXVI. Published by authority of Congress. (Washington: Government Printing Office.)

"The Light Railways Act, 1896." With Notes by Evans Austin. Second Edition. (London: Reeves and Turner.) Price 5s.

"Die Bisherige Versuche mit Elektrischen Zugtelegraphen." By L. Kohlfürst. (Stuttgart: Ferdinand Enke.)

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom all information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

January 5, 1899.

218. J. MÜHLENTHALER. Germany. Improvements in safety plugs for electric installations.
252. J. T. LISTER. London. Means for uniting the filament and leading-in wires of an incandescent electric lamp.*
278. W. PECK. London. Improvements in electrically-propelled road vehicles.*

January 6, 1899.

293. A. E. BAINES. London. Improvements in electrical reaction or choking coils.
338. G. W. MORGAN. Aberdeen. Improved electric arc lamp for portrait photography.
356. L. W. GANS. London. The manufacture of incandescent materials suitable for electric lighting.

January 7, 1899.

380. C. A. LEE. London. New or improved switches, wall sockets, contact makers and the like for use with incandescent electric lamps, in which the filament is formed of substances which conduct only at high temperatures to which it is previously heated by a hot shunt.
405. A. ECKSTEIN and R. P. EIDSFORTH. Salford. Improvements in jacks used in combination with electrical annunciators or indicators for the automatic replacement of the shutter or signal flag.
407. E. DUSSEK. London. Improvements in insulated overhead conductors for electrical railways and tramways.
416. A. BARMAN. London. Improvements in electrical heaters.
422. C. E. CAMPBELL. London. An improvement in or relating to electric light switches.
427. W. H. COTTON. London. Improvements in electric igniters for gas engines.*

January 9, 1899.

462. E. J. SHAW. Walsall. Improvements in arc lamps and lanterns.
465. J. WHITCHER. Isle of Wight. Improvements in electric ceiling roses, fuse and junction boxes and wall-sockets.
485. R. W. PAUL. London. Improvements in telegraphic relays.
489. A. S. BOWLEY. London. Improvements in phonographic apparatus.
490. H. W. SULLIVAN. London. Improvements in electrical relays and transmitters.
503. E. BELZON and P. ROYER. London. Improved advertisement frames adapted for the rooms of travellers' hotels and provided with an electrically actuated clock with an alarm if desired.*
513. H. F. FREED, I. FREED, D. K. CLINK and G. J. REED. London. An improved electromechanical system for providing additional security for safes, vaults and similar receptacles for the storing of valuables.*
514. THE DAVY ELECTRICAL CONSTRUCTION CO. (LIMITED) and J. L. E. DANIEL. London. Improvements in electric arc lamps.
516. A. MUIRHEAD. London. Improvements in telegraphic receiving and translating instruments.
517. C. D. ABEL. London. Improvements in type-printing telegraph apparatus. (Siemens and Halske Aktiengesellschaft, Germany.)

January 10, 1899.

537. J. S. HIGHFIELD. St. Helens. Improvements in pressure regulating apparatus for electric mains used chiefly in connection with storage batteries.
540. P. V. MCMAHON. London. Improvements in methods of operating electro-motors and controllers and switches connected therewith.
571. H. V. JAMES. Salford. Improved electric arc lamp clutch and feed mechanism.
580. D. H. WILSON. London. Telephone systems.*
582. J. DUGDILL. Manchester. A method of operating electric tramcars, &c., where a combined or alternate fixed line conductor and accumulator traction is used.
626. A. L. BAIRD, London. Improvements in or connected with telephonic instruments. (T. Barnet, New South Wales.)*
633. F. HACHMANN, C. PFEIFER and C. ERNST. London. Improvements in printing telegraphs.*
635. C. FRANZEN. London. Improvements in electrical appliances for controlling the supply of gas to burners and effecting its ignition from a distance.

January 11, 1899.

655. F. P. COX. Liverpool. An improved locking and releasing device for electrical switches.
656. F. P. COX. Liverpool. An improvement in electrical switches.
657. F. P. COX. Liverpool. An improved electrical fuse holder.
672. H. W. WILSON. Norfolk. Improvements in continuous-current electric dynamos or generators for train lighting purposes.
690. E. H. TYLER. London. Improvements in means for forming eyes on wire and other ropes, especially applicable to span wires for overhead conductors in electric tramway systems.

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699. TINKER AND HOLLIDAY (LIMITED) and W. CARDNO. London. Improvements in and relating to electric furnaces for the production of calcium carbide and other substances.
710. P. E. E. RAVEROT and P. F. L. BELLY. London. Improvements in or relating to apparatus for electrically controlling mechanical movements.*

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1897.

24,262. VICKERS SONS AND CO. (LIMITED), DAWSON and BUCKHAM. Electric firing apparatus for ordnance.
30,253. LAKE (Cornara). Electro-chemical explosive device.
30,259. WILSON and EVANS. Method or methods for controlling a mechanism or mechanisms by means of electric or electromagnetic waves of high frequency.
30,846. WILSON and EVANS. Method or methods for controlling a mechanism or mechanisms by means of electric or electromagnetic waves of high frequency.
30,923. LEIGH (Sprague). Electric elevators.

1898.

525. THOMPSON. Electric signalling.
933. POLLAK. Electrolytical condensers and electric current-directing devices.
1,140. LEIGH. (The Gesellschaft zur Verwerthung elektrischer und magnetischer Stromkraft (System Schiemann and Kleinschmidt) ad Wilde and Co.) Electro-magnets for electric traction.
1,557. SCULL. Clock-work-operated mechanism for switching electrical current.
2,021. JENSEN. (Patentaktiebolaget Svea.) Electrical log recording instrument for the cabin.
2,417. BOUCHET. Electric circuit breakers. (Date applied for under International Convention, July 2, 1897.)
2,485. OLIVER. Electric arc lamps.
3,507. EVERSHED AND VIGNOLES (LIMITED) and EVERSHED. Electric meters.
4,621. SPOONER. (Vassia.) Electric arc lamps.
8,179. DICK. Means for electrically lighting railway carriages.
19,110. OGDEN. Method of suspending curtains, electric lamp wires, and other articles.
19,668. RICHARDSON, JEVONS and GENT. Mechanism of electrically illuminated devices for automatically making and breaking electric circuits used in such electrically illuminated devices.
22,081. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). (Thomson.) Means for adjusting the reluctance of magnetic circuits.
23,533. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). (Hartham.) Electric arc lamps.
23,958. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). (Thomson.) Electric measuring instruments.

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Co. (Limited).

The fifty-third half-yearly ordinary general meeting of this Company was held on Thursday, January 19, 1899, at Winchester House, Old Broad-street, London, under the presidency of the Marquess of TWEEDDALE, K.T., "to receive the Directors' report and accounts, elect Directors and auditors, and transact the ordinary business of the Company."

The SECRETARY (Mr. George Draper) having read the notice convening the meeting and the minutes of the fifty-second half-yearly and of the extraordinary general meetings held on July 21, 1898,

The CHAIRMAN (having signed the minutes) continued: Gentlemen, I have now to ask your approval of the report and accounts for the first half of our financial year, and in doing so I shall, as usual, draw your attention to the more important features of the business of the last half-year. The gross revenue for the half-year under review amounted to £444,011, or an increase of £284 as compared with that for the corresponding period of 1897.

With regard to this increase, I may mention that during the September half of 1897 we derived extra traffic from Crete, owing to the disturbed condition of that island, but the traffic has resumed its normal state in the half-year under review. There are other fluctuations in various classes of our traffic, but in no case are they important enough to demand any special attention.

The total ordinary expenses for the half-year ended September 30, 1898 amounted to £121,376, or an increase of £12,133. This increase comprises in the present half-year's figures several items of an exceptional character which did not appear in the corresponding period. For instance, duty on new capital, which was issued with your sanction, cost £2,000; then the expenses in connection with the conversion of shares and the issue of new stock amounted to £662; there is also the item under the heading of "Negotiations with foreign Governments, &c.," £3,942. This latter item relates to expenses which have been incurred in connection with different businesses which we are considering, the nature of which will be intimated to you when they come to a conclusion. There is also a subscription which we made to the West Indies Relief Fund of £26. Those items make a total of £6,630, for what may be described as extraordinary expenses. The increase, therefore, in the ordinary expenses may be put at £5,503.

The nature of this increase was fully explained at the last meeting, when it was attributed to the introduction of the automatic system of signalling necessitating additions to our staff, and also to the cost of improved electrical apparatus, together with the various expenses incidental to the necessary increased number of our employés.

If we compare the present half-year's figures with those submitted at the last general meeting, after deducting in each case the items of an exceptional character, you will find that the increase is comparatively very little. I may remark, however, that our expenses have a tendency to grow in a greater ratio than the revenue. I have dealt with this subject on former occasions, but as it is a very important one in connection with the affairs of the Company, I need not apologise for again referring to it.

We have always, as you are aware, kept in mind that a company like ours exists for the benefit of the public as well as for that of its shareholders, and we have, therefore, spent, and shall continue to spend, large sums in improving the efficiency of our service by increasing the number of our cables, by the introduction of the most modern plant and electrical appliances, and by dealing liberally with our staff.

Again, we have from time to time made extensive, and may make still further, reductions in our rates. All this entails considerable increase in our working expenses, while the lowering of our rates, although generally followed by a greater volume of traffic, does not always ensure an increase in our revenue. In fact, not infrequently the contrary is the case. It is only, therefore, by the exercise of strict and judicious economy—consistent with efficiency—that the working expenses can be kept within proper limits. This duty, I can assure you, is never lost sight of, and you may rely upon it that when any increase of expenditure takes place it will be shown to be fully justified.

For the reasons given at the last general meeting—which were that we had re-arranged our headings with the view of our making more careful comparisons in future—it will not be possible to compare the several items in abstracts "A" and "B" with those of the corresponding period of 1897. As compared with last half-year, however, you will find that the general expenses in London amounted to £12,875, showing a decrease of £49. Working expenses at stations were £93,589, showing an increase of £2,328 as compared with those of last half-year. This increase is mainly due to annual promotions and the increase in number of the staff at the stations. There is also an increase under the heading of electrical instruments, stationery and printing, but a decrease under several of the other headings—such as furniture, land lines, &c.—all of which are more or less subject to fluctuation.

Expenses attending repairs and renewals of cables amounted to £41,716, or an increase of £10,079. In comparing the actual ships' expenses we find a decrease of £2,571. The increase in the total is due to the large amount of cable used on repairs, the Malta-Alexandria No. 2 cable (a very old one—about 28 years old) alone requiring no less than 222 knots. The amount received from Governments and other companies for repairs to their cables during the half-year was £7,172 less than in the corresponding period of last year.

The charge against revenue for interest on Preference shares and Three and a-Half Preference stock is £4,399 more than in the corresponding period of 1897. The dividend for the quarter ended June 30 on the old Preference shares was the same as in the previous year, but the dividend on the Preference stock for the September quarter was £4,399 more than the dividend on the Preference shares during the same quarter in 1897. This is made up partly of the increase that was given to the Preference shareholders when the conversion took place, and it also includes the dividend on that portion of the additional issue of £500,000 stock which was paid up in July last, and was, therefore, entitled to dividend for the September quarter.

The net result of the working during the half-year may be briefly summed up as follows:—The gross revenue amounted, as I have already said, to practically the same figure as last year, but the working expenses, the expenses in connection with repairs to cables, and the charges against revenue in respect of dividend on the additional amount of Preference stock were all heavier, so that we carry £5,000 less to the general reserve fund, £15,000 less to the minor reserves, and £6,457 less balance forward to next half-year. Notwithstanding these reductions, gentlemen, I think, after the explanations which I have given you, you will consider the result of the half-year's working highly satisfactory. I am glad to be able to add that the receipts so far as we have gone in the current half-year have been fully maintained.

I mentioned at the last meeting that the conversion of the Six per Cent. Preference shares into Three and a-Half per Cent. Preference stock had been successfully effected. You will see by paragraph 6 of the report that the Ordinary shares have also been converted into stock, and that the Stock Exchange has granted official quotations for both classes of stock. The work in connection with these operations has necessarily been very heavy, but it has been expeditiously carried through, with the least possible inconvenience to our shareholders and others concerned. The Preference stock certificates have practically been all issued, and the greater portion (about 8,000) of the Ordinary certificates have been issued, but there are still about 800 shareholders who have not sent in their old Ordinary share certificates to be exchanged for Ordinary stock certificates. If there should be anyone here who has not done so, we shall feel obliged by his giving the matter attention without delay.

With reference to the additional cables between Porthcurnow and Gibraltar, and Malta and Alexandria, you will see from the report that the first section has been laid. Since the report was issued the remaining sections between Gibraltar and Malta and Malta and Alexandria have also been successfully completed, and will shortly be opened for traffic. When this is done, the telegraphic service between Great Britain, Egypt, and the Far East will be greatly improved. The cost of these cables will be taken partly from the general reserve fund.

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We have under consideration tenders for a new cable repairing steamer to replace the "John Pender," which has been sold. We did not part with the old ship without some feelings of regret, although she was somewhat antiquated as regards her hull and propelling power. During her service as a repairing steamer she did a great deal of good and useful work, but the axiom, "Time is money," is peculiarly applicable to the repair of cables, and we considered it was very desirable, therefore, to replace her by a larger and faster vessel, and one capable of carrying a larger quantity of cable. The amount received for the old ship will be credited to the maintenance ships' fund, and the cost of the new vessel will be taken out of that fund.

I think that I have now touched on all the important matters connected with our business during the half year under review, and I will, therefore, conclude by moving—

"*That the report and accounts of the Directors to September 30, 1898, submitted to this meeting, be and the same are hereby received and adopted.*"

The VICE-CHAIRMAN and MANAGING DIRECTOR (Mr. J. Denison-Pender): I have pleasure in seconding that resolution.

The CHAIRMAN: You have heard the resolution moved by myself and seconded by Mr. John Denison-Pender; and those who are in favour of it will please signify the same in the usual manner. Those of a contrary opinion. Carried unanimously. Then, gentlemen, although this is the first half of the year, yet, under our Articles, Directors are re-elected, and therefore, I am going now to move—

"*That Clement Sneyd Colvin, Esq., C.S.I., who now retires, be and he is hereby re-elected a Director of the Company.*"

The VICE-CHAIRMAN and MANAGING DIRECTOR: I have also the pleasure of seconding that motion.

The CHAIRMAN put the motion in the usual way, and having declared it carried unanimously, said: I now propose—

"*That Sir Henry Charles Fischer, C.M.G., who now retires, be and he is hereby re-elected a Director of the Company.*"

Sir ALBERT J. LEPPOC CAPPEL: I have much pleasure in seconding that.

The CHAIRMAN put the motion and declared it carried unanimously. Continuing, he said: The next resolution relates to the appointment of auditors, and that will be moved in the body of the hall.

Mr. MUIR (a shareholder): I beg to propose the following resolution—

"*That the firms of Messrs. Deloitte, Dever, Griffiths and Co. and Messrs. Welton, Jones and Co. be and they are hereby elected auditors to the Company for the ensuing year, at a remuneration of £100 to each firm.*"

Mr. ANSELL (a shareholder): I beg to second that.

The CHAIRMAN: The resolution which you have just heard read has been proposed by Mr. Muir and seconded by Mr. Ansell. Those who approve it will please to signify the same in the usual way. On the contrary. Carried unanimously. Gentlemen, that constitutes the business of the ordinary meeting; but there is an extraordinary meeting, of which you have had notice, and I will ask the Secretary to read the notice.

The SECRETARY accordingly read the advertisement convening the Extraordinary General Meeting, which was for the purpose of considering and, if thought fit, passing the following resolutions:—

"*1. That Article 29 of the Company's Articles of Association be altered by striking out the amount £10, and inserting in lieu thereof £1.*"

"*2. That the Directors of the Company be and they are hereby authorised (in accordance with Section 6 of the Eastern Telegraph Company's Act, 1898) from time to time to create and issue Debentures or Debenture stock charged on the revenue and undertaking of the Company, so, however, that the total amount of Debentures or Debenture stock for the time being created and issued shall not exceed one-third of the total amount of the capital in Ordinary and Preference stock and shares for the time being created and issued and paid up, and so that all Debentures or Debenture stock created and issued by virtue of this section shall rank* pari passu *with the existing 4 per centum Debenture stock of the Company.*"

The CHAIRMAN: Gentlemen, before asking the meeting to pass the resolutions which have just been read, I will explain the necessity for altering the Articles of Association in the first instance, and the advisability of granting powers to the Directors to issue from time to time the balance of the mortgage debenture stock in the second place. With regard to the first resolution, I will read the Article as it at present stands:—

"When any ordinary shares shall have been converted into stock, the several holders of such stock may thenceforth transfer their respective interest therein, or any part of such interest, not less than £10 in nominal amount, and not comprising any fractional part of a £, in the same manner, and subject to the same regulations, as and subject to which any shares in the capital of the Company may be transferred, or as near thereto as circumstances admit."

You will see that the Article limits the dealings in the ordinary stock to a minimum of £10, but as the preference stock can be dealt with in multiples of £1, it is considered that the holders of ordinary stock should have at least the same facilities in dealing as the holders of preference stock, and, unless we alter the Article, it may cause considerable inconvenience to the holders of ordinary stock. For instance, supposing a holder of £100 stock wished to transfer £95, he could do so according to the present conditions, but as there would be £5 remaining in his account, he could not transfer it, because it would be under the minimum of £10 limited by the Article. So much with reference to the first resolution.

With regard to the second resolution, according to the terms of the special resolution annexed to the original prospectus, the Board of Directors were authorised from time to time to create and issue mortgage debenture stock of the Company to an amount not exceeding one-third of the share capital of the Company for the time being paid up. But when the conditions under which this stock could be issued were embodied in the Eastern Telegraph Co.'s Act of 1898, powers to create additional debenture capital were granted, subject to the sanction of the members in general meeting.

It may frequently happen that it is advisable to issue small portions of this stock in order to acquire shares in other telegraph companies, or for other capital purposes; and also to exchange this stock on certain terms for the Five per Cent. Debentures repayable in 1899, and it would be inconvenient to call a special general meeting of shareholders every time it was found expedient to issue a small portion of the stock. We are therefore asking you to renew the powers which you granted to us when this stock was originally created. I may mention that so far as we know at present there is no necessity to issue any portion of the Four per Cent. Mortgage Debenture stock. Gentlemen, with these explanations, which I hope have been sufficient—and, if not, I shall be glad to answer any questions, or to ask the solicitor to do so—I will move these resolutions.

The SOLICITOR (Mr. Dawes): Do not read them again, my lord; let them be taken as read.

The CHAIRMAN: I beg to move the first resolution, which the Secretary read to you, and which you have at the back of the report, as to the alteration in Article 29.

Mr. GOODSALL: With respect to the issue of debentures, will you give the shareholders the first chance of taking them; and will the stock be issued at par, and not at a premium?

The CHAIRMAN: We are always disposed, as far as we can, to favour our shareholders. I think the shareholders present will admit that; but I should be indisposed to bind the Board to any promise. We have always shown, on every occasion, our disposition, as I say, to do all we can to meet the wishes of the shareholders, and, therefore, I think that you had better leave this matter in our hands with the assurance I have given. I now beg to move that resolution.

The VICE-CHAIRMAN: I beg to second it.

The CHAIRMAN put the motion in the usual way, and having declared it carried unanimously, said: I now move the other resolution, which is seconded by Mr. Denison-Pender in the same way. Having put the motion to the meeting and declared it carried unanimously, he said: That constitutes the business of our meeting.

Mr. PARITT: One word, gentlemen, before we part. There is always a pleasant duty which devolves on us at these meetings—to pass a vote of thanks to our noble Chairman and the gentlemen who sit with him for their services to us in the past six months, and for the very able report which they have been able to present to us again, I am sure we shall also wish to thank them. We must congratulate ourselves, I think, when we find that we are going along so prosperously. Therefore, it is my very great pleasure to propose a vote of thanks to the Chairman and the gentlemen who sit with him at the Board; nor must we forget our worthy Secretary, and the other members of the staff generally. In doing so, I must at the same time congratulate his lordship on the honour which Her Majesty has conferred on him in the distinction of Knight of the Thistle (cheers). It is out of our power to give him any decoration except to make him our Chairman, which is the highest decoration we can confer on him. The honour which has been bestowed on him has been without a doubt well deserved. I beg now, gentlemen, to propose a vote of thanks to our Chairman and all who have worked with him, and made the Eastern Telegraph Co. the valuable institution that it now is.

Mr. G. B. SYMES: I will second it.

The SOLICITOR put the resolution to the meeting in the usual way, and it was carried unanimously.

The CHAIRMAN: I beg to thank you for this vote on the part of my co-Directors and the staff, who, I understood, were embraced—and very properly embraced—in the vote of thanks. I have also to return my acknowledgments for the kind way in which the honour which has been conferred upon me has been alluded to. Let me assure you that I appreciate your goodwill quite as much as any other honour. I am very grateful for the cordial reception you have given to this motion, and I hope that when we next meet we shall be able to give you a dividend which will make you equally satisfied as you are on the present occasion (hear, hear).

The proceedings then terminated.

Yorkshire House-to-House Electricity Co. (Limited).

A general meeting of this Company (whose undertaking has now been purchased by the Leeds Corporation) was held on Wednesday, Mr. GROSVENOR TALBOT presiding.

The CHAIRMAN, in moving the adoption of the report and accounts, said that presumably this was the last annual meeting of the shareholders of the Company that would be held. The Company had been successful from its initiation, and he was confident it would have continued as successfully as in the past. It was a great satisfaction to him personally that round that table were assembled the Directors and solicitor with which the Company was initiated. They had paid during the past year an interim dividend at the rate of 5 per cent. per annum for the half year to June 30, and had now to dispose of £7,068. 19s. 5d. That amount they proposed to pay wholly in dividend. The amount available, with the interim dividend, would equal 6¾ per cent. for the year to Dec. 31, 1898, and a small balance of £87. 9s. 9d. was carried forward. That dividend showed that they were handing over to the Corporation a flourishing concern. The number of lamps the Company had installed in December, 1897, was 49,150; and at the end of September, 1898, 65,328, an increase of 16,178 lamps in the nine months. If they could have carried out installations at the same rate for the whole year, it would have shown an increase at the rate of over 40 per cent. for the year. They were told by some people in the town that they had increased their capital unduly, merely for the sake of inflating the profits of the Company. He thought he had shown that that was absolutely absurd, because they did not increase the capital at any greater rate than they increased the number of lamps installed; and, as a further proof, the Corporation saw the necessity of continuing their policy, and the newspapers told them that they had gone into an additional expenditure of

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£45,000. They had now in hand £217,420 of Corporation Five per Cent. Irredeemable stock, which would have to be dealt with in the future by the liquidator of the Company. That was very valuable stock, and it would be handed over to the shareholders in their due proportion. He felt he must at this meeting express his thanks, and the thanks of his colleagues, to those gentlemen who had worked with them so heartily from the commencement of their undertaking:—Mr. Hammond, the consulting engineer; Mr. Barr, the solicitor; Mr. France, the architect; Mr. Green, the secretary; Mr. Dickinson, the electrical engineer, and others.

The resolution was adopted.

The Chairman and Mr. R. W. Eddison were re-elected Directors.

The CHAIRMAN proposed that they should grant a honorarium to Mr. Dickinson and Mr. Green, of 100 guineas each. He thought that was the least they could do to show their indebtedness to these two men, who had given such untiring devotion to their work during the last six years.

This resolution was adopted unanimously, and, after a formal resolution to wind the Company up voluntarily, and a vote of thanks to the Chairman and Directors had been passed, the proceedings terminated.

City and South London Railway Co.

The following report of the Directors of this company for the half-year to Dec. 31 last will be presented to the half-yearly meeting of shareholders, on Tuesday, 31st inst.:—The receipts from all sources have amounted to £27,588. 9s. 4d., and the cost of working has been £15,498. 5s. 7d., leaving a profit of £12,090. 3s. 9d. Inclusive of balance brought forward, the net revenue account shows a total of £13,171. 0s. 8d. After making provision for Debenture stock interest, a balance is available for dividend of £10,190. 12s. 9d., and the Directors recommend that the full dividend be paid on the Five per Cent. Preference shares, and a dividend at the rate of 2 per cent. per annum on the Consolidated Ordinary stock, leaving £1,419. 12s. 6d. to be carried forward.

The number of passengers (exclusive of season ticket holders) carried during the half-year shows a considerable increase over the corresponding half-year of 1897.

The progress of the Moorgate-street extension has been uninterrupted; both tunnels are completed from the junction with the present line at the Borough to Moorgate-street station, and the three underground stations are almost finished. The shafts are ready for the lifts, the erection of which has already been commenced. The laying of the permanent way is also well advanced, and the subway communication between the Lombard-street station of this company and the Bank station of the Central London has been constructed. The station buildings on the surface at Moorgate-street, Lombard-street and London Bridge will be commenced forthwith. The works of the extension from Stockwell to Clapham Common are progressing very satisfactorily, and it is anticipated that the line will be completed ready for traffic early in the autumn of this year. The erection of the new boiler and engine house at the depôt at Stockwell is proceeding rapidly, and will be ready for the erection of the engines in March. The three locomotives referred to in the last report have been delivered, and, as their working has given satisfaction, tenders for the full number required are now being invited. The thirty additional coaches required are now in course of delivery.

The works of the extension through the heart of the City having now been completed, it is necessary, in order to utilise fully this valuable portion of the line, that the remainder of the authorised undertaking, carrying the line to the Angel at Islington, and thus bringing in the traffic from the north as well as from the south, should at once be proceeded with, and steps have already been taken to secure the site of one of the three stations along the route. It is proposed to let the contract for the works as soon as favourable arrangements can be made. It is anticipated that this portion of the railway will be constructed at a very moderate cost, and can be worked economically, with power supplied from the generating station at Stockwell.

Negotiations are in progress with the London, Brighton, and South Coast Railway Co., for the construction of the subway authorised by the Act of 1893, connecting this company's new station at Denman-street with the London Bridge station of the Brighton company.

In order to further facilitate and economise the working of the City and Brixton Railway, which, when completed, is to be leased to this company, it has been arranged that, in lieu of providing a separate depôt for the Brixton Company, a short tunnel should be made connecting that company's line with this company's depôt at Stockwell. A bill has been introduced into Parliament with this object.

Direct United States Cable Co. (Limited).

The report of the Directors of this company for the six months to Dec. 31 last states that the half-year's revenue, after deducting out-payments, amounted to £54,366. 4s. 10d. compared with £50,098. 2s. 8d. for the corresponding period of 1897, an increase of £4,268. 2s. 2d. The working and other expenses for the same period, including income tax, amounted to £21,620. 19s. 11d., leaving £32,745. 4s. 11d. as net profit, making, with £3,388. 11s. 9d. brought forward, £36,133. 16s. 8d. Interim dividends of 3s. per share for the quarter ended Sept. 30 and of 3s. per share for the quarter ended Dec. 31 (taking £18,213) have been declared, and after setting aside £12,000 to reserve, the balance of £5,920. 16s. 8d. has been carried forward.

No repairs of the cables have been necessary during the half-year. Reserve has been debited with £1,548. 0s. 2d., the balance of the Ballinskelligs buildings and Rye Beach land accounts now written off, and after being credited with interest, realised profit and sum transferred from revenue the balance of the reserve fund, taking the investments at cost price is now £368,534. 1s. 7d.

NEW COMPANIES, STATUTORY RETURNS, &c.

GIFFRE ELECTRO-CHEMICAL AND POWER CO. (LIMITED).—This company was registered on Jan. 18, with a capital of £140,000 in £1 shares, to acquire all or any of the capital, stock, debentures, obligations or securities of the Societe Electro-Chimique du Giffre, to work, develop, and manufacture any articles in accordance with any chemical, electro-chemical, or electrical process, to manufacture, sell and deal in carbide of calcium, and to carry on the business of chemists, &c. The first Directors are:—W. H. Grenfell, John Paddon and Ernest E. Sawyer.

RECORDING TELEGRAPHS (LIMITED).—This company was registered on Jan. 17, with a capital of £7,500 in £50 shares, to subscribe for, underwrite, issue, deal in and convert stocks, shares and securities, and to acquire, develop and deal with any letters patent, brevets d'invention, or rights. The first subscribers are: Capt. R. L. Cowper-Coles, Walter T. Goolden, civil engineer, E. J. Wood, electrical engineer, J. A. Currie, E. P. Reynolds, C. E. Spagnoletti, electrical engineer, and E. E. Cobb.

MATHER AND PLATT (LIMITED).—This company was registered on Jan. 21, with a capital of £775,000, in £10 shares (of which 37,500 are £5 per Cent. Cumulative Preference), to acquire and take over as going concerns the businesses of Mather and Platt, Limited (incorporated in 1892), and of Dowson, Taylor and Co. (Limited), and to carry on the business of mechanical, electrical and hydraulic engineers, machinists, tool makers, boiler makers, founders, metal workers, electricians, &c. The first Directors are: William Mather (chairman), John Platt, Edward Hopkinson, John Taylor, Colin Mather, John Milligan, Hardman A. Earle, John Wormald, J. J. Holden, W. Ernest Mather and Alfred Willett.

AUTOMATIC TELEPHONE CO. (LIMITED).—The annual return, to Jan. 6, has been filed. The capital is £100,000, in 5s. shares, and 314,326 of these have been taken up. 270,296 have been issued as fully paid, and 4s. per share has been called on 17,620, and 1s. per share on the remaining 25,410 shares.

HAMPSTEAD ELECTRIC SUPPLY CO. (LIMITED).—This company's statutory return, to Dec. 4, was filed on Jan. 13. The capital is £200,000, divided into 20,000 Preference and 20,000 Ordinary shares of £5 each. 6,589 of the former and 6,000 of the latter have been taken up, and the full amount has been called, resulting in the receipt of 58,647. 12s. 4d., and leaving £4,297. 7s. 8d. in arrears.

SMITHFIELD MARKETS ELECTRIC SUPPLY CO. (LIMITED).—The annual return, to Jan. 6, has been filed. The capital is £100,000, in £5 shares. 12,000 of these have been taken up and the full amount has been called.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Jan. 19, 1899). Price of silver 27⅜d. per oz. (Jan. 26). Consols (2¾ per cent.) 111—111⅛ for money, 111 1/16—111 3/16 for account; 2½ per cent. 103½—104½ (Jan. 26). Stock Exchange Settling Days: Consols, Feb. 1; Stocks and Shares Continuation Days, Feb. 8 and 22; Ticket Days, Feb. 9 and 23; Pay Days, Jan. 27 and Feb. 10; Mining Share Carry over Days, Feb. 7 and 21.

AMERICAN LIGHTING TRUST.—An effort is being made to form a combination, with a capital of $60,000,000, for the purpose of controlling the electric lighting and gas undertakings of Southern Indiana and Ohio.

ANGLO-AMERICAN TELEGRAPH CO. (LIMITED).—After placing £12,000 to renewal fund for the half year the directors recommend the declaration of the following dividends:—Balance dividend of £1. 4s. per cent. on the Ordinary Consolidated stock, balance dividend of £1. 10s. per cent. on the Preferred stock, and a first and final dividend of 18s. per cent. upon the Deferred stock for the year to Dec. 31 last, payable on Feb. 4, less tax. The balance is about £580. These dividends, together with those already paid, amount to £3. 9s. per cent. on the Ordinary Consolidated stock, £6. per cent. on the Preferred stock, and 18s. per cent. on the Deferred stock for the year 1898.

BARCELONA TRAMWAYS CO. (LIMITED).—The secretary of this company notifies that negotiations have been entered into for the sale of the company's undertaking at Barcelona, and the Board believe that the arrangements will be brought to a satisfactory conclusion at an early date. The lines will then be equipped electrically.

BLACKPOOL AND FLEETWOOD TRAMROAD CO.—The general meeting will take place at Manchester on Feb. 10.

CHAMBERLAIN AND HOOKHAM (LIMITED).—Subscriptions have this week been invited for 4,000 Cumulative Preference shares of £5 each at par in this company, which was registered in 1883, and has now been reconstructed in order to bring in more capital, enlarge the business and put the preference shares on the market. The new company takes over the assets of the old as from Jan. 1, 1898. The working of the old company for 1898 (the prospectus states) showed, after paying a dividend of 7½ per cent. on the paid-up Preference capital and of 5 per cent. on the Ordinary shares, a balance of undivided profit of over £25,000 to be carried forward. The list closes on or before 31st inst.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LIMITED).—The Directors of this corporation, after providing £7,000 for depreciation, carrying forward £3,500, have decided, subject to audit, to recommend a dividend for the half-year ended Dec. 31 at the rate of 10 per cent. per annum, making (with the interim dividend at the rate of 6 per cent. per annum for the June half year) 8 per cent. for the year on the ordinary share capital.

ELECTRICAL JOINT STOCK ENTERPRISE.—The *Investors' Guardian*, in a review of joint stock enterprise of 1898, gives the following figures

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regarding electrical companies for 1896-7-8. The total capital of English electrical companies for 1896 was £9,768,705, 1897 £5,059,800, 1898 £3,452,364; Scottish companies: 1898 £211,600; Irish companies: 1898 *n l*. For telephone ventures the English figures are for 1896 £264,000, 1897 £54,000, 1898 £854,000; Scottish companies *nil*; Irish companies *nil*.

GIFFRE ELECTRO-CHEMICAL AND POWER CO. (LIMITED).—Subscriptions have been invited this week by the General Water Power (Limited), for 130,000 shares of £1 each in the above company, which has been formed to acquire the shares of a French company, carrying on business in Haute Savoie, France. The assets of the French company include leases of certain lands, lime kilns, electric furnaces, and a factory containing from 1,000 H.P. dynamos, offices and works, &c., &c. It is stated that the requisite turbines and dynamos for an output of 4,200 E.H.P. are now in working order, and that an additional installation of equal power is to be completed by June 1 next. It is claimed that carbide of calcium can be economically manufactured at Giffre of exceptionally high quality. We are told that the capital required has already been subscribed.

HAMPSTEAD ELECTRIC SUPPLY CO. (LIMITED).—A firm of outside brokers has been issuing broadcast a circular inviting purchase of shares in the above-named company at £4. 19s. for the £5 share. The concern was introduced at the end of July last. It has *no* parliamentary powers, and operates by means of overhead wires—an antiquated method altogether—for the wayleaves for which it has to rely upon the good graces of every owner of property over which its wires pass. Its business could at any time be dislocated by the transfer of property. And what the maintenance of wayleaves means has been indicated by the experience of the old Brighton company, which had overhead wires and no statutory powers, and worked in opposition to the Corporation, who had underground mains and a provisional order. In the end the company went to the wall, and the Corporation got the business for £5,000. In Hampstead the Vestry have a provisional order under the Electric Lighting Acts, and give a splendid supply at a fairly cheap rate. The company is an opposition concern with overhead wires, and in time it must go. The prospect for shareholders is poor indeed, because the Vestry will never buy; they have no need to do so. The circular above mentioned sets out a number of electric-lighting shares, with their prices and dividends, but they are all of companies established under statutory powers, and the comparison of Hampstead with them is ludicrous.—*The Statist*.

LIVERPOOL OVERHEAD RAILWAY CO.—The accounts of this company for the past half-year show an available balance of £16,586, and the Directors have resolved to recommend payment of a dividend at the rate of 5 per cent. per annum on the Preference shares and 4 per cent. per annum on the Ordinary shares, against 3½ per cent. per annum on the Ordinary shares for the corresponding period last year. The balance carried forward is £4,586, against £2,878 last year.

METROPOLITAN RAILWAY CO.—In their half-yearly report, the Directors state that the arrangements for the experimental electrical working of the line between Earl's Court and High-street, Kensington, are well advanced, and that the work will be completed in about nine months' time.

NATIONAL TELEPHONE CO. (LIMITED).—Subject to final audit, the following dividends are recommended for the half-year to Dec. 31 last:—At the rate of 6 per cent. per annum, less tax, on the First and Second Preference shares; at the rate of 5 per cent. per annum, less tax, on the Third Preference shares; at the rate of 6 per cent. per annum, free of tax, on the Ordinary shares; carrying £50,000 to reserve and about £8,000 forward. The transfer books will be closed from 4th to 17th Feb.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT CO. (LIMITED)—The Directors of this company recommend a dividend for the half-year ended Dec. 31 of 7s. 6d., together with a bonus of 2s. per share on the Ordinary shares, making, with the interim, a dividend of 12½ per cent., and a bonus of 2 per cent. for the year 1898.

WATERLOO AND CITY RAILWAY CO.—The Directors recommend a dividend on the Ordinary stock at the rate of 3 per cent. per annum for the half-year ended Dec. 31.

WESTERN AND BRAZILIAN TELEGRAPH CO. (LIMITED).—The numbers are published of the 190 Six per Cent. debentures (series "A" and "B") of this company, which have been drawn for payment at par on Feb. 2.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Jan. 21	3,745	+ 278	...	...	...
Blackpool Corporation...	...	...	...	...	...	...
Blackpool and Fleetwood Co.	„ 21	129	...	3	410	...
*Bristol Trams & Carriage	„ 20	2,579	+ 198	3	7,642	+ 432
City & South London Ry.	„ 22	1,133	+ 58	4	4,419	+ 85
Dover Corporation	„ 21	148	+ 41	42	7,653	...
DublinUnited(Southern)	„ 20	634	+ 178	3	1,750	+ 534
Liverpool Overhead Rly.	„ 22	1,326	− 28	4	5,293	− 217
*Sheffield Tramways.....	„ 22	1,214	+ 227	3	3,699	+ 739
*South Staffs. Trams.....	„ 20	679	+ 45	3	1,766	− 19

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Jan. 18.		Price Wednesday, Jan. 25.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Week Ending Jan. 25.	
			TELEGRAPHS					£ s. d.		Highest.	Lowest.
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	103	104	103	104	3 16 11	January and July	..	..
25,000	10	..	Amazon Telegraph	3	4	3	4	..	..	..	..
£125,000	100	5%	Do. 5 per Cent. Debentures	91	94	87	92	5 6 5	..	..	..
£905,560	Stock	15/0	Anglo-American	67	69	67	69	4 7 11	Feb., May, Aug., Nov.	67½	..
£3,047,220	Stock	30/0	Do. Preferred	118½	119½	119½	120½	5 1 1	„ „	120¼	119½
£3,047,220	Stock	5/0	Do. Deferred	16⅜	17⅛	16⅜	17	..	„ „	17	16⅜
130,000	10	3/0	Brazilian Submarine	15½	15⅝	15½	16½	4 6 2	Mar., June, Oct., Dec.	16½	15⅜
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	110	114	110	114	4 7 9	June and December	..	..
10,000,000	$100	$2½	Commercial Cable Capital Stock	180	190	180	190	4 4 3	Jan., Apr., July, Oct.	..	..
£1,332,523	Stock	4%	* Do. 4 per Cent. Debenture Stock	103	105	104	106	3 15 8	„ „	104⅞	10 ½
16,000	10	8/0	Cuba Submarine Ordinary (Deferred)	9½	10½	9½	10½	6 13 4	February and August	9⅞	..
6,000	10	10/0	Do. Preference 10 per Cent.	17	18	17	18	5 11 1	„ „	..	..
12,931	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October	..	..
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	„ „	..	..
£30,000	50	4½%	Do. 4½ per Cent. Debentures	104⅞	107⅞	104⅞	107⅞	4 4 1	January and July	..	..
60,710	20	3/0	Direct United States Cable	11⅞	12½	11	12½	5 4 0	Jan., Apr., July, Oct.	12 1/16	1 ⅛
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	102	105	102	105	4 5 9	..	..	..
£4,000,000	Stock	6%	Eastern Ordinary	174	179	174	179	3 18 3	Jan., Apr., July, Oct.	178	176½
£1,295,000	Stock	3½%	Do. 3½ per Cent. Pref. Stock	103	103	103	106	3 6 0	„ „	105½	103
£1,432,268	Stock	6%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	124	128	125	129	3 2 4	May and November	127	125
£89,900	100	5%	* Do. 5 per Cent Debentures, 1909	101	104	101	104	4 17 0	February & August	..	..
£500,000	Stock	—	Do. Provisional Certificates (all paid)	103	103	103	106	..	..	..	..
250,000	10	2/6	Eastern Extension	17½	18	17½	18	3 17 9	Jan., Apr., July, Oct.	17⅝	17⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	129	126	130	3 2 6	February & August	129	..
£16,200	100	4%	* Do. 5 p. c.(Austin.Gov.Sub.)Deb.1900 (reg.)	99	103	99	103	4 17 1	January and July	..	..
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	..	..
£35,100	100	5%	*Eastern and S. African 5 p.c. Mor. Deb., 1900 (reg.)	99	103	99	103	4 17 1	„ „	100½	..
£46,500	100	5%	Do, (Bearer)	100	103	100	103	4 17 1	„ „	..	..
£800,000	100	4%	* Do. 4% Mortgage Debentures, 1909	104	107	104	107	3 15 8	February & August	..	..
£200,000	25	4%	Do. 4% Mauritius Sub. Debs. (red.)	104⅞	107⅞	104⅞	107⅞	3 15 2	May and November	..	..
180,227	10	1/9	Globe Telegraph and Trust	12½	12⅝	12½	13	3 13 10	Jan., Apr., July, Oct.	13	12⅝
180,042	10	6%	Do. 6 per Cent. Preference	16⅝	17½	16⅝	17½	3 9 7	„ „	16¾	..
150,000	10	5/0	Great Northern of Copenhagen	28½	29½	28½	29½	3 7 10	January, April, July	..	..
£150,000	100	5%	* Do 5 per Cent. Debs., 1883 issue Series "B"	101	104	101	104	4 17 7	March & September	101½	..
£97,800	100	4½%	Halifax & Bermuda Cable 4½%1st Mort.Deb.(red)	100	103	99	102	4 8 6	June and December	99	..
17,000	25	12/6	Indo-European	57	60	57	60	4 3 4	May and November	59	58
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904	109	112	109	112	5 7 7	March & September	..	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs.(red)	104	107	104	107	3 14 9	June and December	..	..
11,839	8	4/0	Reuter's	6½	7½	6½	7½	5 6 8	April and October	..	..
2,381	£100 Cert.	6%	Submarine Cables Trust	134	139	136	141	4 6 2	„ „	..	..
15,609	10	—	West African Telegraph	..	..	..	..	..	..	..	..
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	100	103	100	103	4 18 6	March & September	..	..
30,008	2½	—	West Coast of America	¼	1	¼	1	..	..	..	..
£150,000	100	6%	* Do. 4 per Cent. Debentures	102	105	102	105	3 16 2	June and December	..	..
88,321	10	1/6	West India and Panama	1⅞	2	1⅞	1⅞	..	May and November	1⅞	1⅞
34,568	10	6/0	Do. 6 per Cent. 1st Preference	10½	10⅝	10½	10⅝	5 11 7	„ „	10⅝	1 ½
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	„ „	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	104	107	4 13 6	January and July	..	..
64,269	15	5/0	Western and Brazilian Ordinary	12¼	12⅝	12½	12⅝	4 13 2	May and November	..	..
33,129	7½	3/9	Do. 5 per Cent. Preferred Ordinary	8	8⅛	8	8⅛	4 8 2	„ „	..	..
33,129	7½	1/3	Do. Deferred Ordinary	4	4⅛	4	4⅛	..	„ „	..	..
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	105	108	105	108	3 14 1	June and December	..	..
1,168,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	—		—		6 7 10	Feb., May, Aug., Nov.	..	..
£158,100	100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	98	103	98	103	5 16 6	March & September	97	..

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share	Last Dividend	Name	Previous Week's Price Jan. 18.		Price Wednesday, Jan. 25.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 25. Highest	Lowest
			TELEPHONES.					£ s. d.			
44,000	£5	4/0	Chili Telephone (fully paid)	2¾	3¼	2¾	3¼	6 3 1	August	–	–
224,850	10/0	1½d.	Consolidated Telephone Const. & Manufacturing	1/16	3/16	1/16	3/16	6 7 0	July	–	–
28,000	5	4/0	Monte Video Telephone 6 per Cent. Preference	–		..		–	October	–	–
490 000	5	3/0	National	5¾	6	5¾	6	5 0 0	February & August	5 15/16	5¾
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	14	16	14	16	3 15 0	" "	15¾	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	13	15	13	15	4 0 0	" "	–	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	5½	5¾	5½	5¾	4 6 11	" "	5¾	5 11/16
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	99	102	99	102	3 8 8	June and December	100½	–
171,504	1	0/4	Oriental	⅝	¾	⅝	¾	6 13 4	April and October	⅝	–
58,000	5	6/0	United River Plate	4¾	5¼	4¾	5¼	5 14 3	July	..	–
£151,788	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103	106	103	106	4 14 6	June and December	103½	–
			ELECTRICITY SUPPLY COMPANIES.								
6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	12½	12¾	12¾	13½	–	–	13¼	12¾
6,000	10	4/3 3/16	Do. 4½ per Cent. Cumulative Pref.	10¾	11½	10¾	11½	4 4 0	–	10¾	–
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	11½	12½	11	12	2 18 4	February & August	11⅝	–
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6¼	6	6½	3 9 3	" "	–	–
£34,000	5	2/6	Chelsea Electricity Supply Ordinary	8½	9½	8½	9½	3 3 2	March	9 13/16	..
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	113	115	113	115	3 18 3	June and December	..	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds(red)	103	105	103	105	4 15 3	–	..	–
50,000	10	5/0	City of London Elec. Lighting Ord. 40,001 to 90,000	22	24	23½	24½	5 2 1	February & August	24⅛	23¾
10,000	10	1/9	Do. Ordinary 90,001 to 100,000	21	23	21	24	..	..	23	..
40,000	10	6%	Do. 6% Cumulative Pref.	15½	16½	15½	16½	3 13 9	January and July	..	–
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	125	130	125	130	3 13 11	June and December	127½	..
30,000	10	–	County of London & Brush Prov. Ord. (1 to 30,000)	12½	13½	12½	13½	–	–	13 3/16	–
10,000	10	..	Do. (30,001 to 40,000)	12	13	12	13	..	–	..	–
20,000	10	6/0	Do. 6% Cumulative Preference	14½	15½	14½	15½	4 0 0	March & September	14¾	–
15,660	5	2/6	House-to-House Electric Lighting Supply Ord.	9	10	9	10	2 0 0	–	9½	–
12,000	5	3/6	Do. 7 per Cent. Preference	9½	10½	9½	10½	3 6 8	March & September	–	–
15,000	5	10%	Kensington and Knightsbridge Ord.	13	14	13	14	3 18 7	..	–	–
10,000	5	6%	Do. 6% 1st Pref.	7¾	8¼	7¾	8¼	3 12 9	January and July	..	–
110,000	3	–	London Electric Supply Ordinary	3	3½	3½	4	–	–	3⅞	3¾
48,050	5	–	Do. Preference	6½	6¾	6½	7	–	–	6⅞	6 7/16
£100,000	Stock	..	Do. 4% 1st Mort. Deb.	102	104	102	104	3 16 11	Mch., June, Sept., Dec.	103½	–
62,500	10	5/0	Metropolitan Electric Supply Ordinary	18½	19½	19	20	3 0 0	April and October	19½	18⅝
27,500	10	–	Do. (£4 paid)	11½	12½	12	13	..	–	..	..
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	115	119	118	121	3 14 7	June and December	118¾	118½
6,452	10	6/0	Notting Hill Electric Ordinary	17	18	17	18	3 6 8	March	–	–
10,000	5	–	Oxford Electric Ordinary	6	6½	6½	7	–	–	–	..
275,000	1	–	Rand Electric	⅞	1⅛	–		–	..	–	..
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb	86	91	83	91	5 9 1	–	–	–
150,000	$100	$2	Royal Electric Company of Montreal Shares	150	155	160	180	4 9 5	–	170	–
130,900	100	4½%	* Do. 4½% 1st Mort. Debs.	105	107	105	107	4 5 10	April and October	–	..
31,980	5	5/0	St. James and Pall Mall Electric Ordinary	17	18	17	18	4 9 0	February & August	17½	17⅜
20,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	" "	–	–
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.)	..		..		..	June and December	..	–
65,000	5	..	South London Electric Supply Ordinary (£3 paid).	3	3¼	3	3¼	..	..	3 3/16	3 1/16
79,900	5	5/0	Westminster Electric Supply Ordinary	16	17	15½	16½	3 18 9	March & September	16 1/16	15¾
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	2	1/2¾	Brush Electrical Engineering	1¾	2	1¾	2⅛	2 16 5	–	1 15/16	–
90,000	2	1/2¾	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	–	2¼	–
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	111	115	111	115	3 19 0	February & August	113	112½
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101	104	101	104	4 6 7	June and December	–	..
£20,000	5	5/0	Callender's Cable Construction	9½	10½	9½	10½	6 8 7	" "	10½	–
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	110	113	110	113	3 19 8	November and May	..	–
300,000	1	9¾	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	–	–	–
50,000	1	–	Chadburn's Ship Telegraph Ordinary	1⅛	1⅜	1⅛	1⅜	–	–	..	–
50,000	1	7½	Do. 6 per Cent. Cumulative Pref.	1	1¼	1	1¼	4 16 0	–	1 1/16	–
32,098	3	1/6	Crompton and Co. (Nos. 1 to 32,098)	2½	2¾	2½	3	5 0 0	–	–	–
£82,850	100	5%	* Do. 5% First Mort. Deb. (red.)	91	96	94	99	5 1 2	January and July	[illegible]	95¾
99,261	5	2/1½	Edison and Swan United ("A" Shares) (£3 paid)	2½	3	2½	3	6 10 9	February & August	–	–
17,139	5	3/1½	Do. (£5 paid)	4	5	4	5	6 0 0	" "	..	–
£194,023	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	97	99	97	99	4 1 0	June and December	98¼	93
17,400	5	5%	Edmundson's Electric Corporation Ord (fully paid)	5	5½	5	5½	4 10 11	Half-yearly	5 5/16	5¼
112,100	2	1/2¾	Electric Construction Co. (Limited)	2¼	2½	2¼	2½	4 12 0	January & July	2½	2⅜
25,000	2	2/9¾	Do. 7 per Cent. Cumulative Pref.	3	3½	3	3½	4 0 0	July	–	–
£140,600	Stock	4%	Do. 4% First Mortgage Deb. (red.)	103	105	103	105	3 16 2	January and July	10[illegible]	–
91,196	1	–	Elmore's Patent Copper Depositing	¼	½	¼	½	..	–	–	–
12,500	10	8/0	Henley's Telegraph Works Ordinary	23½	24½	24	25	5 4 0	February & August	24¾	24½
8,000	10	7/0	Do. 7 per Cent. Preference	18	19	18½	19½	3 11 10	" "	19	–
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110	115	110	115	3 18 8	" "	–	..
60,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21½	22½	22	23	4 6 11	" "	22¾	22½
300,000	100	4%	Do. 4% First Mortgage Debentures (red.)	102	106	102	106	3 15 6	March & September	–	..
37,850	12	12/0	Telegraph Construction and Maintenance	37	41	37	41	4 6 2	March and July	40	39
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	..		..		..	January and July	..	..
12,400	5	–	Do. Manufacturing Ordinary	8¾	9½	8½	9	–	–	–	..
13,400	5	..	Do. 5% Cum. Pref.	5½	6	5½	6	4 3 4	–	5¾	–
£30,000	5	4/0	Willans and Robinson Ordinary	8¼	8¾	8¼	8¾	4 11 5	April and October	8½	–
£30,000	5	3/0	Do. 6% Cumulative Preference	6¾	7¼	6¾	7¼	4 2 9	" "	–	–
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	106	108	106	108	3 18 8	May and November	–	–
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	..	Blackpool and Fleetwood Tramways	21	22	23	24	..	–	23½	22
25,000	10	6%	Bristol Tramways and Carriage	21½	22	21½	22	2 14 7	–	–	–
25,000	10	6%	Do. (£7. 10s. paid)	18⅝	18¾	18⅝	18¾	1 14 1	–	–	–
£90,410	Stock	4%	Do. 4% Debenture	120	121	120	121	3 6 2	–	–	–
80,000	10	..	British Electric Traction Ordinary	17	18	17½	18½	..	–	18¼	17¾
10,000	10	2/4 7/16	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm.pd.)	13	13½	13½	14	4 5 9	–	13 15/16	13¾
£100,000	Stock	6/2 3	Do. 5% Perp. Deb.	119	121	119	121	–	–	120⅜	120½
40,000	5	..	Buenos Ayres & Belgrano 6% Cum. Pref. (£3 paid).	2½	3½	2½	3½	..	..	3⅛	3
27,500	5	..	Do. do. do. (fully paid)	3¾	4½	3¾	4½	..	..	4	..
£260,000	Stock	..	Do. do. 5% Deb.	100	105	105	109	4 12 0	..	104	103
£35,250	10	3/0	Central London Ordinary	9¾	10½	9¾	10½	2 18 6	June and December	10 3/16	9⅞
178,303	10	1/9¾	Do. (£8 paid)	7¾	8¼	7¾	8¼	2 13 2	" "	7 15/16	7 13/16
£530,000	Stock	2½%	City and South London Railway Con. Ordy.	68	70	69	71	2 17 2	January and July	70	69
22,500	10	..	Do. Ordinary (£4 paid)	3½	4	3½	4	..	..	–	–
9,251	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	3 4 6	January and July	–	–
£187,701	Stock	4%	Do. 4% Perpetual Debenture	131	135	133	135	2 19 7	May and November	..	
20,000	10	6%	Imperial Tramways Ordinary (old £6 shares	17¾	18½	18½	18¾	3 4 0	March & September	19½	18½
10,000	10	6%	Do. 6% Preference	15½	16½	15½	16¾	3 16 2	" "	–	–
£70,000	Stock	4½%	Do. 4½% Debenture	118	119	118	119	3 15 8	..	..	–
57,500	10	3%	Liverpool Overhead Railway Ordinary	9¾	10	10¼	10⅝	3 5 0	February & August	–	–
10,000	10	5%	Do. 5% Preference	14¾	15½	14½	15½	3 5 7	" "	–	–
125 000	Stock	4%	Do 4% Debenture	106	108	106	108	3 14 1	January and July	–	–
20,000	5	3/3¾	New General Traction 6% Cumulative Pref	4¾	5¼	4¾	5¼	5 14 3	–	–	–
£540,000	Stock	3%	Waterloo and City Ordinary	108	111	108	111	15 7	June and December	–	–

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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LOCALITY	REMARKS	Name of Company or Authority Promoting Line.	REMARKS.
Birmingham (Exter			
Bray	h. Gauge, 4'8½". 5 miles (4 de poles and brackets. P under the Light Railways	outh, Devonport and Stoke mway Co.	Suburban and district tramway.
Bray—Glenda	made for an Orde	h Electric Traction Co.	Order has been made by the Light Railway Commissioners.
Dundalk—Bla (County	his district.		
Hartlepools	made for an Orde his district.	nouth Tramways Co., Ltd..	Act has been passed authorising Corporation to acquire and work tramways electrically. Notice to acquire in January 1st, 1900, has been given.
Islington—Cit	er. At present the questi Parliament this session. n box-rail on wooden sleep	shire Light (Electric) Rail- y Co.	Six miles on the overhead system. This Order has not yet been confirmed by the Board of Trade.
London (Sout		f Thanet Light Railways ctric) Co.	Order has been granted under the Light Railways Act (1896).
London U. Tra	be constructed and	h Electric Traction Co.....	
(Light Ry. I	made for an Orde	tch and District Electric ction Co.	
London (Wat and Baker	his district. eased to Company, a	and Prestatyn Light Rail- y Co.	Application has been made for an Order under the Light Railways Act (1896) for lines in this district.
North Staffo	made under the Lig	ampton Corporation.....	It is proposed to equip and work the town tramways electrically.
Potteries	raction with power	end Corporation.....	Application has been made for an Order under the Light Railways Act (1896) for lines in this district.
Stockwell—C	ed by the Light Rai	h Electric Traction Co.....	Application has been made for an Order under the Light Railways Act (1896) for lines in this district.
West Hartle	made for an Orde this district.	h Electric Traction Co.....	Application has been made for an Order under the Light Railways Act (1896) for lines in this district.
	under Light Railwa being made by Parli	elens Corporation	Town Tramways.
	made for an Orde this district.	shire Light Railway Co. ...	Application has been made for an Order under the Light Railways Act (1896) for lines in this district.
	made for an Orde this district.	port Town Council	
	n held by the Lig Order provisionally.	rland Corporation	Bill now before Parliament. Trolley system, to be run from combined lighting and tramway plant. Thirteen miles of tramway.
	made for an Orde this district.	h Electric Traction Co.....	Town tramways in course of reconstruction on overhead trolley.
	ommissioners have	sea Improvements, &c., Co.	Application has been made for an Order under the Light Railways Act (1896) for lines in this district.
Brompton an Pic	made for an Orde	h Electric Traction Co.....	
Charing Cro	this district.		
Euston—Ha	made for an Orde	politan Trams, &c., Co.....	Application has been made for an Order under the Light Railways Act (1896) for lines in this district.
City—Brixto	this district. c traction.	rford Town Council	
Cricklewood			
Great North	t Railways Act (18	on United Tramways Co. . .	Equipment of tramways on overhead trolley system. Powers have been obtained except for the Ealing portion of the line for which application has been made under the Light Railways Act.
Inner Circle	of town tramways.	ict Council	Council are making application for a Bill for power to work electric tramways within their district or any adjoining district.
London—	ted by the Light Ra ed by Board of Trad	erhampton Tramways Co., d.	Notice has been given to the Wolverhampton Tramways Co., Ltd., under Sec. 43 of the Tramways Act 1870 that the Corporation intend to purchase so much of their undertaking as lies within the Borough of Wolverhampton.
Epping	n made for an Orde	h Electric Traction Co.	Light Railway. Lines now worked by steam.
Paddington-	this district.		
Chari	n made for an Orde	Yarmouth and District amways Co.	Electric tramways.
Sub-District	this district.		
Expr		of York Tramways Co.	The Company owns a Provisional Order for working tramways by electric traction.
Whitechape			
Wood Gree			

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THE ELECTRICIAN:

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CONTENTS OF THE CURRENT NUMBER.

NOTES	491	Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe	503
Meetings of Scientific Societies	494	Japanese Notes	504
Notes on the Turin International Exhibition. Illus. Concluded	495	The Regulation of Wiring Rules. By C. H. Wordingham	505
Glasgow Corporation New Electric Supply Works.—A Study in Emergency Work. Illus.	496	Physical Society	506
The Fatal Accident at Southampton	500	Correspondence	511
The Institution Wiring Rules. By R. E. Crompton	501	Legal Intelligence	512
THE COST OF MUNICIPAL ENTERPRISE	502	Trade Notes and Notices	514
		Companies' Meetings & Reports	517
		New Companies, &c.	520
		City Notes	521
		Companies' Share List	522

NOTES.

MR. PREECE'S next birthday, falling about ten days from now, is giving rise to a multitude of Press rumours, more or less in the nature of guesses, but most of them substantially true, though mistaken in detail. It is not the fact that the Engineer-in-Chief and Electrician of the Post Office will be asked to remain in his present post; and it is well known that he does not wish to remain there. All the same his services will not be lost to the Post Office, for the very sufficient reason that they cannot be dispensed with at this juncture. Mr. PREECE is bound to quit his post, the Treasury having "no funds"—so the fiction runs—to pay the holder of any office after he has reached his sixty-fifth birthday; but, by a still more pleasing fiction, a retiring officer may be employed (and handsomely paid) under a different title, though his appointment has been vacated. It requires no gift of prophecy, therefore, to predict with tolerable confidence that the course contemplated in Mr. PREECE's case will be to retain him in some such capacity as advising electrical engineer to the POSTMASTER-GENERAL, but to allow him that freedom of action which a man of his eminence in the profession outside the Department may justly claim as an alternative to the complete severance of all official ties. Mr. PREECE's position in that case will remain virtually what it has been hitherto, but it will be, as the phrase goes, "a position of greater freedom." We hope to congratulate him on the arrangement, whatever it may be, and wish him many happy returns of the day.

AN important principle is involved in the decision of the Court of Appeal to reverse Sir FRANCIS JEUNE's decision of last April to the effect that the County of London and Brush Provincial Electric Lighting Co. would have to remove the mains laid by them without the sanction of the Vestry of St. Mary, Battersea. It was stated in the Court of first instance that the Company had laid about 77ft. of mains, at a depth of 2ft., within the parish of Battersea, the whole of the work being carried out on a Sunday. All previous attempts to negotiate with the Vestry having failed, the Company had adopted this course as a last resource; but Sir FRANCIS JEUNE decided that the act was illegal, and that the Company would have to remove the mains and pipes thus laid. The decision of the MASTER OF THE ROLLS and Lord Justices RIGBY and VAUGHAN WILLIAMS on Monday, however, was to the effect that by thus clandestinely laying pipes and mains the Company had in no way interfered with the statutory rights of the Vestry. One of their Lordships characterised the action of the Company as "high-handed," and regretted that he could not deprive them of any advantage they had gained by their "lawless conduct." At the same time, their Lordships concurred in the opinion that, as the Vestry existed only for the public good, by its refusal to grant permission to the Company to lay its mains, when it might have granted such permission without any injury to the public, it had placed itself in the wrong.

THE sagacity and mere worldly wisdom of local authorities is not brilliantly displayed in the conduct of the Battersea Vestry. In the first instance it refused a lump sum from the Company for granting the latter the way-leaves necessary for the proper conduct of its business; then it haggled over an annual payment, demanding the ridiculously large sum of £50 a year for the way-leave for less than 100ft. of main; finally, it has been told by the Court of Appeal that the Vestry's statutory rights have not been violated, and it will have to allow the mains to stay without being entitled to any payment whatever. *Verbum sap.*

OUR correspondent in Japan sends us a number of interesting notes on the progress of electrical industry in the land of the chrysanthemum. These, together with a map of the electric supply stations in Japan, will be found on a later page in our issue this week. Few of our readers will regard this map without feelings of surprise, for it reveals the astonishing fact that there are no less than 44 public undertakings for the supply of electric light and power. Eleven of these are driven by water-power, of which there is abundance in many parts

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of the Japanese islands; the remainder being driven by steam. In addition to these public concerns, there is a very large unconsidered residue of private installations.

In another column we publish the complete text of Major Cardew's report on the Southampton accident. The facts of the case were clear and uncontested: In a street box were a number of temporary joints in high and low-pressure cables, jumbled together in some confusion. The insulation of one of these joints was found to be defective, and a man was sent down to re-tape it. Everyone connected with the affair seems to have known that there were "live" high-pressure joints in the box, but it was thought that the defective joint was a low-pressure one. This was erroneous, and in consequence the unfortunate workman received a shock which killed him.

Although the deaths from electric shock in this country have not been very numerous, the majority of them would have been avoided if reasonable precautions had not been neglected. In some cases negligence on the part of the victims themselves has been the prime cause, while in others their superiors have not been entirely free, at any rate from moral blame. In commenting on the occurrence at the time of the inquest, we pointed out that there was no apparent reason why the high-pressure mains should not have been switched off, and we see that Major Cardew is of the same opinion. Even if the cables had not been seen to be tangled or crossed, and if the joint to be re-taped had actually been a low-pressure one, it was running needless risk to work in the street-box while other temporary joints there were charged at high pressure. We feel bound to express the opinion that another has been added to the list of accidents which might easily have been avoided.

Major Cardew, in his report, calls attention to the danger of high-pressure mains being mistaken for low-pressure ones, and suggests that the attention of manufacturers should be directed to this point. It would be interesting to hear some cable-manufacturers' views on the matter. There would appear to be no difficulty in passing lead-covered cables through a thick red paint before sending them out, or in giving the compound, in which taped or braided cables are impregnated the colour of a danger-signal. Such a step would, however, be worse than useless if the colour were liable to wear off or to don the "customary suits of solemn black," and perhaps a better plan would be to give *low*-pressure cables a distinctive colour, say a bright green, wherever they were brought into proximity with high-pressure ones. The cost of this pigment would be small, and would hardly increase the price of the cable, but even were this not the case, money spent on ensuring the safety of *employés* is never money badly spent.

Cable Interruption.—

	Date of Interruption.
Para—Maranham	Nov. 15. 1898

Conduit Explosions.—Explosions have been occurring in the electric lighting conduits at Persignan (France), and the Mayor has decreed that the conduits are to be efficiently ventilated within three weeks.

Lord Kelvin.—A weekly newspaper, called *The Syren*, in a short biographical sketch of Lord Kelvin, states that, "by birth, he is an Irishman and a mathematician, for he first saw the light at Belfast, in 1824."

"The Coming Electric Railroad."—Under this title Prof. S. H. Short, of Cleveland, who is now in this country, has contributed to the *Cosmopolitan* a popularly-written article on electric railroad traction in the United States.

Institution of Mechanical Engineers.—The Institution of Mechanical Engineers has now definitely removed from its offices in Victoria-street to its magnificent new quarters at Storey's Gate, St. James's Park, Westminster, S.W.

Royal Society.—At the meeting of the Royal Society yesterday the following Papers were down for reading:—"The Constitution of the Electric Spark," by Prof. A. Schuster, F.R.S., and G. Hemsalech; and "On the Effects of Strain on the Thermo-Electric Qualities of Metals," by Dr. M. Maclean.

The Post Office London-Birmingham Underground Telephone Cable.—We find that in our notice of this cable last week we were in error in stating that the whole of the cable is the British Insulated Wire Co.'s manufacture. We learn that a portion of the cable is being made for the Post Office by the Western Electric Company at their North Woolwich factory.

Owens College.—At the last meeting of the Council the treasurer reported that a donation of £2,000 had been received from Captain Partington towards the cost of building the new physical laboratory. The treasurer also reported that he had received from Dr. E. Hopkinson a sum of £1,884, which had been contributed by the relatives of the late Dr. John Hopkinson for the erection of a wing of the laboratory to be devoted to electro-technical work, and a further sum of £50 from Mr. F. J. Schuster for the same object. The generous gifts already received have enabled the Council to proceed with the building, but a large additional sum is required to enable them to complete and equip the laboratory.

Applications of Ether Waves.—On Monday evening last, under the auspices of the Highbury Literary Association, a large audience of about 1,500 people assembled in Highbury Quadrant Church to hear a discourse by Dr. J. A. Fleming, F.R.S., on "Applications of Ether Waves." The lecture was fully illustrated by experiments. After dealing with the elementary portions of the subject and describing the chief facts which indicate the existence of an optical ether, the lecturer passed on to discuss the experiments of Hertz and the experimental production of electromagnetic waves. Experiments were conducted in the presence of the audience illustrating the process of wireless telegraphy with ether waves. The audience expressed their hearty appreciation of the successful illustrations.

An American Municipal Electric Lighting Plant.—The municipalisation of electric light undertakings is coming to the fore in the United States. The Water Committee of Portland, Ore., have a clause in the new City Charter which provides for the completion of an electric light and water-power scheme by 1905. It is estimated that 160 H.P. could be obtained by utilising the natural flow of the city water from the high reservoirs to the low ones, at the water works. At present a sum of £16,000 is paid annually, for the city lighting, to the Portland General Electric Co.; but the advocates of municipalisation are of opinion that the city lighting should not cost more than £10,000. There are 708 arc lamps of 2,000 c.p. and 637 glow lamps at present in use in connection with the public lighting, and unless current can be contracted for at about 16s. per horse-power per annum it is intended to erect a municipal electrical system.

The Institution of Electrical Engineers.—At the last meeting of the Institution of Electrical Engineers Dr. Silvanus P. Thompson, who presided, announced that the Council, acting upon the powers conferred upon it by the new Articles of Association, had elected an honorary member. Honorary members, he said, could only be elected one in each year. Under the old Articles of Association the choice of the Council was restricted, inasmuch as they could only elect as honorary members persons of distinction who were not in actual practice as electrical engineers or electricians, all others being excluded. For two or three years past it had been the wish of the Council to do honour to the greatest living electrical engineer and electrician, viz., Lord Kelvin, by elect-

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ing him as honorary member, but they had been debarred from doing so by the fact that the old Article 18 forbade the election of one in actual practice. When the new articles were being drawn up in the summer and autumn of last year this article had been revised in order that they might have in the future a power from which they had been excluded in the past. The new article, therefore, contained no such restriction, and, coming into force on January 1st this year, the Council had naturally taken the earliest opportunity of nominating Lord Kelvin for election as honorary member. It had communicated to Lord Kelvin its desire to elect him, and he had been good enough to say that he was flattered by the wish of the Council to put him into that position—the first under the new rules, and he had intimated that he acceded to the wish of the Council, whereupon the Council had that evening elected him an honorary member of that Institution.

The Fire Prevention Committee's Testing Station.—The new testing station of the British Fire Prevention Committee was opened on Tuesday last. The station consists of two private houses standing on their own ground, on one bank of the Regent's Canal, near Regent's Park. The principal building will be used for committee rooms and laboratories, while in the gardens have been erected three large brick testing chambers or "huts" for furnace tests of fire-resisting materials in large quantities. Near these huts there has been erected a water-gas generating plant, consisting of a small vertical boiler and gas producer, the gas from which is conveyed direct through a large main and sluice valves to the huts, on the flame chamber floors of which it is burned at a number of nozzles. Immediately above the flame chamber is the testing chamber, communication with which, in each case, can be made electrically, from two Roberts-Austen electrical pyrometers, which have been erected in one of the laboratories. These pyrometers make photographic records of the temperature, and also indicate the momentary temperature by a spot of light on a direct reading scale. The primary objects of the Committee are: Firstly, to direct attention to the urgent need for increased protection of life and property from fire by the adoption of preventive measures; secondly, to use its influence in every direction towards minimising the possibilities and dangers of fire; and thirdly, to undertake independent investigations and tests of materials, methods and appliances for fire resisting purposes. Thus it will be possible to obtain reliable records as to the merits of various materials. The tests will be of an independent character, carried out on scientific lines with reference to practical purposes. The reports of tests will state simply the bare facts of occurrences, with tables, diagrams and illustrations, and, it is stated, will on no account include expressions of opinion or any expression that might be read as comparison or criticism. The tests will be under the direction of an executive committee, presided over by Mr. E. O. Sachs, and including a number of names well known to the electrical engineering profession.

The Measurement of Elasticity.—At a meeting of the Institution of Junior Engineers, at the Westminster Palace Hotel, on Friday, January 27th, a lecture was given by Prof. Ewing on "Measurements of Elasticity." After a general account of what is meant by elasticity and elastic strain, the lecturer proceeded to define the various constants by which the elasticity of a material could be expressed. The ones usually measured were Young's modulus of elasticity, or the stretch modulus, and the modulus of rigidity, or the shear modulus. From these two the other constants could be inferred. In measuring Young's modulus the whole amount of elastic stretching in such a substance as wrought iron did not much exceed one one-thousandth of the original length. The determination of the modulus with any accuracy, therefore, required measurements of great refinement, except in the case of wire where long lengths could be dealt with. For experiments with long wires a simple scale and vernier, reading, say to hundredths of an inch, would suffice, but for short specimens such as were used in the testing machine, where the measurements were made on a length of eight inches or so, extensometers were required capable of reading at least to ten-thousandths and much preferably to fifty-thousandths of an inch. The lecturer showed several forms of an extensometer of his own invention which had been found convenient and accurate. This instrument is entirely self-contained and is attached to the piece under test by two set-screws at the ends of the length on which the observation of extension is to be made. In its usual form for tension tests it reads to one fifty-thousandth of an inch, but in a special form designed for measuring the elastic compression of short blocks, the readings are taken to $\frac{1}{250000}$ in. The lecturer next described the very imperfectly elastic condition into which iron or steel is thrown by straining beyond the ordinary limit of elasticity. Immediately after being overstrained and when the load is removed, the piece on being reloaded does not follow Hooke's Law at all, and cannot be said to have any elastic limit. But as time passes the elasticity comes back, and after an interval of a few days in the case of wrought iron, or of many weeks in the case of steel, it is found that the material has practically perfect elasticity up to a limit which may be much higher than the initial elastic limit.

Cosmopolitan Lamp Data.—Messrs. R. S. Hale and J. S. Codman, in an article in the *Electrical World* for January 7th, have compiled a number of statistics of the lamp data of American and other important cities. From a table in this article we gather that the distinction of having the greatest number of glow-lamps per thousand inhabitants may be claimed by Boston, the number of lamps being 1,232. Next in order is New York, with 859 lamps per thousand inhabitants. Below we give the table referred to:—

City.	Population.	Lamps, arcs and motors in 16 c.p. equivalent.			Lamps per 1,000 inhabitants.	
		Central stations.	Isolated plants.	Total.	Central stations.	Total.
Boston	500,000	418,000	198,000	616,000	836	1,232
New York	2,000,000	978,000	740,000	1,718,000	489	859
Chicago	1,750,000	513,000	765,000	1,278,000	294	730
Brooklyn	1,125,000	267,000	55,000	322,000	237	286
Baltimore	600,000	188,000	36,000	224,000	313	373
Philadelphia ...	1,390,000	366,000	122,000	488,000	282	375
St. Louis.....	656,000	271,000	122,000	393,000	413	600
San Francisco...	350,000	209,000	22,000	231,000	598	660
Buffalo	375,000	85,500	40,000	125,500	228	335
Rochester	178.000	175,000	9,000	184,000	982	1,040
Cincinnati	365,000	173,000	28,000	201,000	475	551
New Orleans ...	280,000	70,000	11,000	81,000	250	289
Vienna	1,574,000	388,000	...	...	246	...
Paris	2,511,000	365,000	...	...	185	...
Brussels	531,000	48,000	...	...	90	...
St. Petersburg..	1,035,000	60,000	142,000	202,000	58	195
Rome	473,000	60,000	...	...	127	...
Berlin	1,667,000	298,400	..	...	178	...
Hamburg	625,500	83,900	...	...	134	...
Breslau	373,000	28,300	...	...	76	...
Leipsic	400,000	41,900	...	...	105	...
Bremen	142,000	48,000	...	...	338	...
London	5,000,000	920,000	...	...	184	...
Birmingham ...	478,000	36,600	...	...	75	...
Leeds	390,000	25,000	...	..	64	...
Liverpool	636,000	67,600	...	...	106	...
Manchester.....	530,000	91,700	...	...	173	...
Sheffield.....	338,000	28,000	...	...	83	...
Dublin	252,000	11,000	...	...	44	...
Edinburgh.....	261,000	63,000	...	...	242	...
Glasgow	817,000	59,000	...	...	72	...
Brighton.....	121,000	43,000	...	...	353	...

Wave Motion near a Theoretical Hertzian Oscillator.—In a Royal Society Paper, read January 19th, Prof. Karl Pearson and Miss Lee investigate the variations in the field round a *theoretical* Hertzian oscillator. The italics emphasise that a Maxwellian "double point" of initial maximum moment $\pm El$ is understood, but as the actual oscillator has been shown by Bjerknes and others to give a damped wave train, the maximum moment is taken to run down with the time, and to oscillate between the limits $\pm Ele^{-pt}$. Hertz's own theory, adopted in most text-books, is considered insufficient because the actual oscillator has sensible extension and its wave train is not steady. The present Paper attempts to remove the latter objection only, and confines itself to a theoretical investigation of the damping of the wave train. A series of diagrams, to replace the well-known Hertzian diagrams, have been produced by Miss Lee, representing the

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field for seven complete oscillations, and showing how the field for some 12 metres round the oscillator chosen gradually falls to $\frac{1}{10}$th of its maximum initial strength. Dealing next with the type of waves propagated, their velocities and their phases, the authors conclude that three waves of electromagnetic force, instead of two, may be considered as sent out, viz., a wave of purely transverse electric force, a wave of electric force parallel to the axis, and a wave of magnetic force. The following summarises their remaining conclusions. The velocities of these waves undergo remarkable changes in the neighbourhood of the oscillator, these changes extending to distances greater than those within which a great proportion of Hertz's interference experiments were made. The point of zero phase for both transverse and axial electric waves does not coincide with the centre of the oscillator, so that these waves appear to start from spheres of small but finite radius round the oscillator. A fourth wave dealt with by Hertz, namely, the wave of magnetic induction, does not, as he supposes, start with zero phase from the origin, but with a finite phase. The wave in the equatorial plane, largely relied upon by Hertz for his interference experiments "of the first kind," is a compound of the waves of transverse and axial electric force, and has a much more complex series of velocity changes than Hertz appears to have realised. Hertz's experiments should be made at distances greater than 6 to 7 ($\lambda/2\pi$) from the centre of the oscillator. In Hertz's case this amounts to about 10 metres—a distance at which Hertz rather terminated than started his interference experiments. Only at such a distance are the phase curves sensibly linear.

The Telephone Service.—A series of three articles, published in *The Times* of January 20, 23 and 24, gives from the pen of "a correspondent" an admirable statement of the telephone question from the point of view of a supporter of the National Telephone Co. Although taking sides with the Company, and severely criticising the action and inaction of the Government since the inception of telephony in 1877-8, the historical facts are accurate and fairly complete. Starting with the formation and amalgamation of the Bell and Edison companies, and the "initial blunder" of the Post Office in not acquiring the telephone patents in those early days, when it had the opportunity, the first article goes on to mention the famous law suit in which the telephone was declared a telegraph in 1880, and the policy pursued by the Government in granting licences and imposing restrictions, until the amalgamation of the United Telephone Co. with its affiliated companies. It is stated that the difference between the aggregate valuations of the amalgamated companies and the actual construction cost was £1,280,768 in £4,565,027, and this figure has remained a constant quantity, while the capital invested at June 30 last stood at £6,264,260, and the Company had accumulated a reserve fund of £600,000. The second article commences with the debate in the House of Commons in 1892 on the motion of Dr. Cameron in favour of the nationalisation of the telephone service, and the declaration of the Government of its intention to purchase the trunk lines. This is followed by copious extracts from the famous Treasury Minute, and an account is then given of the various developments up to the publication of Sheriff Jameson's report on the Glasgow inquiry. In this article, it is stated, with regard to the inquiry by the Select Committee of the House of Commons in 1895, that :—

> It is a matter of common knowledge, however, that the chairman submitted a report to the Committee condemning the granting of any municipal licences; but as Parliament was then on the eve of a dissolution, and the Committee were not unanimous, the report was withdrawn.

It will be remembered that this Committee merely published the full minutes of the evidence taken, without presenting any report to Parliament. The last of the three articles deals with the "latest departure in Government policy," upon which it comments shrewdly. Of the statement made by Mr. Hanbury during the telephone debate on April 1, 1898, to the effect that the Company's plant and system could be replaced for a little over two millions, it is said :—

> Upon what evidence Mr. Hanbury made this statement is not known, but one more incorrect or calculated in the mouth of a responsible Minister to injure the Company is impossible to imagine. The best answer that can be given to Mr. Hanbury is that the Company has expended, in cash on its plant, machinery and system, upwards of £5,000,000, of which amount the sum of nearly £2,500,000 has been spent since 1892, on the faith of the arrangements concluded with the Government, and with respect to which Mr. Preece stated before the Committee of 1895 that the Company was employing the best materials, was doing its work in a way of which he approved, and that if the Post Office took over the system in 1911 it would (if the Company continued to do as they were doing) have a first-rate system with first-class materials and telephones.

The formation of the 1898 Select Committee, and its report, are thoroughly criticised and the article is summed up by a list of the six mistakes of the Post Office with regard to the telephone question, viz., its refusal to acquire the patents originally, its policy of impeding and harassing the companies during their development, the favouring of unlimited competition and failure of this policy, the acquisition of a portion only of the companies' undertakings, the refusal of adequate powers for running lines, and finally its contemplation of a reversion to the old policy of obstruction "coupled with an unfair competition." It should be mentioned that, in the course of the last article, it is stated that the Postmaster-General has given the Company notice that he does not intend to grant it any more wayleaves to carry its wires along railway lines, in any place where the Postmaster-General is, or is likely to be, in competition with the Company. The granting of these wayleaves was, it is said, held out in the Treasury Minute of 1892, as one of the principal inducements to the Company to fall in with the policy of the Government and part with the trunk lines.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

MONDAY, February 6th.

SOCIETY OF ENGINEERS.

7:30 p.m. Ordinary Meeting at the Royal United Service Institution, Whitehall. The President for the past year, Mr. W. W. Beaumont, will present the premiums for Papers read during the year, after which Mr. John Corry Fell, the President elect, will deliver his Inaugural Address.

TUESDAY, February 7th.

RÖNTGEN SOCIETY.

8 p.m. General meeting at 11, Chandos-street, Cavendish-square, W., when Mr. Wilson Noble will read a Paper on "A Modified Form of Toepler Mercury Pump." The President will then introduce a discussion on "The Röntgen Ray Photography of Soft Tissues."

WEDNESDAY, February 8th.

SOCIETY OF ARTS.

8 p.m. Ordinary meeting. Paper to be read: "Nernst's Electric Lamp." By James Swinburne.

THURSDAY, February 9th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting, when the discussion on the following Papers will be continued:—(1) "Rules for the Regulation of the Wiring of Premises for Connection to Public Supply Mains," by J. Pigg; (2) "The Regulation of Wiring Rules," by C. H. Wordingham; (3) "The Institution Wiring Rules," by R. E. Crompton. Time permitting the following Paper will be read: "Electric Traction by Surface Contacts," by Miles Walker.

SOCIETY OF ARTS.

8 p.m. Adjourned Discussion on Mr. Dixon H. Davies' Paper "The Cost of Municipal Enterprise."

FRIDAY, February 10th.

PHYSICAL SOCIETY.

5 p.m. Annual General Meeting in the Rooms of the Chemical Society, Burlington House, W. Address by the President. At the Ordinary Meeting which follows, a Paper on "An Ampere-Meter and a Volt-Meter with a Long Scale," by Benjamin Davies, will probably be read by Dr. Oliver Lodge.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. Annual General Meeting at the New Institution Building, Storey's Gate, St. James's Park. Among the Papers down for reading is one by H. G. V. Oldham, on "Evaporative Condensers."

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read, "The Electrical Driving of Engineering Workshops," by W. Middleton.

ROYAL INSTITUTION.

9 p.m. Evening Discourse, "The Motion of a Perfect Liquid," by Prof. H. S. Hele-Shaw.

SATURDAY, February 11th.

INSTITUTION OF ELECTRICAL ENGINEERS.

2:30 p.m. Students' visit to the Shoreditch Central Station, Coronet-street, Shoreditch. Party limited to 20.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture on "The Mechanical Properties of Bodies," by the Right Hon. Lord Rayleigh F.R.S.

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NOTES ON THE TURIN INTERNATIONAL EXHIBITION.

(BY OUR OWN CORRESPONDENT.)

(*Concluded from page 41.*)

One of the novelties in Messrs. Ganz's exhibit of dynamos and motors was a distributing system on the Ferraris-Arnó principle.* This method was suggested by Prof. Ferraris a few months before his death, and it has been successfully worked out by his distinguished assistant Prof. Arnó. Suppose an alternating current motor with four coils, A, A', B, B', set at right angles and connected as shown in Fig. 8. If two alternating currents, differing 90deg. in phase, are sent through them, as shown in the figure, a rotatory field is

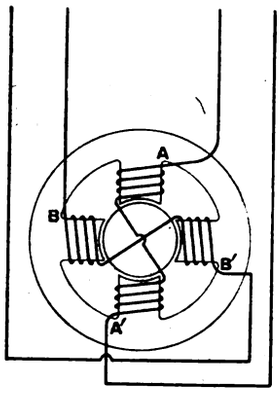

FIG. 8.

produced, and if the armature is given a definite polarity it will rotate at the same speed as the field. Now if the circuit B B' be interrupted the motor will work as an alternating-current synchronous motor, and it will at the same time generate an E.M.F. at the terminal of the circuit B B', differing 90deg. in phase from the primary current in A A'. Once started, the motor, therefore, acts as a transformer, the E.M.F. in the secondary B B' depending on the number of turns of the coils. With the aid of a stationary transformer (Fig. 9) this induced E.M.F. may be made two-phase, although the current in the main circuit is only single-phase. It is also possible to have three wires in the secondary circuit, as in Fig. 10, instead of two. This latter method of

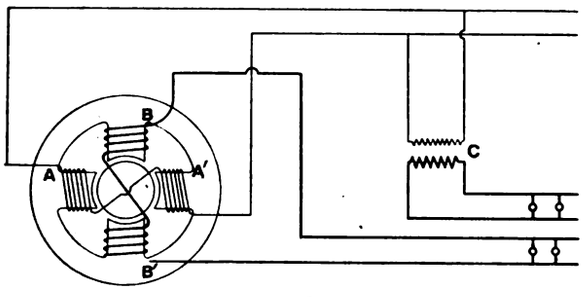

FIG. 9.

connection is used especially for starting motors, with the aid of a third wire from one of the transformers. Messrs. Ganz had nine motors in various parts of the exhibition started on this principle.

A 70 kilowatt three-phase dynamo, exhibited by the same firm, has some points of interest. The coils are stationary, and there are 10 revolving pole-pieces, five on each side of the armature. These are not placed opposite one another, but shifted at an angle of 24deg. By increasing this angle to 36deg. the machine is made two-phase, and by placing the poles opposite to one another it generates single-phase alternating currents. Amongst other machinery of Messrs. Ganz's may be mentioned a 100 kilowatt three-phase transformer, several continuous and alternating-current motors (*see* Fig. 11), and an apparatus for the automatic switching in and out of transformers.* The latter is said to work well, but it appears to me that there are too many mercury contacts.

Mechanical Applications of Electricity.—These were very numerous. The Officine of Savigliano exhibited a 5-ton electric crane, several electrically-driven drills, both stationary and portable, and an electric hammer. Messrs. Larini Nathan and Co. showed a 15-ton crane, operated by three Belloni and Gadda motors, and the latter firm, as well as Messrs. Brioschi and Finzi, demonstrated the suitability of electric motors for driving light cotton and wool machinery. There were also several electrically-driven lathes exhibited by various Italian firms, and Messrs. Worthington's pumps were also actuated by electricity. The most important mechanical application of electricity, however, was an enormous turret with two powerful guns, for the Italian Navy, which was moved entirely by electrical power. On the other hand, the exhibits under this heading which attracted most attention were, perhaps, the numerous electrical fans.

Storage Batteries.—A large number of firms, chiefly Italian, had batteries of storage cells on view, these being, however, with but two exceptions, of foreign make. Thus the new Tudor pattern, and the Hagen, Elieson, and Blot batteries were represented. In a cell exhibited by the Societá Cruto of Torino, made under Col. Pescetto's patent, a paste is used, consisting of a mixture of lead oxides and a substance obtained by a reaction of sulphuric acid upon sugar. The latter is said to increase the conductivity. In the Garassino cell, made by Messrs. Vandel, of Avigliana, the active material is spongy lead, obtained by the electrolysis of lead oxide, and mechanically compressed.

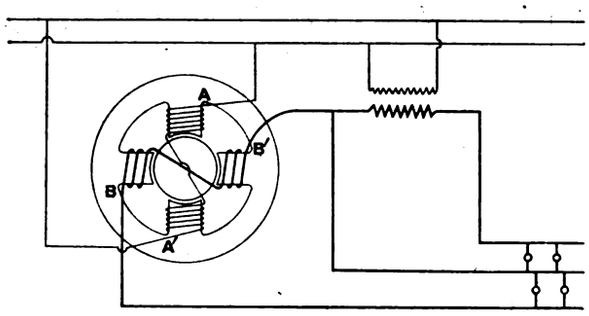

FIG. 10.

Instruments.—Messrs. Siemens and Halske had a large number of measuring instruments in their exhibit. Among these were, on the one hand, voltmeters and ammeters of the moving coil pattern, and, on the other hand, wattmeters which were everything except dead-beat. The Siemens and Halske integrating meter is based on a similar principle to Lord Kelvin's. A lever actuated by clockwork swings continuously to and fro, and, when current is passing through the ammeter portion, this lever engages with the train of the registering wheels, the angle through which the first wheel of the train is rotated depending on the current. The Compagnie pour la Fabrication des Compteurs Electriques of Paris had meters of the Cantono-O'Keenan, Thomson and Duncan patterns, and Déri and Hummel meters were exhibited by Messrs. Ganz and Co. and the Allgemeine Electricitäts Gesellschaft respectively. Other exhibitors of voltmeters, ammeters and laboratory instruments were Messrs. Hartmann and Braun, the Weston Electrical Co., the Tecnomasio of Milan and Mr. Olivetti, of Ivrea, the instruments shown by the last-named having some points of novelty. Mr. Marconi exhibited his celebrated instruments in the Marine section, and performed successful experiments, and Prof. Rosa demonstrated how Herzian waves could be applied to synchronise clocks.

Wire and Cable.—There were only two exhibitors of insulated wire and cable, viz., Messrs. Pirelli and Co., of Milan, and Messrs. Tedeschi, of Torino. The former showed an interesting collection of all the materials and apparatus used in connection with the manufacture and laying of rubber

* See also *The Electrician*, Vol. XL, p. 254.—[ED. *E.*].

* See *The Electrician*, Vol. XL., pp. 374 and 392.—[ED. *E.*]

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cables, from a specimen of the *Ficus Elastica* to a complete outfit for the laying of submarine cables. Among their exhibits was an underground cable, submitted to a pressure of 20,000 volts for the benefit of the visitors.

Literature.—Messrs. Rosenberg and Selier, of Torino, provided a collection of English, American, German, French, Italian, Spanish and Russian books and journals relating to electricity. These were placed at the disposal of the public, and were greatly appreciated.

Historical.—The electrical industry in Italy is only at its commencement, but there is no doubt that some of the most striking discoveries in the domain of electricity during the present century are due to Italian workers. The bad political and economic conditions under which Italy has suffered, and is still suffering, and a certain contempt of the Latin races for practical industries, have caused this country to be among the last nations to enjoy the benefits of these inventions. But yet such men as Ferraris and Pacinotti are highly esteemed by their fellow countrymen, especially by those who are among the ranks of the workers. At the Turin Exhibition the early apparatus made by Volta, Galvani, Ferraris and Pacinotti were exhibited. The famous controversy between Galvani and Volta was illustrated by the original apparatus. The early electric piles were to be seen, the cells in separate glasses devised later, and Volta's electrometers, condensers, electrophorus, &c. All the rough apparatus made by Ferraris in 1885 for demonstrating the principles of the rotatory field were also shown, and last, but not least, Pacinotti's first continuous-current dynamo of 1864, with the toothed armature which has been revived in modern machines. Pacinotti did not only invent the ring armature; there are disc and drum armatures to be seen ante-dating those of Siemens and Edison. It may not be generally known that Prof. Pacinotti is still living, and is by no means an old man. He is Professor of Physics at the Agricultural School at Pisa, and has not of late been devoting attention to electrical subjects.

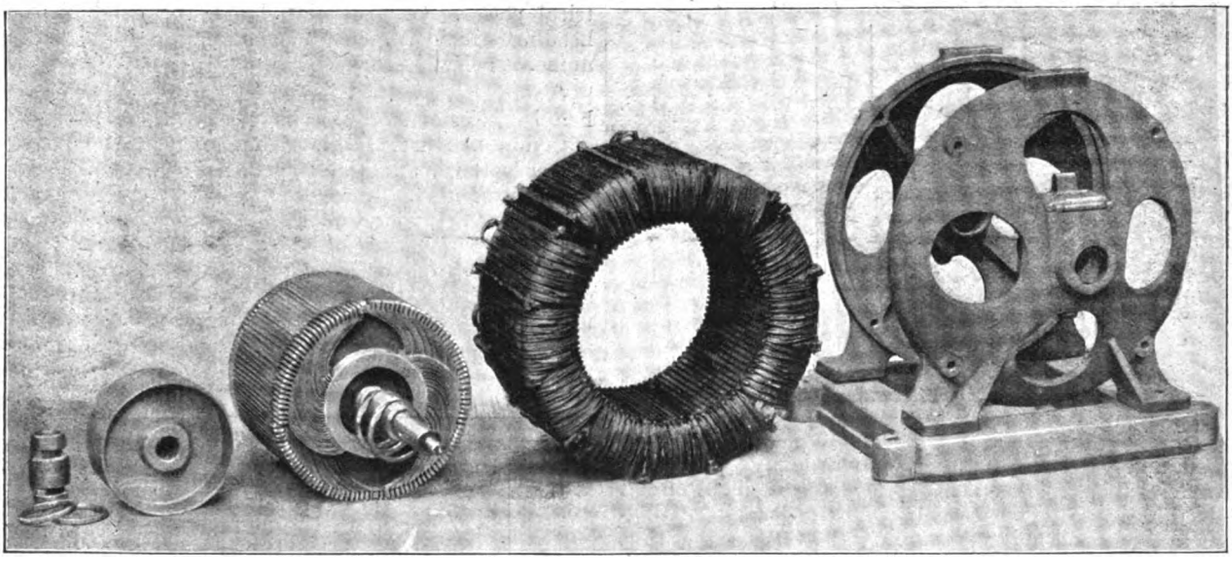

FIG. 11.—GANZ THREE-PHASE MOTOR.

GLASGOW CORPORATION NEW ELECTRIC SUPPLY WORKS.—A STUDY IN EMERGENCY WORK.

In view of the recent starting of the new electric supply works in Glasgow, a short history of the electrical enterprise of the "second city" might not be without interest to our readers, by way of preface to some account of the new works.

The introduction of electric lighting into Glasgow was due to private enterprise, and dates from as far back as 1885, in which year the pioneers of the firm which is now known as Messrs. Mavor and Coulson (Limited) laid down a lighting plant consisting of some 200 H.P. About 1890, owing to the success of this undertaking, the same firm were induced to form a company and to secure premises in John-street, where they laid down a Ferranti alternating current plant, with which they supplied an extended district in the neighbourhood by means of overhead cables, the maximum output being some 80 amperes, at 2,500 volts. By this time the Glasgow Corporation, seeing that the gas works were already municipal property, and that it would not be well to have a competitive lighting system, decided to buy up the private enterprise, and secured the Millar-street and the John-street stations as a going concern for £15,000. The Corporation immediately set to work to give a more extended supply. The site in Waterloo-street was secured, and a low tension three-wire system was laid down for private lighting, with a series system for the arc lighting. The supply was started in February, 1893, from the Waterloo-street station, and the plant then consisted of seven Willans units of a total of 1,400 to 1,500 H.P. for the incandescent lighting, with four Brush arc lighter driven from two Easton, Anderson and Goolden engines for the street lamps, 77 Brush lamps being erected at first, although the plant was arranged for 112. The mains laid down at first for the private lighting were entirely on the Kennedy bare copper system. The following year it was necessary to increase the station and two plants of 225 kilowatts each were laid down. This necessitated the removal of the arc lighting plant to the disused station at John-street, where the Brush dynamos were run from the original engines. In the following year it was again found necessary to increase the plant, and two more units were laid down. Again, in 1896, another two similar plants had to be added, which last two completely filled up the available space at Waterloo street. The increase of boiler plant, we might add, followed on the same lines as the engines, the original equipment consisting of five marine type boilers of 300 H.P. each, another similar one being added in 1894, two Babcock-Wilcox, of 700 H.P., in 1895, and another of the same size in 1896, to complete the station.

With this station full up, and no further scheme ready matured, the position of the Glasgow electricity supply undertaking began to enter upon the serious position in which it now finds itself, but which, from all appearances, it will very soon triumphantly emerge. In order to cope with the load at the peak there were put down, in the autumn of 1897, two large Tudor batteries, each of 2,000 ampere hours capacity, and capable of being discharged in an hour if necessary, one being placed about a mile west of the central station and the other about a mile to the east.

In the autumn of 1897 Mr. Arnot, the Corporation electrical engineer, resigned, and the Council advertised for a successor who should not only act as a chief engineer, but should also

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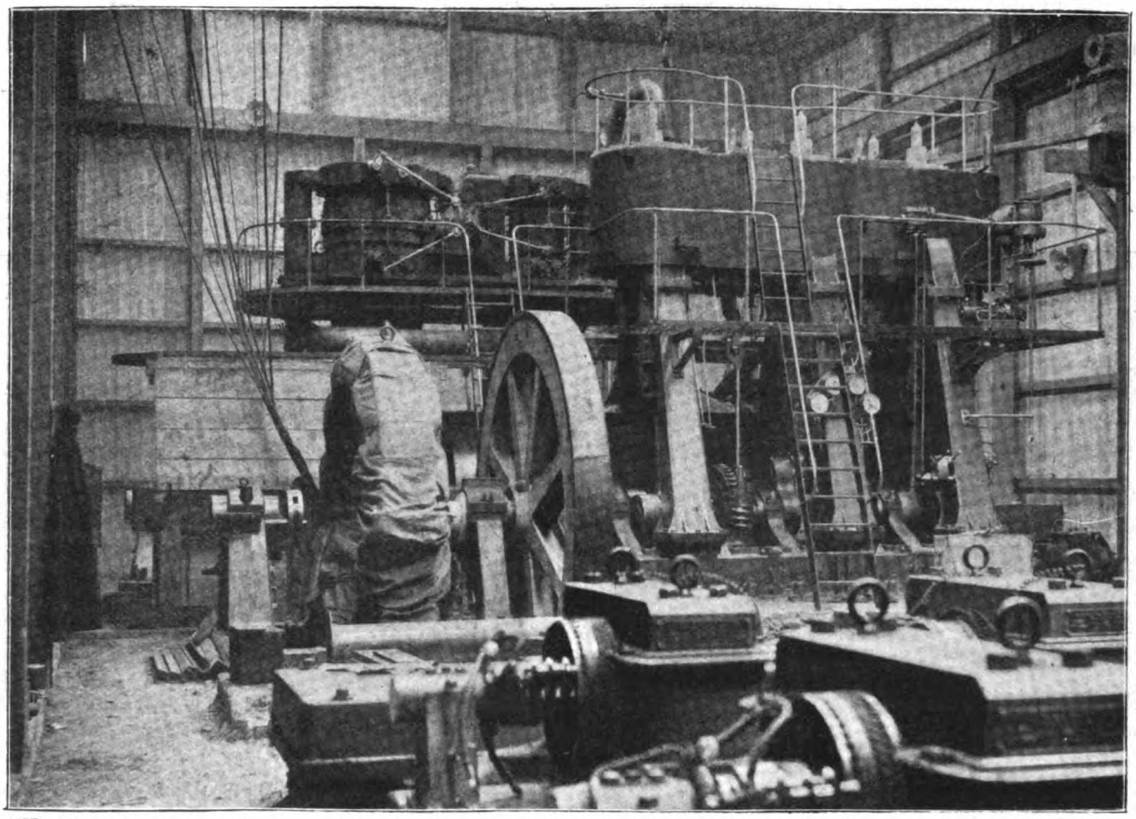
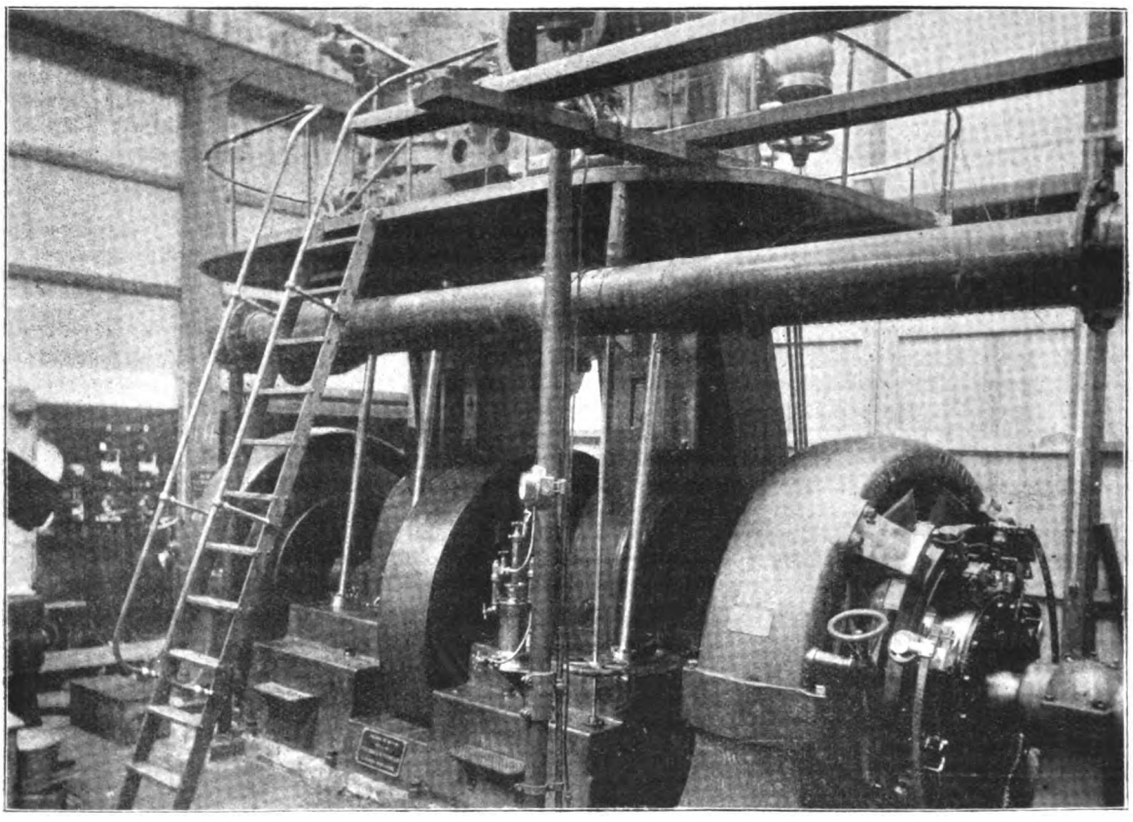
be capable of carrying out all the duties of a consulting engineer to the Corporation. The choice fell upon Mr. W. A. Chamen, who was at that time with Messrs. Crompton and Co. as their chief engineer. Mr. Chamen took up his duties early in 1898, and found the state of affairs such that any extra strain at the station would cause more or less serious interference with the lighting, as during the peak it was necessary to run the whole of the station plant, and to discharge the batteries at their full output, recharging them again as the machines became available on the falling off of the load at night. It was not long before Mr. Chamen had his scheme fully matured and laid before the Council, who authorised



GLASGOW NEW MUNICIPAL ELECTRIC SUPPLY STATION. VIEW SHOWING PLANT IN THE TEMPORARY SHED; BOOSTER IN THE FOREGROUND AND PAUL-SCHUCKERT GENERATING SET IN THE REAR.



GLASGOW NEW MUNICIPAL ELECTRIC SUPPLY STATION. BALL AND WOOD ENGINE DIRECT-COUPLED TO WALKER DYNAMO IN TEMPORARY SHED.

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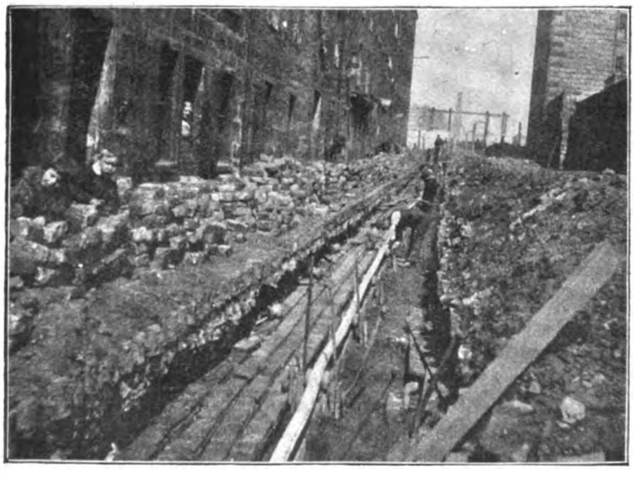
him to forthwith push on with it. This scheme embodied a 500-volt supply with 250 volts on the consumer's terminals.

Suitable sites for new generating plant were secured, one on the north side of the Clyde at Port Dundas, adjacent to the Forth and Clyde Canal, with convenient facilities for water and fuel; the other on the south side of the river, with suitable railway sidings. The site on the north side was the first to be considered, as the station on it was to relieve the overload on the existing Waterloo-street station. Mr. Chamen found that it would be impossible to get plant of his own selection erected to meet the following winter's load, so he advertised for tenders for any plant of whatever sized units offerers

Trench with Pulleys in Position and Length of Cable about to be Laid

might find most convenient, either new or second-hand, with the only stipulation that they were to be on the ground by the following August. As a result of this, the plant subsequently described in this article was offered and accepted by the Corporation. Unfortunately, however, owing to disputes in the building trades and other causes the foundations were not ready to receive the plant by the time specified, although the bulk of the plant was fairly well up to time as far as the delivery was concerned, and as a consequence the first engine was not got under steam till quite the end of the year.



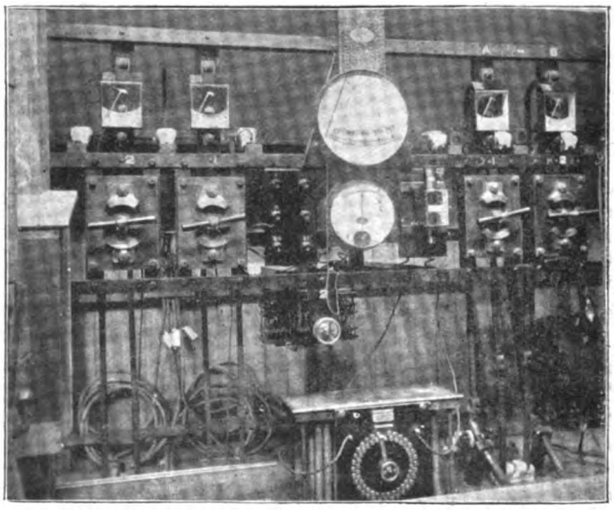
Trench running South from New Power Station; Four Feeders in Position, and the Fifth being Laid.

Happily, Mr. Chamen had foreseen the possibility of some hitch occurring in the delivery of the plant, and soon after his arrival at Glasgow he refused to make any more coneections to the mains, except under a signed agreement that the consumer should be cut off if at any time the exigencies of the demand demanded it, owing to too great a strain on the station. During the early part of the present winter, by dint of running the plant at about 25 per cent. overload during the two hours of the peak, things were kept going in a very satisfactory manner, and the voltage rarely fell much below the normal. Early in December last the demand increased to such an extent that it was found necessary to disconnect 160 of the recent consumers who had been connected under the agreement above referred to, although in a number of cases these consumers were reconnected during the daytime, and only disconnected during the peak.

The new station is a handsome pile of buildings of red pressed bricks, relieved with red sandstone facings, erected on a site adjacent to the Port Dundas Canal. The canal will afford a cheap and easy method of delivery of fuel, removal of ashes, &c., although at the same time, if it is found necessary, by the erection of a light swing bridge across the canal, the

Cable about to be Drawn-in from a Drum.

railway siding which runs along the opposite bank can easily be carried into the coal store. The station buildings consist of a central tower, in which is situated a suite of offices for the works manager, and also fully-equipped test rooms, &c., required for the proper working of the station. On either side of this central tower is a battery room, 77ft. long by 26ft. wide. Behind is the main machinery hall, 553ft. long by 59ft. wide, and 30ft. high to the travelling crane rails. This is lined throughout with white glazed bricks. Parallel to this



Temporary Switchboard.

and immediately behind is the boiler house, 559ft. long by 81ft. wide, also lined with white enamelled bricks. The central chimney is 200ft. high by 11ft. diameter, and the two outer ones each 250ft. high by 13ft. diameter. To the rear of the boiler house is a coal store capable of accommodating upwards of 2,000 tons of fuel as a reserve stock, above which are coal tanks to contain the daily supplies as required. The canal extends along the whole length of this store, and the fuel can be discharged by an electrically-driven Temporley trans-

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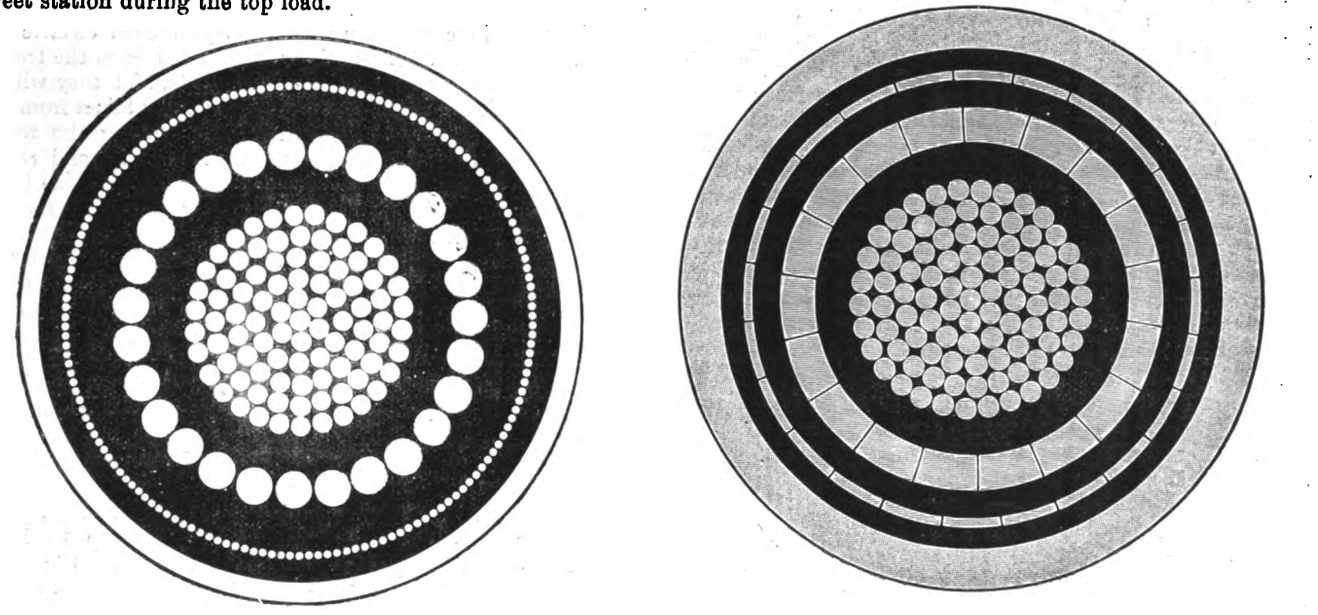
porter, direct from the barges into either the store or the supply tanks. The comfort of the employees has been carefully considered in arranging the station, and numerous rooms are provided for the staff in each department, all being fitted with bath rooms and lavatories. The station buildings are designed to ultimately accommodate upwards of 30,000 I.H.P. of plant, but the present contracts now in progress are only for the central portion, consisting of the tower, the battery rooms, and the central third of the machinery hall, boiler room and fuel stores, &c. This portion will allow of some 10,000 I.H.P. of plant being erected.

As the permanent buildings were not ready to receive the plant in time for this winter's load, and as it was imperative that part of it should be running to assist the heavily overloaded Waterloo-street station, a temporary wooden shed some 80ft. long by 35ft. wide was erected over the permanent foundations to house the first instalment of some 2,200 I.H.P. of plant. The permanent boilers were put in and a galvanised iron shed was put up over them, and a temporary iron chimney 5ft. diameter by 100ft. high was erected on one side of the central chimney shaft. By this means, and by connecting up a few feeders to the central area of supply with a temporary switchboard, a considerable amount of assistance has been rendered daily for the past few weeks to the Waterloo-street station during the top load.



CALLENDER'S CABLE. SECTIONS OF THE TRIPLE CONCENTRIC MAINS. B. I.W. CABLE.

Weight = 45 tons per mile; Copper Section = 1 sq. in.; Scale, full size.

The plant installed in this temporary shed is erected in its final position and on its permanent foundations, and as soon as the main roof is on the shed will be removed. The plant comprises a vertical compound engine, made by the Ball and Wood Co., of New York, having cylinders 20½in. and 44½in. diameter and 24in. stroke, with a speed of 150 revolutions per minute. The cylinders are fitted with Corliss valves. To each end of the shaft of this engine is coupled an eight-pole dynamo, made by the Walker Co. Each dynamo has an output of 300 kilowatts at 250 to 300 volts, but is capable of taking an overload of 50 per cent. The carbon brushes do not require adjustment between no load and 25 per cent. overload. The field magnets are compound wound, so that the machines can be used as tramway generators when so required. A separate surface condenser having the air and circulating pumps driven by electric motors has been supplied by Messrs. W. H. Allen and Co., of Bedford.

The next set consists of a vertical triple-expansion condensing marine engine with condenser, the pumps being driven off the I.P. cylinder crosshead. The diameters of the cylinders are 17in., 25½in., and 38in. respectively, with a 30in. stroke, running at a speed of 120 revolutions per minute. The governor is of the throttle type, and is fitted with suitable adjustment for varying the speed while running. This engine is coupled direct to a shunt-wound twelve-pole Schukert dynamo, with a capacity of 550 kilowatts at 500 to 600 volts. The set was supplied under contract with Messrs. Mavor and Coulson, of Glasgow.

The remaining plant consists of two engines by the Mirilees, Watson and Yaryan Co., of Glasgow, of their new enclosed type. It comprises one 400 H.P. triple-expansion engine having cylinders 14in., 22in., and two 24in. diameter respectively, with a stroke 12in. and a speed of 380 revolutions per minute. There are four cranks at right angles. The other set consists of a 200 H.P. compound engine, with cylinders H.P. 14in. and 21in. diameter, with a 12in. stroke, running at 380 revolutions per minute, the two cranks being placed opposite each other. These engines are directly coupled to two shunt-wound two-pole Crompton dynamos, having outputs of 255 and 125 kilowatts respectively, at 500 to 600 volts. The contract for these plants was with the engine builders. Both engines exhaust to one condensing plant of the same type as the American engine, supplied by Messrs. W. H. Allen and Co. In all cases the air pumps are of Edwards's design, and the gearing is of Hollicks's balance friction type.

Two sets of balancing motor-dynamos have been supplied by the India Rubber, Gutta Percha and Telegraph Works Co. (Limited). Each set can be coupled to the three-wire system, and each side of each set is capable of dealing with an output of 150 amperes at 230 to 300 volts at a speed of 650 revolutions per minute. The field-magnets are compound-wound, and all the necessary starting and regulating resistances have been provided by the makers.

Two sets of boosters for charging the batteries have been provided by Messrs. Mavor and Coulson, of Glasgow. The motors are shunt wound, and take current from the 'bus bars at 500 to 600 volts, and the boosters have an output of 225 amperes at 20 to 160 volts. They are separately excited at 250 volts, and run at 850 revolutions per minute. The makers have supplied all the necessary starting and regulating resistances.

A storage battery has been supplied by the Tudor Accumulator Co., and consists of 335 cells, arranged in two sets on the 500 volt three-wire system. There are 25 pairs of regulating cells on each half battery. The capacity of the battery is 1,100 ampere-hours, at a discharge of 150 amperes, and it can stand a maximum discharge rate of 250 amperes.

The present switchboard is only of a temporary character, constructed by the station staff to meet the immediate requirements, but tenders have been accepted for the permanent gear, which will be erected as soon as the permanent buildings are completed, and the wooden shed removed.

The steam and feed pipes consist of welded wrought

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steel with flanges welded on solid. The valves are of the Templer and Ranoe type. The feed pumps are only a temporary arrangement at present, and consist of a Wier's steam pump and a three-throw electrically-driven pump made by Messrs. Hayward-Tyler and Co., fitted with Hollicks's patent gear. The motor is run off either a 250 or 500-volt circuit, a further range of speed being obtainable by sliding the magnets along over a dummy armature, thus reducing the lines of force passing through the windings.

At present only two boilers have been erected, these being of the Babcock and Wilcox type. Each has an evaporative duty of 15,000lb. of water per hour at 200lb. pressure. A superheater has also been fitted in the combustion chambers. The furnace firing is done by chain stokers driven by electric motors.

The feeders consist of triple concentric cables, lead-covered and laid in earthenware troughing, run in solid with bitumen. The conductors have positive (centre) 1 sq. in. sectional area of copper, negative (middle) 1 sq. in. section, neutral (outer) 0·8 sq. in. section. The contract for these was divided between the British Insulated Wire Co., who have supplied their well-known paper insulated cables, and Callender's Cable and Construction Co., who have supplied their extensively used fibre cables. The distributors are of the same class as the feeders, and of sectional areas to suit the requirements, principally, however, of 0·15in. triple concentric. The most important work up the present time in the cable-laying department has been getting down the feeders from the new station to the present area of supply, so as to take some of the load from Waterloo-street as soon as possible. The handling of these heavy feeders was a matter of great difficulty, and the generally accepted methods of cable laying have had to be greatly modified to suit special local requirements. We may mention that, although the two firms who are supplying the cables do an enormous business of this kind, these feeders were the largest they have ever turned out. It is also worthy of note that the Corporation officials have themselves directed the laying of the cable with their own staff.

It is intended to have a three-wire system with 500 volts across the outers, and the original three-wire 200-volt supply will be gradually changed to the higher pressure, *i.e.*, 250 volts. There are to be 19 feeders supplying from the new station on the north side at Port Dundas, and seven from the south-side station. These are to be completed within the next 18 months, in accordance with the first portion of the whole scheme. The feeding points will average a quarter of a mile apart, and will feed a 0·15 sq. in. network of three wires; but where a larger demand will be required in the centre of the city a 0·25 sq. in. network will be laid. Arrangements have also been made for running extra feeders where required to feed midway between the present feeding points.

At the points of distribution manholes are built in the footways, and special fusing and disconnecting appliances are fitted in the boxes, so arranged that if a fault occurs on either the feeder or either one of the distributors the fuse in connection with the faulty cable will blow, and thus cut out the fault from the supply. These fuses are arranged so that they may be disconnected with the greatest facility and with no risk of short-circuiting, and special care has been used in the design of the arrangement to insure against electrolysis and from high voltage in manholes. The feeders are placed wherever possible at junctions of the main thoroughfares, and connections are made to distributor boxes at corners opposite the feeder manholes by means of a 0·25, 0·3, or 0·5 cables drawn through cast-iron pipes under the roadways. Halfway between the feeding points a network connection is made between the two sides of the road by means of a 0·25 cross cable, entering at manhole built for this purpose, and arranged with special fittings for disconnecting purposes. This connection will, of course, be found a convenience in aiding the distribution in the event of its being necessary to disconnect any of the sections of the distributor between the feeding points, and will also be in readiness for the extra feeders which may be required between the present feeding points.

The service cables are of concentric or triple concentric lead-covered lock coil armoured cable, covered with a semi-circular tile stamped "Electricity," and the T-joint boxes are of an entirely new design, and so arranged that a connection can be made without interrupting the continuity of the distributor.

Glasgow was the first city in the kingdom to adopt 1 sq. in. triple concentric feeders, and owing to the size of the cables and the care with which they require handling, special appliances have been made for the purpose of drawing them into the trenches. The cables are delivered on drums in 110 and 125 yards length, and the cable is drawn off in these lengths over rollers placed at intervals of 6ft. in the trench. The troughs, which are either of iron or earthenware, are laid first for taking the full length of cable; the rollers, which are of wood with steel spindles and grooved, are fixed over the troughs by means of wooden standards, these being designed so as readily to keep in position. The drum is then mounted at one end of the cut, and a winch at the other, and the cable is drawn off the drum by means of a steel rope hawser worked from the winch. By this means the cable is drawn over the rollers to its full length, and is in exact position for lowering into the troughs. Wooden saddles are placed in the troughs, and a layer of pitch poured in to form a bed before the cable is let down into the trough.

In about a month's time it is hoped to be able to start the arc lighting in connection with the Springburn electric car route. The lamps, 106 in all, are suspended from the trolley poles along the route by suitable brackets, and they will be run in 10 series off 500 volts, the supply being taken from the triple concentric distributors already laid along the route. The circuits are controlled by means of switches and resistances fixed in the bases of the columns and some of the bases are also used as disconnecting and fusing points for the distributors, the interiors being fitted with specially designed connections for this purpose. Lead-covered paper and jute cables are drawn into 2in. cast-iron pipes, and into the bases of the columns for the wiring of the circuits; and the connections to the lamps are made by means of rubber cables drawn up inside the trolley poles.

As most of our readers are doubtless aware from the advertisements that have recently been appearing in our columns, Mr. Chamen is at present asking contractors for tenders for further plant for next winter's load. The plant at present being asked for comprises two 200 H.P. sets, two 400 H.P. sets, three 1,100 H.P. sets, and two 2,200 H.P. sets, these two latter sets being capable of working up to 1,500 and 3,000 I.H.P. respectively for two hours at the peak. Contractors are to leave the Corporation the option, too, of ordering more of the larger sized units within a specified time if they so desire. This programme shows that Mr. Chamen means business, and intends to get the two new stations at work as soon as possible.

In conclusion, we cordially tender Mr. Chamen our thanks for permitting us to publish these particulars, and also his chief assistant, Mr. William Lackie, the resident engineer, Mr. J. Christie, the head of the mains department, and Mr. J. C. A. Ward, for the assistance they have rendered us in furnishing us with information.

THE FATAL ACCIDENT AT SOUTHAMPTON.

The following is the full text of Major Cardew's report on the fatal accident which occurred at Southampton on December 12th:—

I have the honour to report that, as appointed by the Board of Trade, I held an inquiry on December 21st into the cause of a fatal accident to Walter Day, a jointer in the emplyment of Messrs. W. T. Glover and Co., who are the contractors for the street work in connection with the extension of the electric light supply at Southampton. The inquiry was held in the Council Chamber at Southampton. The town clerk represented the Corporation of Southampton, who are the undertakers. Mr. J. D. Bassitt, solicitor, appeared for Messrs. Glover and Co. and for Mr. J. Brooking, their local superintendent. I attach my notes of the evidence given at the inquiry, and a transcript of notes taken in shorthand, kindly forwarded to me by the town clerk. There does not appear to be any doubt as to the facts of the case, which are briefly as follows:—

The Corporation, for the purpose of extending the area of their electric supply, are laying down a system of high-pressure mains to supply trans-

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formers placed in street boxes, and also a system of low-pressure mains, to serve consumers from these transformers. The contractors for the street work are, for various reasons, behind time, and in order to carry out promises made to intending consumers, who were waiting for the light, the Corporation unfortunately commenced to supply before the laying of the high-pressure mains was completed and proper joints made. The mains were still in charge of the contractors, who had working parties engaged upon them at the time, while the arrangements for supply were naturally under the control of the engineer to the Corporation, a division of responsibility which in itself is likely to lead to mistake and danger.

The high-pressure mains are concentric lead-covered cables laid in earthenware "ways," the outer conductor being connected with earth at the generating station, and the inner conductor being therefore charged to the full pressure (2,000 volts) from earth. The low-pressure mains are almost exactly similar in appearance to the high pressure, and are laid in similar "ways" alongside of the high pressure, where they follow the same route. The separate lengths of main are to be connected together by means of cast-iron junction boxes, but, as these had not arrived, temporary connections had been made in three street boxes by means of pieces of single cable connecting the respective inner conductors and outer conductors, the joints being covered with india-rubber tape. In the box where the accident took place branch connections were made from the high-pressure mains to two street transformers, and the work had evidently been hurried, the ends of cables and connections crossing each other and presenting the appearance of a tangled mass. Besides the high-pressure mains, there were three low-pressure mains passing through the box.

Between three and four p.m. on the 12th inst., a party of the contractors' employés was engaged in passing rods through the cable ways in order to draw in cables in the upper portion of the High-street, and one of them, Henry Flux, by name, lifted the cover of the street box mentioned above in order to give notice when the end of the rod appeared. He saw sparking taking place between one of the cable ends and the side of the box, and pointed this out to Mr. Brooking, the superintendent, who got into the box and examined the fault, receiving a slight shock when he took hold of the insulating covering of the inner conductor. This was no doubt due to surface leakage. By hastily tracing out the faulty cable with his eye, he had come to the erroneous conclusion that it was a low-pressure cable, being misled by the confusion in the box, and, strangely enough, the shock he received confirmed his mistake. He therefore asked for some rubber strip to repair the fault, and, as there was none available, went to find the jointer who had made the joints, and instructed him to re-tape the joint. The electrical pressure was on at the time, although it could easily have been switched off at the generating station. Brooking was warned twice by Mr. Shepherd, the clerk of the works, to be careful, as the fault might be on a high-pressure main, but persisted that he had identified it to be low pressure. The jointer, Walter Day, went at once to the box, got into it, handled the cable carelessly, and received a fatal shock. He was at once dragged out by Brooking and Shepherd, who tried artificial respiration, and fetched a doctor, but life was extinct.

This accident greatly resembles the recent fatal accident at Chelmsford; in both cases a temporary connection to the inner conductor of a concentric system of mains proved deficient in insulation, and in both cases the breakdown was the natural result of the very imperfect nature of the joint and of the use of single cable connections to the inner conductor. On several occasions I have pointed out the danger incurred by such connections, which, moreover, are expressly forbidden by the following conditions attached by the Board of Trade to its consent to the connection with earth of the outer conductors of the system in this and all similar cases, viz:—

1. That the high-pressure mains, and any service lines in connection therewith, be concentric throughout.

2. That the outer conductor in all cases form a complete metal sheathing round the inner conductor.

In the concentric system, as properly carried out, there are two earthed metallic shields surrounding the inner or charged conductor, and any breakdown of the insulation of the latter must inevitably cause a short circuit, which will operate the safety fuses and cut off the pressure automatically. Even where the concentric arrangement of conductors is not carried out at the joints, as in my opinion it should be, a cast-iron joint box is always provided and thoroughly earthed on to the outer metallic protection of the main. If in any part of the circuit the insulating covering alone is relied upon for the safeguarding of the charged conductor the system at once loses its security and becomes decidedly more dangerous than one in which separately insulated conductors are used throughout. This is now fully recognised by all engineers of experience.

There are two dangers disclosed by this inquiry against which the Board of Trade should provide in considering new proposals for supply at high pressure. These are, first, the danger that high-pressure mains may be brought into use for supply before they have been completely laid, properly jointed, examined and tested, and while they are still in charge of other parties than the undertakers. Secondly, that high-pressure mains may be mistaken for low-pressure mains, passing through the same street box if the different mains are not readily distinguishable from each other.

With regard to the first of these dangers, the Board of Trade Regulations certainly provide that (Regulation 10):—A high pressure circuit shall not be brought into use unless the insulation of every part thereof has withstood the continuous application, during one hour, of pressure exceeding the maximum pressure to which it is intended to be subjected in use, that is to say, in the case of every electric line a pressure twice the said maximum pressure, and in the case of every machine, device, or apparatus a pressure of 50 per cent. greater than the said maximum pressure. The undertakers shall duly record the results of each test.

This test had not been carried out in this case. It would probably have at once developed the fault, but might not have done so, and I think it will be desirable to definitely forbid any attempt to supply at high pressure through unfinished mains and before the mains have been thoroughly examined and taken in charge by the undertakers. It is probable, as stated by the engineer to the Corporation, that great pressure was brought to bear on him to induce him to commence supply on these mains against his better judgment. It should also be noted that Mr. Brooking stated that he protested against supply being commenced in the unfinished mains, but had yielded to an urgent request. I fear there is a distinct tendency in the case of electrical undertakings managed by municipalities to unduly press the engineers to start the works before they are properly complete, and it would strengthen the hands of these engineers if the Board of Trade distinctly forbid any makeshift arrangements.

The second danger is one which has only lately arisen, but which certainly, in this case, has proved to be a very real one. It can, of course, easily be provided against, and the attention of the manufacturers will no doubt be directed to this point, which appears to have been overlooked.

To sum up, I am of opinion that Walter Day lost his life from electric shock received while carrying out instructions given under a misapprehension by his superior, whereby he was placed in a position of extreme danger; that the high pressure mains from which the shock was received were not in a proper and fit condition to be brought into use for purposes of supply; and that the regulations and conditions imposed by the Board of Trade on the undertakers had not been complied with in the case of these mains.

THE INSTITUTION WIRING RULES.*

BY R. E. CROMPTON.

Nearly four years have elapsed since the Council decided that the Institution wiring rules should be revised. A Committee was then appointed to deal with the matter, and subsequently sat throughout the greater portion of two sessions, with the result that the revised rules were issued in July, 1897. I have discussed these rules with several gentlemen who are competent to express an opinion on the matter, and I find the general feeling to be that the labours of our Committee were not misspent, and that the rules in their present form are, of all those now in existence, the best fitted to become the standard set accepted by all parties.

My object, therefore, in writing this note is to try and promote the adoption of the Institution rules as the standard rules to be prescribed by consumers, insurance companies and municipal authorities, and to be worked by wiring contractors. Of these four classes, the fire insurance companies are, of course, the most interested, as they act as guarantors of the safety of installations passed by them; and it is to the gentlemen who act as inspectors and technical advisers to the insurance companies that I primarily address myself. The objects which the Committee had in view when framing the present rules were identical with those of the fire insurance companies, every principle laid down and every detail described having for its object the avoidance of fire risk. I say this advisedly, for although some few details were intended to prevent either danger to person from shock, or discontinuity of supply, yet even in guarding against these dangers we are indirectly guarding against fire risk also. At present there are issued by fire insurance companies several distinct sets of rules, differing among themselves, indirectly in principle, but, mainly, in the size and carrying capacity allowed for the conductors and in small matters of dimension. In these respects I believe the Institution rules occupy a midway position—that is to say, they are more stringent than some and less so than others; but all are dealing with the same questions of electrical supply and with the same fire risks. Why, then, should this diversity in rules continue? Is not this the time for us to invite insurance inspectors to appoint a committee to decide in what points the Institution rules can be improved, made more (or less) stringent, or added to, so that they may be satisfactory to all, and may thus establish that uniformity which will undoubtedly result in simplifying the work of contractors, and which, therefore, assuredly in the end will give the consumer better value for his money? The Committee throughout tried to place themselves in the position of fire insurance inspectors, and if I recollect aright, the rules in their draft condition were sent out to a number of inspectors for their criticisms and remarks; and all criticisms received were accepted and dealt with as far as was possible. If it is a fact that these rules differ in points which fire insurance inspectors consider vital, now is the time for these gentlemen to come forward and give us the opportunity of amending or supplementing them; but I sincerely hope that this discussion will open the eyes of everyone to the desirability of uniformity, and to the great waste of time, and the annoyance to consumers and everyone concerned, that arise from the multiplicity of rules which at present exists. It has been said that the Institution rules cannot be enforced. It is true that the Institution as a body cannot enforce its rules, but in drawing them up it did the next best thing—it appointed, from amongst those of its members who were best qualified to deal with this matter, a committee to draw up a set of rules which would be a guide to any consumer, and which could be adopted and enforced by any one having the requisite authority. In fact, all that is now required is, that wherever the words "should be" occur in the rules, the words "must be" should be substituted.

* Paper read at the Institution of Electrical Engineers, Jan. 26, 1899.

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THE COST OF MUNICIPAL ENTERPRISE.

A Paper on "The Cost of Municipal Enterprise" was read on Wednesday evening last, at the Society of Arts, by Mr. DIXON H. DAVIES, and was followed by a discussion—which was adjourned until Thursday next—presided over by the Attorney-General, Sir RICHARD WEBSTER, who, in a masterly speech, disclosed the many mischievous features of municipal trading. Unfortunately, the general subject, the contents of the Paper, and most of the speeches, have a directly electrical interest, sufficient to justify our devoting considerable attention to them in this article. We say unfortunately, because we feel—and the facts brought out in the Paper strengthen our opinion—that, to a very large extent, electrical undertakings are being made the raw material, as it were, for a number of crude experiments in speculative municipalisation. Thus, a mere fortuitous coincidence has invested these quasi-political phenomena with a strange and unwelcome interest for the electrical profession, who are compelled to see the arena of their activities made a playground for "progressive" politicians. In the early portion of his Paper, Mr. DAVIES deals with general facts and principles; among which he made the interesting statement that the aggregate debt of local authorities in the United Kingdom is now 252 millions sterling, a figure more than one-third of the national debt. In 20 years municipal liabilities have increased 120 per cent., a rise largely brought about by municipal adventuring in trading concerns such as electricity works. As regards electrical undertakings Mr. DAVIES remarks:—

But electricity is fast advancing into almost universal use for trade as well as private purposes. If the authorities retain possession of this industry and keep pace with the needs of the future, they will have to spend 100 millions where they have at present spent one. Surely such a vista of capital commitment should give pause to the counsels of those adventurous spirits who, with a vicarious enterprise, are so ready to land the ratepayers in further trading risks.

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Much more than the mere cost of municipal enterprise, however, occupied Mr. DAVIES's attention; the latter portions of his Paper are a detailed criticism of its relations with commercial and other sections of the community, and attempt with considerable success to demonstrate the stagnating influence of bureaucratic municipal trading—that enemy of progress which Prince BISMARCK stigmatised as "the boa-constrictor, bureaucracy." Arguing from the attitude of the Municipal Corporations Association towards electrical companies which seek powers to do business in competition with local authorities, Mr. DAVIES draws the following forcible and soundly logical deductions. The italics are our own:—

> Surely here we see the municipal trader in his true colours. He does not wish to trade in the same way that any commercial man trades, facing difficulties as they come, contending with his rivals whomever they may be, adapting himself to new conditions, scrapping his existing plant as soon as it is superseded, and substituting more efficient plant, often at great sacrifice. *Your municipal trader won't hear of scrapping superseded plant.* He wants protection for the ratepayers' trade. If science has shown that he is on the wrong lines, and has made an improvident investment, so much the worse for science, which must go to the wall before the necessities of municipal trading. *Science must wait until his machinery wears out.* That will be quite time to introduce anything new.

With every interest in keeping each municipal works *in statu quo*, and armed with absolute powers to extinguish rivalry, what inducement will there be for municipalities to adopt new methods or improved manufactures? Surely none. And in this fact the industrial sections of the electrical profession—and in no less degree the more scientific sections also—may find food for painful reflection. Of what real advantage is it that the municipalisation mania creates a temporary demand for electrical manufactures, when the transient demand is to be followed by an era of stagnation and repression. If municipalities are to be permitted to acquire and hold electrical patent rights, as is proposed, what is to prevent them from doing so in order to strangle a possibly inconvenient new invention, just in the same way that no less than 104 local authorities are to-day in possession of electric lighting Orders, which they show no intention of putting to any practical use, but which, as Mr. DAVIES observes, "have been taken for the dog-in-the-manger purpose of keeping companies out, and so have a directly retarding effect." Yet this discreditable practice is one of the most favoured tactics of local authorities, and, we should have thought, sufficiently indicates the hostility towards real progress on the part of those who have adopted it. In fact, while the electrical profession, as such, would gladly welcome, and the industry would probably benefit greatly from, the municipalisation of electricity works on a free and open commercial basis, they cannot but be ultimately, and, indeed, speedily, injured to a serious extent by the bureaucratic spirit of monopoly with which this class of enterprise is now being regarded by municipal authorities. We do not, of course, advocate unlimited competition, especially in the case of electric supply and tramway undertakings; but we deny *in toto* that anything in the nature of a monopoly of business is contemplated in the Electric Lighting Act, 1888, the following clause from which explicitly provides to the contrary:—

> The grant of authority to any undertakers to supply electricity within any area, whether by licence or Provisional Order, shall not in any way hinder or restrict the granting of a licence or Order to the local authority or to any Company or person in the same area.

This clause cannot be too widely quoted as an antidote to the rubbish many local authorities, and the newspapers that give voice to their opinions, are talking about "the monopoly" which the Electric Lighting Acts are falsely alleged to have conferred on these authorities.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

A New String Interrupter.—The string interrupter has distinct advantages over the hammer and the tuning fork, being more reliable and adjustable than the former, and more cheap and convenient than the latter. L. ARONS describes a new form of string interrupter, which provides the additional advantage of altogether dispensing with electromagnets in the circuit, and thus eliminating the heavy inductances which make high frequencies so unmanageable. It consists of a copper wire which carries a current, and is by virtue of that current attracted by a bar magnet or a permanent magnet of the horseshoe pattern. This attraction interrupts the current and sets the wire vibrating in its natural period. The best arrangement consists of a stretched wire bearing at its centre a thin platinum wire dipping into mercury covered by a layer of water. The binding screws holding the wire are in metallic connection, so that the current divides at the platinum wire and proceeds in opposite directions to the two binding screws. A horseshoe magnet is fixed above the wire, one pole attracting one half and the other pole the other half. Since very short and thin wires can be used, frequencies of 800 or 1,000 per second are easily attainable. The wire can be easily brought into a powerful magnetic field, and the loudness may thus be increased to a very high amount.

[ARONS, *Wied. Ann.*, No. 13, 1898.]

Visibility of Röntgen Rays.—E. DORN proved some time ago that the ordinary eye is sensitive to Röntgen rays, although the impression obtained is always diffuse, even from a well-defined point, owing to the fact that the rays are not refracted, and thus impinge upon every part of the retina simultaneously. More recently, the same author has conducted some experiments with totally colour-blind persons. One of them saw the Röntgen rays as of an almost painful brilliance. He saw them as an elliptical ring, probably owing to the fact that the central rays were absorbed to a greater extent by the humours of the eye. Since the peripheral portions of the retina contain only rods, and no cones, it follows that the rods are sensitive to the Röntgen rays, a probability which is further supported by the fact that the cones are usually imperfectly developed in colour-blind eyes. None of the observers who saw the rays clearly could bring them to disappear altogether except at one spot, which corresponds to the entrance of the optic nerve, and is usually termed the blind spot. On repeating the experiment with a lead plate containing a small hole held just in front of the eye, a single bright spot was seen, which disappeared on reaching the blind spot. So far as the experiments go, they show that the mechanism of perception for the Röntgen rays is practically identical with that for ordinary light.

[DORN, *Wied. Ann.*, No. 13, 1898.]

New Form of Hertz Experiments.—Advances in the construction of wave detectors are always welcome to the worker in the fascinating field of electric waves. J. PRECHT describes a detector for Hertzian waves which has several advantages, the most notable being its property of returning instantly to its normal state on the cessation of the waves. It consists, essentially, of a spark gap connected with the sections of an ordinary Hertzian resonator provided with a parabolic mirror. The spark gap is inserted in the circuit of an influence machine, which introduces the old principle of a relay. The anode is pointed, and the cathode blunt. The distance is so adjusted that a spark discharge is just unable to pass, and the only indication of activity is a faint glow at the anode. The adjustment is tested by breathing on the spark gap, which should at once lower the discharge potential, and produce a shower of sparks. This shower of sparks is also produced when the mirror receives electric waves from a distant source. After the waves have ceased, the glow sets in as before. It is not necessary to connect both the electrodes with the resonator. It suffices to connect the sections of the latter with two wires which nearly touch the cathode, so that secondary sparks can pass over to the latter. The waves are also indicated by the fall of the discharge potential as shown by an electrometer.

[PRECHT, *Wied. Ann.*, Nov. 13, 1898.]

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Pyroelectricity.—J. and P. Curie, the discoverers of piezo-electricity, thought they could reduce all pyroelectric phenomena to piezo-electricity by taking into account the changes of volume accompanying all changes of temperature. The same view was held by Röntgen, and Riecke and Voigt thought they had proved it by their tourmaline experiments. But on going over the results again and repeating the experiments, W. Voigt has found that they were vitiated by erroneous assumptions concerning the thermal dilatation of the tourmaline used. As a matter of fact, only about 80 per cent. of the pyroelectric charge of tourmaline crystals can be reduced to piezoelectric effects. The remaining 20 per cent. the author proposes to call the true pyroelectric charge. This result is more consistent with the theory which regards these phenomena as due to the dislocation of charged molecules. It is evident that a rise of temperature is capable of producing such a dislocation or change of orientation apart from a change of volume, if one of the crystallographic axes occupies a singular position with respect to the others. In all crystals where that is the case, as in tourmaline, tr ue pyroelectricity will be obtained. In all others, the pyroelectric charges are in reality piezoelectric. The author proposes to use a squeezed tourmaline crystal as a source of a standard quantity of electricity.

[VOIGT, *Wied. Ann.*, No. 13, 1898.]

Magnetisation of Crystals.—The quantitative work of König and Stenger on the orientation of crystals in a magnetic field has completely verified the theory of crystalline magnetism laid down by Kelvin. But there are as yet only very few results available concerning the force with which a crystal tends to assume its position of equilibrium at different temperatures. Such an investigation, which has an important bearing upon our views concerning the nature of magnetisation, has been carried out by A. Lutteroth. Faraday had found a general diminution of the couple with rise of temperature, the difference between the induction along the two horizontal axes decreasing as the temperature increased. This is not always strictly true. For it depends upon which axis is chosen as the axis of suspension. In all the crystals examined, both diamagnetic and paramagnetic, comprising a number of alums and hydrated sulphates, the difference of any two chief permeabilities changes in a linear manner with the temperature, but the change may be either positive or negative. If the crystals belong to an isomorphous group, the three temperature coefficients are in a constant proportion. In the sulphates of Ni, Co and Zn the temperature coefficient of the couple is positive or negative according as to whether the axis of greatest magnetisation is chosen for suspension, or the axis of medium magnetisation.

[LUTTEROTH, *Wied. Ann.*, No. 13, 1898.]

Dielectric Conduction.—In recent times we have learnt to bridge over the gulf between conductors and dielectrics, and have begun to consider every conductor as possessing a dielectric capacity and every dielectric as possessing a definite though small conductivity. Such conductivity can be placed in evidence by inserting large thin sheets of the dielectric between metallic conductors. W. Leick thus obtained a sheet of guttapercha showing only some 90 ohms resistance. But a current through this dielectric was not found to obey Ohm's law. The conductivity of the guttapercha steadily increased with the current strength. This might be due to several causes. It might be due to a polarisation of the dielectric by the weaker currents. But even a very rapid interruption of the current failed to reveal such a polarisation. It might also be due to the heating of the guttapercha by the stronger currents, since almost all dielectrics become more highly conducting on heating them. But measurements show this explanation to be entirely inadequate. When a telephone is introduced into the circuit the first snap on making the circuit is followed by several minor noises. Guttapercha and paraffin show no polarisation, but sulphur and collodion show it very strongly.

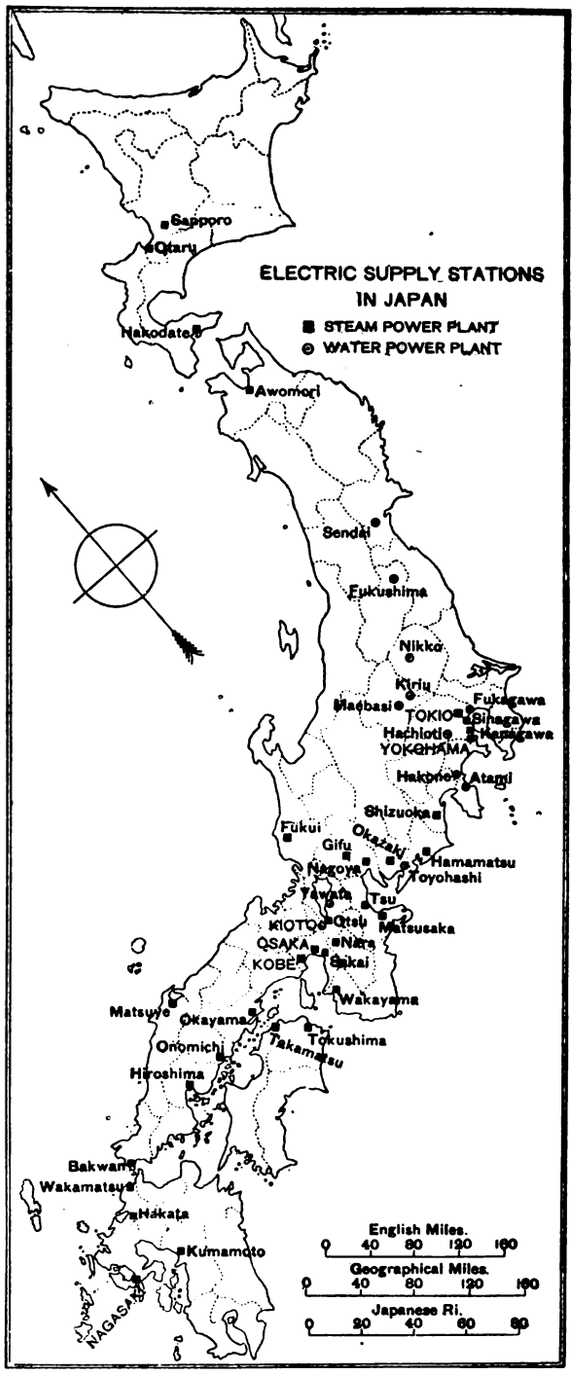
[LEICK, *Wied. Ann.*, No. 13, 1898.]

JAPANESE NOTES.

(FROM OUR OWN CORRESPONDENT.)

TOKIO, *December 12, 1898.*

Electric Lighting.—Not including a large number of isolated private plants, there are now about 44 public central electric lighting stations in Japan, 11 of which are driven by water power. The majority of these are in a flourishing condition, paying as much as from 10 to 15 per cent. dividends on their capital, and in the case of one water power plant as high as



25 per cent. dividend. The accompanying map shows the distribution of steam-power and water-power electric supply stations in the Japanese kingdom. One defect in Japanese electric lighting is the lowering of the supply pressure. Owing to the high price of coal, the station engineers attempt to reduce the coal bill as much as possible by reducing the voltage of the line, which is carried out as far as customers will submit to. Another defect is that, owing to the high rate of interest paid for capital, companies will not put aside capital in reserve plant, so that the stations have to be run on a small margin of plant. In the earlier days English machines, such as the

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Victoria-Brush, the Hopkinson, and the Mordey alternator, were imported. Later on, however, American and German machines captured the market. Very little machinery of English make is now to be met with in new plants. American and German manufacturers are doing an extensive business.

Train Lighting.—The lighting of railway trains on the Japanese lines is an important branch of electrical work. The "Stone" system, as used in this country, is very commonly adopted, as is also a system in which an oil engine is placed in the brake van to drive the dynamo. The first-named of these is now undergoing trial on the Imperial Government Railway, and the second-named system has been adopted by the Sanyo Railway Co. It is stated that some of the railways are making experiments with ordinary storage battery systems, but the results of these are not yet published.

Telegraphic Enterprise.—Quite an extensive telegraph system exists in Japan, comprising a large number of small villages, many having but few inhabitants. The number of lines between the principal towns and villages has greatly increased during the past few years. Last year an important telegraphic event was the laying of the submarine cable between Japan and Formosa, a distance of 868 knots. This was laid by the Japanese cable steamer "Okinowa Maru." The cable has a seven-strand copper core weighing 130lb. per knot, and has a capacity of 400 "kana," or signals, per minute. This service having proved insufficient, the laying of another cable is now projected.

The Telephone.—Telephone exchanges now exist at Tokio, Osaka, Kobe, Yokohama and Kioto, that at Tokio having no less than 4,500 subscribers. Exchanges are shortly to be established at Nagoya and Bakan, while several more are projected. A long distance line connects Tokio and Kobe, a distance of 376 miles, the line communicating at intermediate points with Yokohama, Nagoya, Kioto and Osaka. The line has a complete metallic circuit. The exchanges and subscribers have recently had old Gower-Bell instruments replaced with either solid back or Delville instruments. The subscribers' connections with the central are largely made through lead-covered underground wires.

Electric Power Transmission.—Electrical power transmission is the most important branch of electrical engineering in Japan. Mountainous as the country is, it is very easy to obtain power for generating electrical energy. A typical installation is to be found in Kioto, where water is conducted through several miles of canal from the famous Lake Biwa. An aggregate of 3,000 H.P. is brought from the lake to the power-house, and is used for lighting, traction, spinning, weaving and various small industries such as clock making, &c. Another installation is at Ashio Mine, and was installed by Messrs. Siemens and Halske, and is used for pumping, winding and the locomotion about the mines. A dozen or more mines in the neighbourhood are working by electricity and quite as many are in course of construction. The application of electric power to the driving of workshops and factories is also very popular in Japan. New overhead travellers are mostly driven by electricity, as, for example, in the Osaka Arsenal, in the Kawasaki Dockyard and in the Imperial Steel Works. Considering the enormous amount of water power available, and the fact that in Japan one ton of coal costs from 20s. to 80s., the rapid growth of electric transmission is easily accounted for.

Electric Traction.—In regard to electric traction, Japan is "still in its cradle." There are only six tramways, including the three lines now under construction, and one of these six is run in connection with a mining undertaking. The reason is that the local authorities find it either dangerous to have such rapid transit in their narrow streets, or object to the unsightliness of the overhead trolley lines, while both the conduit and accumulator systems are expensive. The future of electric traction is very hopeful, not only within the towns, but also in suburban districts, especially where water power is available. It is reported that an American, named C. T. Yerkes, is forming a syndicate, with a capital of $10,000,000, for the purpose of covering Japan with a network of trolley lines; but the rumour is not credited in Tokio.

THE REGULATION OF WIRING RULES.*

BY C. H. WORDINGHAM.

The question of the conditions necessary to be attained in order to provide for safety from fire and reliability in the utilisation of electrical energy for various purposes has attracted a very large amount of attention from the earliest days of the industry, and numerous sets of rules and regulations have been promulgated from time to time. Many different authorities have taken upon themselves to issue these rules, and, inasmuch as there are various conflicting interests in an installation of electric light or power, and as each authority is determined to abide by its own particular rules, the difficulties of the wiring contractor are many and great. In consequence of this, and for other reasons, there is, at the present time, a very widely diffused feeling that there should be some definite standard set of rules by which everyone will agree to be bound. There is an essential difference between the rules necessary to secure efficient and safe wiring, and those equally necessary, to secure a satisfactory utilisation of the public supply. The former will, practically speaking, be independent of the system of supply. The latter will vary greatly with the nature of the distribution adopted by the supply company, and also to some extent with local conditions. This fact has not been sufficiently generally recognised. It appears possible, and, undoubtedly, most desirable, to draw up a set of regulations of universal application; but so far as the public supply authorities' regulations are concerned, it will be necessary either to draw up a single model set of regulations which can be modified for every particular case, or several standard sets of regulations to suit different systems of supply which might possibly meet with general acceptance. The former would probably be the more likely to meet with success.

It is important to consider, when framing regulations, what power exists to enforce them. This point was fully discussed by the author in a paper read at the 1896 Convention of the Municipal Electrical Association.† It was then shown that the power given in the Electric Lighting Acts is extremely unsatisfactory, and does not by any means give the undertakers a sufficiently strong hand to deal effectively with wiring contractors, and the course adopted by Glasgow was advocated by the author for imitation by other towns. Since then the same powers have been sought and obtained by Manchester, and there should be no difficulty in similar powers being obtained in all cases where municipal authorities are the undertakers. The course referred to is to obtain a special Act to make the regulations in question. It might be somewhat difficult for existing companies to obtain similar powers, but the experiment would be well worth trying.

To consider first the question of wiring regulations, properly so called. There are several excellent sets of rules in everyday use, but the author ventures to think that those issued by this Institution are the best that have yet been produced. They are the outcome of the most careful deliberation, and no one rule was drawn up until it had been most thoroughly discussed by men actually engaged in the work affected. Indeed, it may be said without any hesitation that these rules represent the unbiased opinion of electrical engineers at the present time as to the best means of securing safety from fire and efficient utilisation of energy. It is greatly to be regretted, however, that no matter how good the rules may be, they, in the existing state of things, can only be suggestions, and when individuals have drawn up other regulations which they have found to work well in practice, and with the details of which they are thoroughly acquainted, they are extremely loth to adopt "suggestions." The only possible way in which uniformity can be attained is by first of all thoroughly thrashing out the whole question at one or more meetings, in which all the parties interested are adequately represented. When this has been done it should be possible finally to decide upon a set of rules which will cover the whole of the points raised in the discussion, and then, if every person will abide loyally by the decision arrived at, the desired result will be attained; but it is futile to hope for this unless persons will sink their own individual preferences, and it may be their own *amour propre*.

It is not the author's object in this Paper to enter into the question of particular regulations. He had the honour of forming one of the committee that drew up the Institution rules; but a few words may not be out of place on the general question of enforcing rules when made and agreed upon. There is, in the author's opinion, great necessity at the present time for the proper supervision of fittings used in connection with electric lighting and motive power. By fittings it is intended to imply such apparatus as fuses, switches, ceiling roses, wall sockets, lampholders, &c., not ornamental electroliers, brackets, &c., which are after all only

* Abstract of a Paper read at the Institution of Electrical Engineers, Jan. 26 1899.

† See *Proceedings* Municipal Electrical Association, p. 30: "The control by Municipal Authorities of consuming devices, and the wiring connecting them to mains." [*The Electrician*, Vol. XXXVII., p. 282.—ED. *E.*]

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metallic casing for wiring. Quite recently the author has introduced into Manchester a system of testing and registration of such fittings.* It has only been in operation for a few weeks, but the results are eminently satisfactory. It is found that all makers of repute welcome the action taken, that they are anxious to submit samples, and that they see the value of the certificates and the advantages of the official recognition of their wares. At the same time wiring contractors derive great convenience from being no longer in doubt as to what fittings will or will not pass inspection, and further, consumers have the satisfaction of knowing that the apparatus fixed on their premises has been certified by an unbiased authority.

It has long been the practice to test and stamp fittings intended to be used in connection with the supply of water, but, so far as the author is aware, no attempt has hitherto been made to apply this system to electrical fittings. The treatment necessary in the two cases differs materially, for whereas in an ordinary house but few water taps are required the same house would require a large number of electrical fiittings, hence it is not possible to attempt actually to test and certify every individual fitting. The course adopted by the author, therefore, is to require manufacturers to submit in duplicate samples of the fittings they propose to supply in Manchester. One of the duplicate samples is then subjected to certain tests, and if it fail to pass, the two samples are returned to the manufacturer; if, on the contrary, it conformed to the regulations, the second sample is kept for reference, so that it may be seen by any contractor or consumer, and a certificate is issued stating that the article may be used. This certificate remains in force for one year, but may be renewed from year to year without further tests. It would be tedious to enter into all the regulations affecting this registration. The author will be happy to forward a copy of the rules to any member desiring to have it. The author was led to take the step in question very largely in consequence of the extreme difficulty, amounting almost to an impossibility, which exists in defining the conditions necessary in such articles as switches and fuses to ensure safety. This fact was very strongly impressed upon the members of the Institution Committee when drawing up the wiring rules, and at the author's suggestion it was thought that instead of specifying a given length of break, height of cover, &c., it would be far preferable to specify certain conditions which a given fitting should fulfil.

In Manchester the tests specified for a fuse are that when duly fitted up with its cover in position and connected to mains giving the pressure for which it is intended it shall break the circuit when those mains are short circuited through it with a fuse wire corresponding to its rated capacity, placed between its contacts. In carrying out these tests the fuse is tested in three positions, namely: (1) with the base horizontal; (2) with the base in a vertical plane, the fuse wire being horizontal; (3) with the base in a vertical plane, the fuse wire being vertical. For switches the conditions specified are that a switch when used in the ordinary manner shall be capable of breaking a current 50 per cent. in excess of that for which it is rated at a pressure 50 per cent. in excess of that at which it is intended to work. In addition to these tests there are other tests to insure that the parts are properly proportioned to prevent heating. The better class of fittings are found to conform to these tests with ease, and, therefore, on this score there can be no objection to them.

Consulting engineers are in a much stronger position than undertakers not possessing special powers, because the contractor working under their supervision is working to a definite specification under which large powers are given to the engineer. In the author's opinion it would be a considerable boon to consulting engineers, and would tend greatly to uniformity in practice, if some central authority—which, seeing that the Board of Trade is probably out of the question, should certainly be this Institution—were to undertake the testing of fittings in a somewhat similar manner to that adopted for local work by the author. It should not be a matter of extreme difficulty to establish a small testing station for the purpose, and it could readily be made self-supporting, for manufacturers would doubtless be prepared to pay a substantial fee for the testing and registration of their fittings if the certificates issued carried the weight of the Institution behind them.

The author is aware that fittings are not the only things demanding attention. There is the question of the best kind of insulation to employ for the conductors and the best kind of casing, but these matters are fully dealt with in the Institution rules, which are so drawn as to admit every existing system the efficiency of which has been demonstrated in practical work. We may therefore leave the subject of wiring regulations, and pass on to that of regulations make by undertakers for the efficient supply of energy to the installations of consumers connected to their mains.

The most widely employed system of distribution at the present time is the multiple wire, and perhaps the more important subdivision of this is that in which continuous current is distributed.

* [See *The Electrician*, Vol. XLI., p. 746.—Ed. *E.*]

Now, for multiple wire distribution it is essential that the balancing of the circuits should be good. It may be said that the three-wire system will be the most widely used, and, therefore, contractors should be required to divide their installations into two approximately equal circuits when a certain demand is exceeded. In Manchester this limit has been fixed at a low figure—namely, 12½ kilowatts—but the author ventures to think that the results attained by proper balancing entirely justify the slight inconvenience which may be said to be experienced in consequence by the contractor. As a matter of fact, this inconvenience with modern good wiring is not great, for it has become the practice, in any case, to limit greatly the number of lamps on a single circuit. Therefore, in practice the only hardship is the provision of two small main switches and fuses instead of one large one. Again, in order to secure efficient balancing it is important that, as far as possible, all motors should be supplied from the two outer conductors. For this reason the author has required in Manchester that all motors exceeding 2½ kilowatts shall be wound for 400 volts. In every system of distribution, whether two-wire or multiple wire, it is important to guard against sudden rushes of current, and, therefore, it is important to draw up rules with regard to the gradual starting of motors. This involves special switch-gear and interlocking arrangements between switches, but the difficulties are such as can be readily overcome. In the case of large photographic or stage arc lamps, it is necessary to take similar precautions, and, of course, in the case also of charging batteries or working electric furnaces.

Another important point which will require different treatment according to the system of supply is in connection with the earthing of one of the conductors. In the case of a continuous-current supply on the multiple wire system of distribution, it does not appear to the author desirable to allow any portion of the consumers' wiring to be directly connected to earth, whether the middle conductor of the system be insulated or not. There is much to be said in favour of the middle conductor being earthed at the central station and something against it, but the reasons against earthing one conductor of the consumer's installation are extremely cogent, the most important being that, although on the whole the balancing on the network may be extremely good, there must of necessity in some streets be a considerable local want of balancing causing heavy currents to flow through the middle wire. If then there be two consumers separated by a few hundred yards, both having one conductor earthed, and if there be a heavy current flowing down the middle wire and causing a fall of potential of several volts along that wire there will then be currents set up in the earth from the earth conductor of one consumer to that of the other, and the result may be serious electrolytic troubles, worse in fact than might arise from an improperly bonded tramway return. This reason alone appears sufficient to the author to preclude a system of wiring which requires the earthing of one conductor in a consumer's installation. The same objection does not apply with equal force if the distribution be effected by means of alternating currents, though in this case trouble may be anticipated if an earth return be used on the local telephone service. The author desires it to be understood that it is on these grounds alone that he deprecates an earth return system of wiring; for isolated installations there is much to recommend it, and also in cases in which the system of supply is a high pressure one, and each consumer is supplied from his own alternating current transformer.

From what has been said it will be seen that the regulations comprised in this second group are of a totally different nature from wiring regulations proper, and the contention that they cannot be made absolutely uniform will probably be thought justified. The matter has received the attention of the Municipal Electrical Association for some time past, and a committee of their Council is at the present time drawing up a model set of rules for the use of municipal stations. It is greatly to be desired, however, that a general set of rules acceptable also to the engineers to companies should be decided upon.

Electric Power Transmission in California.—From an available head of 1,325ft. in a waterfall on the Kaweah river, about 29 miles east of Visalia, Cal., it is proposed to obtain about 1,800 electrical horse-power, and transmit this over a distance of 40 miles to a number of towns in the neighbourhood. The transmission will be by means of overhead lines worked at 17,300 volts at the station end; but ultimately, when the load is increased, the voltage will be raised to 34,600 volts. The power will be utilised chiefly for pumping purposes in connection with irrigation, and special tangential impulse wheels have been devised for the hydraulic installation, which is under an exceptionally high head. The conveyance of the water from the river to the penstock will necessitate six miles of open flume and a short rock tunnel.

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THE ACTION OF MAGNETISED ELECTRODES UPON ELECTRICAL DISCHARGE PHENOMENA IN RAREFIED GASES.*

[PRELIMINARY NOTE.]

BY C. E. S. PHILLIPS.

The experiments herein described were undertaken in order to ascertain what would be the action of strongly magnetised electrodes upon electrical discharge phenomena in rarefied gases, and especially upon the charged residual gas, when all external stimulation had ceased. For this purpose an apparatus was constructed, as shown in Fig. 1, consisting of a soda-glass bulb, B, open at both ends for the purpose of inserting the pointed soft iron electrodes, E_1 and E_2, and with the leading tube L attached for connection to a sprengel air-pump. No precaution was taken to keep mercury vapour out of the bulb B during the experiments. Each electrode had a screw thread of suitable pitch cut upon it, in order that the brass cups C_1 and C_2, when screwed into position and sealed with cement to the glass, might serve to keep the electrodes central, to reduce the possibility of their rushing together under the influence of strong magnetic forces, and to seal air-tight the two ends of the bulb. The poles of a large electro-magnet, M_1 M_2 were insulated from the electrodes by means of two thin glass sheets, G_1 G_2. A discharge from the secondary of an induction coil or other suitable source, could then be passed through the bulb, the exhaustion varied and the electrodes magnetised at pleasure.

Results.

A pressure was obtained within the bulb, such that cathode rays began to be freely emitted by the negative electrode, and from the screw thread cut upon it there came a helix of rays which gave rise to the appearance of golden-green rings of fluorescence upon the

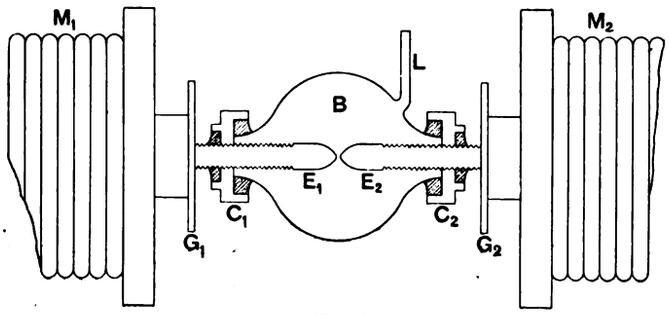

FIG 1

inner surface of the glass vessel B. When the electrodes were magnetised these green rings twisted somewhat and moved forward, the direction of rotation depending upon the polarity of the magnet emitting the rays. It has already been noticed† that an external magnet, placed behind the negative electrode will cause rotation of the green fluorescence upon the walls of an exhausted tube, and that the direction of motion is opposite to what it would be in the case of a wire placed at right angles to the axis of the magnet, and in which a current flowed away from the pole. In the above experiment, the rotation was only partial but agreed in direction with the results of other observers.

The bending forward of the rays is evidently dependent upon their partial rotation, because, on reversing the polarity of the magnet emitting them, the direction of their rotation was also reversed, and the bending forward still occurred. That a positively charged body, moving in a definite direction sets up magnetic whirls in planes transverse to its path, is generally accepted, the whole effect, indeed, being treated as a current flowing in the same direction; and it seems only logical to conclude that were the body negatively charged, its motion would give rise to effects similar to those accompanying a flow of current in the opposite direction. From this we should expect cathode rays to behave towards a magnet just as would a wire carrying a current in the opposite direction to that in which the charged particles, constituting the rays, are supposed to be moving—a view which is borne out by experiment. The pressure was then still further lowered, until a 3in. spark from a 10in. Apps induction coil was only just able to start the glow. Under these conditions irregular green patches flickered upon the inner surface of the glass; but when the electrodes were oppositely magnetised these green flecks immediately vanished, and, the resistance of the residual gas within the bulb becoming smaller, a hazy blue cloud formed between the points.

Owing to the ever varying charges upon the inner surface of the bulb and upon the electrodes themselves, it could not be ascertained whether this blue cloud tended to assume a definite geometrical form or not. It was found, however, that, after a strong stimulation of the bulb had taken place and then been stopped, the electrodes meanwhile remaining unmagnetised, on exciting the magnet, a luminous ring suddenly appeared within the bulb, between the pointed ends of the electrodes, and in a plane at right angles to the direction of the magnetic lines of force. The ring shone brightly for a moment, when the magnet circuit was "made," and it was more sharply defined at high exhaustions: becoming, in fact, hazy and indefinite, if the pressure within the bulb was slightly increased.

On the other hand, the rarefaction must not be carried too far, for it is necessary, in order to obtain this luminous effect, that the residual gas within the bulb should be very generally stimulated by the passage of the discharge. The following combinations were then tried:—After stimulation, both the leading wires attached to the electrodes were removed from the secondary of the induction coil, and (*a*) insulated, (*b*) joined together and insulated, (*c*) joined together and connected to earth, (*d*) one insulated and the other connected to earth. In all these cases the ring formed equally well when the pointed ends of the electrodes were oppositely magnetised. On the other hand, as long as the points were made either both N or both S, no ring could be obtained.

In another experiment, after the exhaustion had been carried somewhat further and the bulb strongly stimulated, a second ring flashed out momentarily when the magnet circuit was completed; it formed concentrically with the smaller and more permanent ring, and appeared to be situated upon the inner surface of the glass bulb.

Observations as to the actual mode of formation of what I venture to call the primary ring, *i.e.*, the smaller one of the two, could at this stage of exhaustion be conveniently made. It appeared to emanate originally as a bright stream from between the electrodes, and then to curl rapidly round the magnetic axis, that portion most distant from the electrodes gaining upon the rest, ultimately disengaging the tail of the stream from between the points, and thus forming an equatorial circle of light within the bulb. The ring then spread out and became somewhat wider and less well

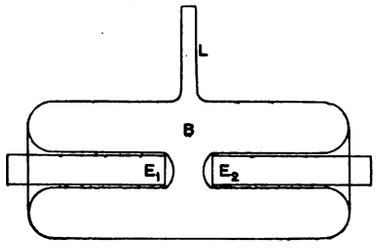

FIG. 2.

defined, and as it gradually died away the glow seemed to be rotating more and more slowly until at last it flickered and vanished.

It appears, in fact, that this luminous ring spins between the electrodes from the moment it forms under the action of the magnet, the high initial velocity with which, in that case, it must be set in motion tending to keep it rotating, even after the magnetic lines have reached a maximum. The gradual expansion of the ring, which begins to take place immediately it has formed, may, according to this view, be due partly to centrifugal force, and also partly to the attraction exerted by an electrostatic charge residing upon the inner surface of the glass walls of the bulb. It is significant, too, that when the ring had all but disappeared, the sudden turning off of the magnet slightly revived the luminosity. At the instant the ring formed, the glass walls of the bulb became charged so strongly that a spark could, in some cases, be seen to pass between the outer surface of the glass and the brass cups C_1, C_2 attached respectively to either electrode. It should be noticed that the ring is generally very sensitive to variations in the charge upon the glass walls, and that touching the bulb at various places with the fingers produces vigorous movements of the glow within. In a bulb, the diameter of which was about 3in., the ring threaded itself on to either of the electrodes E_1 or E_2, when the centre of the bulb was electrically connected to the cups C_2 and C_1 respectively.

When only one electrode was magnetised, after the bulb had been stimulated, the rotation of the glow was more easily seen, owing to the formation around the magnetised electrode of a wide, spiral-shaped luminous cloud which was apparently rotating as it became more and more dim, and it was then noticed that the direction of rotation could be reversed by reversing the polarity of the magnetised electrode. No change in the effect was observed when the connections to the bulb were reversed.

The form of the electrodes was next varied, but the effects produced were mainly the same. With a pointed cathode and a concave anode the ring formed as usual, but it was observed that whenever these relations were reversed no ring could be obtained. Indeed, having first of all stimulated the bulb with the concave

* Paper read at the Royal Society, Dec. 15, 1898.
† *Phil. Trans.*, 1879, Part II., p. 657.

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electrode negative, it was not only impossible to obtain a ring on magnetising the electrodes, but even when the connections were reversed still no ring would form until after repeated or prolonged stimulation of the bulb. Neither did a ring form when the electrodes were magnetised so that like poles faced each other—a similar result to that already observed with pointed electrodes. It may be worth recording that when pointed electrodes were employed, the ring formed equally well, whether the bulb was stimulated by means of a Tesla oscillator, an induction coil, or a Wimshurst influence machine.

Finally, experiments were made with external magnetised electrodes, the exhausted bulb being shaped as shown in Fig. 2. In this case, of course, the discharge was oscillatory, and consequently the effects were not very directly comparable to those already described. At a low pressure, however, and when the bulb was filled with a green glow, on disconnecting the induction coil and magnetising the electrodes, a flash of white light was observed within the tube and irregular green splashes momentarily made their appearance upon the glass.

In conclusion, I desire to offer my thanks to Dr. Silvanus P. Thompson, F.R.C.S., for kindly permitting me to use the Tesla apparatus at his laboratory, and for the interest he has taken in the progress of these experiments.

TRANSFORMER DESIGN.*

BY F. W. CARTER, B.A.

In designing transformers it is usual to assume values for certain of the quantities which occur, and to determine the details of the transformer to suit the prescribed values of these quantities. Thus, the maximum induction to which the iron is subject, the proportions, or even the size of the cross-section of the magnetic circuit, the resistance of the coils, and the maximum current-density in them, are often assumed. It is not, however, necessary to give prescribed values to these quantities, and, in fact, in practice the effect of changes in the assumed quantities is tried, and the best transformer is really arrived at by a method of trial and error. Any such method is, however, tedious and imperfect in the case of a machine in which there are so many quantities that may be varied, and the present Paper is intended principally to determine, once for all, the best conditions of proportion and distribution of waste of power, in order to obtain as little loss of energy as possible. The transformer may be made to satisfy these conditions by the method of trial and error, by successive approximation, or by any other method, but as the analysis indicates a perfectly direct method of obtaining the transformer to satisfy the outside conditions, and to give minimum waste of energy with materials of given quality—a method, too, which will present no difficulty to a tolerable arithmetician—the author has shewn, in detail, how to obtain the particulars of such a transformer.

The assumptions on which the work is based are :—

1. That the hysteresis loss is given by Steinmetz formula, *i.e.*, that it varies as the volume of iron, as the frequency, and as some power of the maximum induction. (The $\frac{1}{6}$th power is generally taken, but the results are worked out for a general index in an appendix)

2. That the eddy-current loss varies as the volume of iron, as the square of the frequency, as the square of the thickness of the core plates, and as the square of the maximum induction.

3. That the ohmic loss varies as the resistance of the coils, and as the square of the current in them.

The author considers these assumptions fully justified by experiment, at any rate for such inductions as occur in this sort of work.

The first result arrived at may be stated thus :—Given the core of a transformer, the number of turns of wire in the coils required to make the loss of energy a minimum, is such as to make the ohmic loss equal to 0 8 times the hysteresis loss, together with the eddy current loss. This is shown to be true whether the load is constant or variable, provided that, in the latter case, we understand by a loss the time average of that loss. The effects of various other distributions of loss are discussed in the course of the Paper, and it is shown that if the above relation is not satisfied we can always improve the efficiency of the transformer without altering the cost by satifying it. Thus, it is concluded that this distribution of waste energy should be attained wherever possible. A general expression for the number of convolutions of wire to satisfy this condition when the core is given is now obtained, further details being given later on.

The author now points out and proves that the waste of power can be made practically as small as we please by increasing the size of the transformer, and concludes that some condition is necessary to limit the size. He, therefore, in the following sections, prescribes the maximum current density to be used, in order to limit the size of the transformer. It is then shewn generally how to determine the size and particulars of a transformer to have the aforementioned distribution of losses when the *proportions* of the core are given.

The author now attacks the problem of finding the best proportions to give to the core, in order to make the waste as small as possible. The conclusions arrived at are perfectly definite, for it is shewn that, in the case of a shell transformer, if a, b, c, l, be as indicated in Fig. 1, to a first approximation, $\frac{1}{9\pi}=\frac{a}{14}=\frac{b}{9}=\frac{c}{7}$

This approximation neglects eddy-current losses, and assumes that the hysteresis loss varies as the $\frac{1}{6}$th power of the induction. The effect of eddy-current loss makes it necessary to increase b and l slightly in the same proportion, and, if anything, to very slightly decrease a and c. The amount of the correction depends on the

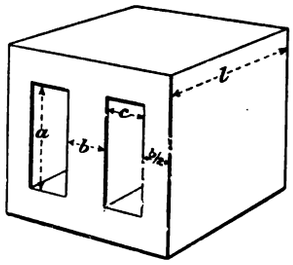

FIG. 1.

amount of the eddy-current losses, that is, on the thickness of the core plates. The effect of assuming a general index in Steinmetz formula is investigated in an appendix, and it is shown that in general $1=\pi b$, and $a=2c$, whilst the ratio of b to c—depending on the index and on the eddy-current losses—is something greater than one, probably always between 1·1 and 1·5.

The same investigation for a core transformer gives, to the same approximation,

$$\frac{1}{9\pi}=\frac{a}{28}=\frac{b}{9}=\frac{e}{14}$$

where 1, a, b, c now refer to the quantities so marked in Fig. 2.

The corrections to be applied are the same as for a shell transformer. General expressions are given to determine the size of the transformer having these proportions and satisfying the condition of best distribution of losses.

The details of the direct method of design to satisfy the foregoing conditions are now gone into, and, as it is the all-day efficiency that is to be made as great as possible, it is first shown how to determine the time average of the losses from the load-time-curve —supposed approximately known. The author thus obtains the particulars of the transformer in terms of known quantities, depend-

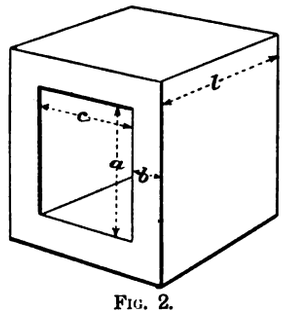

FIG. 2.

ing on the quality of the iron, the conditions of load, the amount of insulation, and the external conditions of voltage, frequency, &c. A comparison is then made of transformers, designed according to the foregoing methods with some actual transformers, the same constants as obtain in the actual transformers being, wherever possible, used. As was to be expected, there is always a saving of waste energy, sometimes at the cost of an increase in the amount of iron, and sometimes requiring a decrease.

Some appendices are added in which the chief part of the mathematics is developed in general terms, and certain points bearing on the subject are gone into. The chief of the latter is a discussion of the best thickness of the core plates, in which it is shewn, that if the shape and outside size of the core is given, together with the total flux of magnetic induction, and the thickness of core-plate-insulation, there is a certain thickness of plate which makes the iron loss a minimum. An equation is obtained giving this thickness, and it is found, on substituting ordinary values for the quantities involved, that the thickness of the plates is less than is usually used, being generally between 7½ and 10 millimeters.

* An abstract, by the author, of a Paper "On the Best Proportions to give to Transformer Cores, and the Most Advantageous Distribution of the Wasted Energy ; together with a Direct Method for the Design of Transformers, in order to Obtain Maximum All-Day Efficiency," read before the American Institute of Electrical Engineers.

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PHYSICAL SOCIETY.

At an ordinary meeting of the Physical Society on Jan. 27th, Mr. G. Griffith, M.A., vice president, in the chair, a mathematical Paper was read by Dr. E. H. BARTON, on

"The Equivalent Resistance and Inductance of a Wire to an Oscillatory Discharge."

Maxwell's treatment of the self-induction of cylindrical conductors was extended by Lord Rayleigh, in an article published in the *Phil. Mag.* for May, 1886, to alternate currents that follow the harmonic law at constant amplitude. Dr. Barton now modifies the analysis, and further extends it to include the decaying periodic currents obtained in discharging a condenser, and to the case of damped trains of high frequency, *i.e.*, the Hertz waves in general. The theoretical value (R″/R′) for the ratio of equivalent resistances to waves, respectively with and without damping, agrees very well with Mr. Barton's experimental results.

Mr. OLIVER HEAVISIDE, in a communication (here abstracted), said that he had by another method of mathematical analysis arrived at the same value as Mr. Barton for (R″/R′). In addition to the causes hitherto suggested as affecting the attenuation factor, it was possible that the conductivity of the wires to vibrations millions per second might be less than with steady currents, and that the voltage at the beginning of the wave train might be large enough to cause some leakage. Both resistance and inductance become infinite with infinite damping, and they differ somewhat from the corresponding quantities for undamped waves.

Mr. ROLLO APPLEYARD then described (1) some experiments upon dephlegmators, in which he has attempted to replace the platinum gauze valves of the ordinary fractionating tubes by bends in the tubes. The general form of the apparatus consists in a series of elongated bulbs, the top of each being connected to the bottom of the one above it by a horizontal S-shaped tube. The vapour condensed in any intermediate bulb falls back into the preceding S-bend. The first portions of the distillate are thus returned to the boiling flask, leaving a little at each bend to act as a wash for the ascending vapour. At the early stage of distillation the bulbs and bends behave as required, but it is found that at the later stages certain of the bulbs become completely filled with liquid sustained by the upward pressure of the vapour, and unless the heating is very carefully managed "geyser" actions may take place. Some arrangement of overflow tubes is, therefore, required for the bulbs. Mr. Appleyard also exhibited (2) a temperature tell-tale, to be used in connection with vats and for other purposes, where an alarm is to be sounded by making electric contact when temperature rises or falls beyond certain limits. A J-shaped glass tube has its short limb sealed and its long limb open. Water or other suitable liquid is poured in, completely filling the short limb. Mercury is then made to displace nearly all the water in the short limb; the surplus water in the long limb is removed by a pipette, and mercury is also adjusted to a convenient level. Two platinum contact wires are sealed into the glass at a short distance above the free surface of mercury in the long limb. The tube may be ½in. in diameter, with a long limb of 5in., and a short limb of 2½in. The quantity of mercury in the tube is generally arranged so that at temperatures below the boiling point of the contained liquid the mercury level is lowest in the long limb. In this case, if the temperature is raised to the boiling-point of the contained liquid, the mercury assumes approximately a common level in both limbs, for at the boiling-point of the liquid, under these conditions, the vapour pressure is equal to the barometric pressure. Hence, the liquid and the mercury are not spurted out.

Mr. WHOPPLE said that when working with an ordinary thermometer tube the contacts were inefficient owing to oxidation. Moreover, the mercury column broke up, and in some cases mercury clung to the contact wire. He asked if these difficulties occurred in Mr. Appleyard's apparatus.

Mr. WATSON suggested that in some cases the long limb might with advantage be closed. With regard to the dephlegmator he thought that the bends should each be duplicated by a short tube, so as to provide one path for the descending liquid and another for the ascending vapours. This seemed to be the object of the platinum gauze in fractionating tubes.

Mr. APPLEYARD, in reply, explained that the change of level in the "tell-tale" was a sudden rise of about an inch of mercury in a tube half an inch in diameter. This rise was able completely to envelope the contact wires, surface oxidation could not affect the working, and there could be no such thing as failure of contact. Moreover, the tube was too wide for mercury to be held up by capillarity. The large area of contact enabled the instrument to be used for strong currents. The cost was small, and the only adjustment consisted in choosing a liquid of suitable boiling point, for the platinum wires could be sealed in anywhere in the long limb; about 2½in. from the bottom was a good position for them. The sudden rise occurred when the temperature was one or two degrees above the boiling point of the contained liquid.

Mr. T. H. LITTLEWOOD then read a Paper on

"The Volume-changes which Accompany Solution,"

and described an apparatus for measuring the contraction observed when solids are dissolved in a liquid. Two glass bulbs are arranged one above the other, so that liquid can pass from the upper one to the lower one through a stop-cock, and from the lower one upwards into the neck of the upper one through a second stop-cock. This neck, which forms the top of the upper bulb is fitted with an india-rubber stopper. The lower bulb is tubulured, and provided with a glass stopper. A horizontal capillary tube is fitted into the india-rubber stopper, so that volume-changes can be determined, after the manner of using Bunsen's calorimeter. The weighed solid is introduced at the tubulure. The measured amount of water is poured in at the neck. Paraffin oil is then poured in at the tubulure so that the apparatus is completely filled; the lower bulb with the solid and the oil, the upper bulb with the water. The apparatus is then exhausted, and, finally, it is placed in a tank of water at constant temperature. When the stop-cock between the bulbs is opened solution begins, and the resulting contraction is measured. For small amounts of salt dissolved in constant volume of liquid the contraction is very nearly proportional to the amount of salt. For larger amounts the contraction is greater in proportion than the added salt. If a strong solution is gradually diluted, then for equal amounts of water added the contraction becomes smaller for successive amounts of added water. Mr. Littlewood applies Ostwald's theory and the theory of Van der Waals to the observed results, and expresses the contraction as a logarithmic function of the volumes and the internal pressures.

Mr. LEHFELDT thought the india-rubber stopper was a weak point in the apparatus. With regard to the theory of the contraction, Tammann (*Leitschr. fur Phys. u. Chem. 1895*) had given an expression which was rather more intelligible. Tammann found that the effect could be regarded as equivalent to a change of pressure, and by attributing this quality to the solution, the characteristic surface becomes the same as that for water. The volume of the solution would then follow similar changes to those that water undergoes with increasing pressures.

Prof. EWING said the experiments reminded him of the very first piece of research work he had done in physics, which was 25 years ago, on the same problem, with Mr. McGregor. An examination of the electrical properties of solutions of certain salts led to an investigation of their changes of density and volume. In some cases the contraction observed was so great that the volume of the solution was less than the original volume of the water to which the salt had been added. They made some measurements, but the apparatus they had used was very rough compared to that described by Mr. Littlewood.

Mr. WATSON asked whether Mr. Littlewood had made any simultaneous density measurements. There were some solutions for which the contractions and corresponding densities had been worked out. By examining successive dilutions of strong solutions, and the corresponding densities, a check might be made as to the numerical results obtained by Mr. Littlewood's apparatus.

Dr. CHREE suggested that, in place of the logarithmic expression, the total contraction might possibly be better represented by a few terms of a series, involving increasing powers of the difference of volume, each term being multiplied by a proper constant.

Mr. LITTLEWOOD, in reply, said that the india-rubber stopper possessed advantages in regulating the height of the capillary tube. It did not introduce sensible error, for it was possible to work with it to a centigram of mercury in the capillary. On the other hand, temperature changes of one-tenth of a degree involved one centigram more or less of mercury in the tube. Bunsen, using an india-rubber stopper, obtained very accurate results in calorimetry.

The CHAIRMAN proposed votes of thanks, and the meeting adjourned until February 10th (annual general meeting).

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *January 20, 1899.*

Consolidation of Carbon Interests.—On January 16 a company was organised under the title of the National Carbon Co., its object being to purchase or otherwise obtain control of many of the largest carbon manufacturing companies in the United States. The capital of the new company is $10,000,000. In addition to controlling many of the well-known American concerns, it is stated that the company will own a half interest in the Ottawa Carbon Co., Ottawa, Ont., which practically controls the carbon industry of Canada. The companies involved manufacture carbons for every conceivable purpose in the electrical line.

Electrical Export Trade.—Manufacturers of and dealers in electrical apparatus in this country are making extensive preparations for a large export trade. The newly-acquired national territory is evidently looked upon as a promising field for enterprise and activity in the electrical line, and considerable briskness prevails in some branches of the trade just now in arranging plans for the handling of this new business. As regards the general subject of export trade of electrical apparatus, it is interesting to note that this trade is growing, not only with England, but with the British colonies, especially South Africa and New Zealand. There is hardly a vessel leaving this port in which there are not large consignments of electrical machinery and electrical appliances. Mines in the

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neighbourhood of Johannesburg have recently made large calls on the manufacturers, and at Cape Town and Port Elizabeth the electrical equipments for street railways have been installed by American firms. Cotton mills in India, Japan and China have also been fitted with electric light machinery from the United States, and American electric locomotives for use in mines are being sent to all parts of the world. If the amount of estimating being done at present by manufacturers for electrical material required abroad is an indication of what may be expected of the trade during the year, the foreign business in anticipation will eclipse all previous records.

Compressed-Air Motor Trucks.—Considerable interest has been excited in the past few days over the wide publicity given to the plans of the International Air Power Company, which was incorporated on January 14th, with a capital stock of $8,000,000. The purpose of this company is to build trucks and cars to be propelled by compressed-air power. What adds so much interest to this enterprise is the fact that many very prominent men are interested in it.

CORRESPONDENCE.

ACCUMULATOR SWITCHES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your description of a multiple form of accumulator switch, in your issue of Jan. 20, reminds me of an arrangement of the same nature I designed for a small generating plant, about two years ago, to allow of the supply of current to lamps while charging accumulators. The rise in E.M.F. is so large, that a good number of cells must be taken off the lighting circuit, which must be removed one at a time. A two-way switch cut out seven cells at a stroke at one end of the battery, while the ordinary multiple contact switch gave the control over seven individual cells at the other end, thus affording perfect regulation up to the full charging E.M.F. of some 143 volts for 55 cells.

An automatic interlock between the two is undoubtedly an improvement, but I should hardly think the use of the two-way switch is patentable, and it is very useful under certain conditions. As a general rule I prefer a small motor transformer, which avoids both the trouble of the high E.M.F. and the speeding up of the engine.—Yours, &c., FRANCIS G. BAILY.

Edinburgh, Jan. 30.

LEGAL INTELLIGENCE.

Vestry of St. Mary, Battersea v. the County of London and Brush Provincial Electric Lighting Co. (Limited).

IMPORTANT JUDGMENT.

This case came before the Court of Appeal on Monday on the appeal of defendants from a decision of Sir Francis H. Jeune in April last. The question to be determined was whether the defendant Company, who held a provisional order to supply electric energy within the district of Wandsworth, are entitled to lay their pipes in Trinity-road. Battersea, part of which is admittedly in the parish of St. Mary, Battersea, within the area of supply of the Battersea Electric Lighting Order. In October, 1895, defendants broke up the pavement, and laid their pipes in a portion of Trinity-road, and in the same month plaintiffs complained of this, and contested the company's right to do what they had done. The defendants expressed regret, and said that their sub-contractors had laid a cable within the Battersea parish without any authority from them. The company asked permission to keep the cable where it was, but the Vestry declined to allow this, and accordingly the company took up the cable. In September, 1896, a further dispute arose between the parties as to whether another part of Trinity-road was in the parish of Wandsworth or Battersea. The Vestry did not take any notice of that circumstance for the moment, and the company, on Sunday night, Oct. 18, 1896, proceeded to lay seven pipes under the pavement of the road which the plaintiffs alleged was undoubtedly in the parish of Battersea. The Vestry, however, on Nov. 18, 1896, wrote to the defendants requiring them to take up so many of the pipes as were in the parish of Battersea and to restore the pavement within seven days. The defendants replied that they could not admit that they were acting without authority, or that they were not entitled to do what they had done. The plaintiffs thereupon brought their action for a mandatory injunction, and Sir Francis Jeune held that the Vestry had vested in them the area in question and that defendants had no right to do what they had done, and gave judgment for the plaintiffs, but suspended the operation of the injunction pending the result of the present appeal. The case was fully reported in *The Electrician* of March 11 and April 22 last.

Mr. CRIPPS, Q.C., for appellants, stated that the undisputed fact was that the company had laid their wires and mains under a small portion—something like 100ft.—of the Vestry's district in order to supply light to their customers in the adjoining district of Wandsworth, the company holding a provisional order to supply electric current within the latter district.

The MASTER OF THE ROLLS: Does the fact that it is only a "small portion" of the district which is affected make any difference?

Mr. CRIPPS: No. It was a question of right between the parties. The question really to be determined was whether the Vestry had sufficient interest 2ft. down, in which the pipes were laid, so as to make the company trespassers against the Vestry's interests. He contended that the Vestry had no interest in the subsoil, their interest being confined to the surface, and, therefore, that they were not entitled to the mandatory injunction. His submission was that the property in the subsoil was vested in the adjoining owner, and not in the Vestry or Corporation, and cited the case of "Baird *v.* the Mayor, &c., of Tunbridge Wells" in support of his contention.

The MASTER OF THE ROLLS: Even if you are right there, you had no right to break up the street.

Mr. CRIPPS: No, perhaps not. But what I am saying is that the local authority had no right in the subsoil, where the pipes and mains are now laid, to entitle them to an injunction to order us to remove them, because we are not trespassers so far as they are concerned.

The MASTER OF THE ROLLS: You say you were trespassers, but that it is not a continuing trespass; in fact, that you got off their land on to somebody else's.

Mr. CRIPPS: Yes, that is my submission. I say that a local authority has no interest in the subsoil and no power over it, except under certain provisions as to sewering, and so on. We might have been trespassers at one time, and should have been liable to an action for damages if we had done any damage; but there was no damage done. The company put down the wires on a Sunday night because it was thought to be the most convenient time to do it.

Mr. BRAY, for the Vestry, argued that the injunction could be maintained, and contended that even though the Vestry might not have a statutory right of property in the subsoil they had statutory power of control over it.

At the conclusion of the arguments of counsel,

The MASTER OF THE ROLLS, in giving judgment, said he did not think that anything would be gained if they took time to consider the case. It was not altogether satisfactory, but he should begin his observations at once by saying that he did not consider they were in a position to grant a mandatory injunction, as it did not appear that the plaintiffs had taken any proceedings under Sec. 109 of the Metropolis Local Management Act, 1855. That was an important section, and he would not say what the result might have been if the plaintiffs had proceeded under it. He was bound to say that he thought the argument of the appellants was well founded, so far as a mandatory injunction was concerned. The case stood in this way. It seemed that some time in 1896 the appellants, after failing to come to terms with the Vestry, and knowing perfectly well that the Vestry would object to their laying down those pipes under their streets, took the law into their own hands and wilfully and in a high-handed manner broke up the street for about 100ft., and laid down their mains in excess of their powers. They got the thing down on a Sunday night, which was utterly and entirely illegal, and the fact that it was so was a temptation to their lordships to be equally high-handed with them, and to say "You have put your things there, and you must take them up." They could not, however, do that. They had to consider the rights of the parties, and to see that the rights of the plaintiffs were not interfered with by the mains being allowed to remain where they were. It was said that the rights of the plaintiffs were interfered with, because the wires were only 2ft. below the surface of the street which was vested in them. If that was so there was a continuance of trespass. The answer to that was found in the Tunbridge Wells case. In that case the fight was between the local authority and the owner of the soil underneath the street. The decision both in the House of Lords and the Court of Appeal was in favour of the owner of the soil and against the local authority. That case decided that there was vested in the urban authority such property only in a street as was necessary for its control, protection and maintenance as a highway for public use. If that was so, the plaintiffs in the present case had only vested in them so much soil under the street which fell within that definition, and they could not maintain the action as owners of the soil under the pavement. If that was so, one of the most formidable grounds on which the plaintiffs could base their case was disposed of. Then the plaintiffs said, "Well, even although we are not owners of this soil, we have some statutory control over it which is interfered with by the continuance of your pipes." He (his Lordship) felt bound to come to the conclusion—he regretted it, because he would rather come to a conclusion the other way—that the plaintiffs had not made out that any rights of theirs had been interfered with by the continuance of the pipes in the position in which they were. That being so, the mandatory injunction must be discharged.

Lord Justice RIGBY concurred.

Lord Justice VAUGHAN WILLIAMS also concurred. He wished to make one observation about the conduct of the parties. He entirely agreed that the admitted facts before them showed that the company took a very lawless and high-handed course. They were very perverse in their conduct, and that would make him in a sense regret that one could not deprive them properly of any advantage which they gained by such conduct. He, however, hesitated before expressing that feeling because he did not

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know what the course of conduct of the local authority might have been. They were (according to Sir Francis Jeune) unable to meet their opponents in this matter. If the plaintiffs had acted for the public good he should have nothing to say further than what had already been said with regard to the conduct of the company, but if they had forgotten that they existed for the public good, and had allowed themselves to refuse the company their permission to do that which could in fact have been given without any harm to the constituency—if that was the proper word—which they represented in Battersea, and with great advantage to the inhabitants of the adjoining parish, it would then take away any feeling of regret that he might otherwise have felt of having to leave the company in a position of any advantage which they gained by their lawle s action.

The MASTER OF THE ROLLS: The following words must be struck out from the order, "using or permitting to remain," and there will be no order as to costs.

The appeal was accordingly allowed, without costs.

Heyl-Dia v. W. T. Glover and Co. (Limited).

At the Manchester Winter Assizes, on Wednesday, Mr. Heyl-Dia, electrician, sued Messrs. W. T. Glover and Co. for damages for alleged wrongful dismissal.

Mr. C. A. RUSSELL, Q.C., said the plaintiff had been in the employment of defendants under an agreement, by which it was provided that he was to act as superintending engineer and manager of a department of the company's business for a period of five years from Jan. 1, 1898. The dismissal took place on Sept. 26, 1898, and, consequently, when the agreement had more than four years to run. The plaintiff, an electrical and chemical engineer, in the course of his researches, had invented an insulating material for electric cables, which it was claimed was as efficient as gutta-percha, and much cheaper. This material ("Diatrine") was a successful invention, and in 1894 plaintiff came over from Germany with his secret, and was introduced to the principals of the defendant company. In August, 1894, Mr. Heyl-Dia entered into relations with the company and undertook to communicate his secret process to them, receiving in consideration a fixed annual sum and an agreed royalty. In 1897 Mr. Henry Edmunds and Mr. G. B. Samuelson, the principals referred to, decided to convert the business into a limited company, and on May 12, 1898, the agreement on which the present action was based was entered into between plaintiff and Messrs. W. T. Glover and Co. (Limited). Five years' service as engineer was, by the agreement, to be considered to begin on Jan. 1, 1898, and by another clause the plaintiff was not, during the continuance of the agreement, to communicate any information about his processes to anybody outside the firm. The financial terms were that Mr. Heyl-Dia was to have £3,000 in shares and £500 a year during the five years. The manager of the company, Mr. James Morton, died in September, 1893. The plaintiff and Mr. Morton had been on the best of terms, and had not Mr. Morton died the difficulties now in question might never have arisen. Soon after his death, however, Mr. Edmunds, the managing director of the company, informed Mr. Heyl-Dia that it was intended to appoint Mr. Hartford, who had been outside representative of the company, as secretary of the company in place of Mr. Morton, and that Mr. Heyl-Dia would have to take his orders from Mr. Hartford. The plaintiff objected to this. The new secretary was, however, appointed, with control of the plaintiff, and Mr. Heyl-Dia at once wrote and said the Directors, by taking this step, had made it impossible for him to fulfil the terms of his agreement. Mr. Russell said the circumstances under which the letter was written made it impossible to regard it as a letter of resignation. Four days afterwards the Directors wrote to Mr. Heyl-Dia, accepting his resignation, and telling him that his duties ceased "from one o'clock to-day, when you will hand over your keys." The plaintiff at once wrote and denied that he had tendered his resignation. Nevertheless, the dismissal took effect. Mr. Russell pointed out that the position of the plaintiff was a most serious one. Upon the faith that this agreement would be carried out he had bargained that he would give the company information about his own manufacturing process, and abstain from giving information to anyone else; and if he was to be held still bound by that agreement his position was that he had lost altogether a valuable invention in addition to his salary and occupation.

The PLAINTIFF gave evidence in support of this opening statement, and, in cross-examination, admitted having written a letter to a third person the day after his letter to the Directors, saying: "I have resigned, and hope it may be for our mutual benefit." He denied, however, that he intended to resign when he wrote to the Directors the letter that had been read by Mr. Russell.

Mr. HENRY EDMUNDS denied that Mr. Hartford, the new secretary, was without technical knowledge. He had often been "under-study" to Mr. James Morton, and had in that capacity already given orders to Mr. Heyl-Dia. The plaintiff absolutely refused to take orders from the new secretary.

Mr. PICKFORD, Q.C., for defendants, argued that the refusal of the plaintiff to take instructions from Mr. Hartford was an unconditional one. The Directors had a right to make their own appointment to the secretaryship, and the plaintiff's refusal to take instructions from the man they chose was an act of insubordination. The Directors would have been only too glad to have kept Mr. Heyl-Dia, as a good man, and would, as a matter of fact, have kept him but for his refusal to take instructions from the new secretary. He wrote to the Directors resigning (as he had told a third person) his position with the firm. The Directors interpreted his letter, as indeed the writer must have interpreted it, as a resignation, and they accepted it. Afterwards the plaintiff seemed to have repented of the step he had taken.

Mr. Justice BIGHAM reviewed the evidence, and the jury found for the plaintiff for £750 and costs.

Gold v. Winter.

Judge Lumley Smith, at the Westminster (London) County Court, on Monday, continued the hearing of this case (previously reported in *The Electrician* for Dec. 23 last). It was a claim for £75, balance of £100 commission in connection with the Chiswick provisional order.

Mr. G. C. MARKS, consulting engineer, was now called for the defence, and said Mr. Grant died and Mr. Bourne gave him instructions to sell the option. It was advertised, and the purchase was carried out in 1897. The sale took place to defendant. The option would have expired two months from the date of the sale.

The case was, later in the day, reported to have been settled out of court.

Mr. E. F. COLLINS, clerk to the Chiswick Council, by his Honour's permission, asked permission to make a statement. He said his council objected to the statement made about "trafficking with the option." His Council had nothing to do with the parties, and knew nothing of the transactions. The Order was obtained, and immediately transferred to Messrs. Bourne and Grant. The whole of the transactions in the matter had been in the shares of that company, and his Council protested against the dealing with these shares in this way. They thought the statements amounted to an allegation of corrupt practices against them. They had done all that was possible to press the matter on, but without avail. He thanked the learned judge for allowing him to make the observations he had, as the Council had been severely criticised over the matter, with which they had nothing to do.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. The Author hopes that, besides Telegraph and Telephone Engineers, it may, perhaps, also prove of service to those in charge of cables for the transmission of light and power. The localisation of faults has been very fully investigated, including the different degrees in which the various methods are affected by the presence of a second fault or of general leakage.—*Extract from Preface.* Demy 8vo, fully illustrated. 10s. 6d., post free; abroad 11s.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition now ready.*

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition. Price 2s, post free.

"WIRELESS TELEGRAPHY: SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES."—By Dr. O. J. Lodge, with many original illustrations. *Enlarged Edition*, 2s. 6d. net, 2s. 9d. post free.

"ELECTRIC MOTIVE POWER," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"LABORATORY NOTES AND FORMS."—With the above title we have ready the New Edition of a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

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"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated. price 1s. 6d.; post free, 1s. 9d.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97.' A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. Prospectus on application.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. A fine large paper edition with wide margins for notes can also be supplied. Price 12s. 6d.; post free, 13s.; abroad, 13s. 6d. *New Edition in the press.*

"THE ALTERNATE CURRENT TRANSFORMER," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *New Edition.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 8d. each, post free.

"ARMATURE WINDINGS OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free; abroad, 6s. 6d. Digest post free.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free; abroad 13s. 6d. Prospectus post free.

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The "Big Blue Book" for 1899 will be sent out to subscribers next week in the order of subscription. The Directory Division has been corrected up to Feb. 2, 1899, and all the latest new names, changes of address, &c., will be found included. The Handbook Division has been much extended, many valuable tables having been added. The volume will contain, also, the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways, finally corrected to Feb. 2, 1899. The price of the Directory and Handbook remains the same—10s., post free 10s. 9d.; abroad, post free, 12s.

TENDERS INVITED.

The Guardians of St. Leonard's, *Shoreditch* (London), require tenders for wiring and fitting the workhouse, infirmary, casual wards, &c. Specifications can be obtained at the office of Mr. C. H. Doughty, Town Hall, Old-street, E.C. Further particulars are given in an advertisement, and tenders must be delivered to the Guardians at their meeting, to be held at 204, Hoxton-street, N., on Wednesday, Feb. 15, at 4 p.m.

As announced in our advertisement columns, the Corporation of *Harwich* invite offers for the transfer of their provisional order. Tenders must be sent in by May 17 next to the town clerk (Mr. A. J. H. Ward), Harwich.

The Corporation of *West Hartlepool* invite tenders for feeders, mains, arc light leads and road work. Further particulars are given in an advertisement, and copies of specifications, forms of tender, &c., can be obtained from the town clerk, Mr. Higson Simpson. Specifications and drawings can be seen at, but not obtained from, the offices of Prof. Alex. B. W. Kennedy, 17, Victoria-street, London, S.W. Tenders to Mr Simpson, by Monday, the 13th Feb.

The Gas committee of the *Nelson* Corporation invite tenders for the supply and erection of the following plant:—(*a*) steam dynamo, ejector condensers, &c., (*b*) switchboard, (*c*) alterations to accumulators, (*d*) overhead crane. Additional particulars are given in an advertisement, and plans, specifications, &c., may be obtained at the office of the engineer (Mr. Wm. Foster). Tenders must be sent to the town clerk (Mr. R. M. Prescott), Town Hall, Nelson, not later than noon on Tuesday, Feb. 14.

The Electricity Supply committee of the city of *Gloucester* require tenders for the supply of jet condensers and air pumps, cast-iron condensing water pipes, and steam, exhaust and feed pipes, &c. Specifications, &c., can be obtained, after the 6th inst., from the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, London, S.W. Tenders to the town clerk (Mr. Geo. Sheffield Blakeway), Guildhall, Gloucester, by Tuesday, 28th inst. An advertisement contains additional particulars.

As announced in an advertisement, the *Edinburgh* Town Council invite tenders for the supply of an overhead travelling crane and storage batteries. Specifications, &c., can be obtained from the resident engineer (Mr. F. A. Newington), Dewar-place, and specifications and drawings may be seen at, but not obtained from, the office of Prof. A. B. W. Kennedy, 17, Victoria-street, London, S.W. Tenders to the town clerk (Mr. Thomas Hunter), City-chambers, Edinburgh, by Feb. 20.

The Electric committee of the *Belfast* Corporation invite tenders for the supply and erection of water-tube boilers, two 12½ kilowatt dynamos and switchboard. Some particulars are given in an advertisement, and specifications, &c., can be obtained from the city electrical engineer (Mr. Victor A. H. McCowen). Tenders must be lodged at the office of the town clerk (Sir Samuel Black) by 10 a.m. of Thursday, 23rd inst.

The Corporation of *Lowestoft* invite tenders for the supply and erection of the following plant:—(*a*) boilers and fittings, economisers, feed pumps, &c.; (*b*) pipe work, &c., for engine and boiler house; (*c*) steam dynamos and motor boosters; (*d*) storage batteries; (*e*) main switchboard and connections; (*f*) overhead travelling crane; (*g*) underground mains and conduits, road work, &c.; (*h*) arc lamps and posts; (*i*) station lighting. Tenders to Town Clerk, 115, High-street, Lowestoft, by noon, Feb. 6.

The *Buxton* District Council invite tenders for the supply of feeders, mains and arc light heads. Tenders to Mr. Josiah Taylor, Town Hall, Buxton, by Feb. 6.

The *Leyton* District Council invite tenders for a motor generator and the necessary switch gear. Tenders to Mr. R. Vincent, Town Hall, Leyton, by Feb. 6.

The *Hampstead* (London) Vestry invite tenders for the supply of oils for machinery at the electricity station. Tenders by 15th inst. to the Vestry Clerk.

The *Hull* Corporation invite tenders for wiring the tramway power station. Tenders to chairman of Works committee by 8th inst.

Tenders are required for the wiring of various public buildings in *Stockport*. Tenders to Gas and Electricity offices, Stockport, by Feb. 10.

The *Wolverhampton* Lighting committee invite tenders for extending the electricity station building. Tenders to Chairman of Lighting committee, Town Hall, Wolverhampton, by the 27th inst.

Tenders are invited for the wiring and fitting of the library premises, Whimple-street, *Plymouth*. Tenders by Feb. 8 to the borough electrical engineer, East-street, Plymouth.

The *Fulham* (London) Vestry require tenders for electric motors for driving pumps. Tenders to the clerk by Feb. 8.

The *Kingston-on-Thames* Guardians invite tenders for private telephone communication between the various workhouse buildings. Tenders to clerk, Union offices, Kingston-on-Thames, by Feb. 14.

The *Southampton* Corporation require tenders for the electric lighting of the new Isolation Hospital. Tenders to the town clerk by 17th inst.

The *Glasgow* Corporation invite tenders for the reconstruction of the tramways in Crown-street and Cathcart-road. Tenders to Sir J. D. Marwick, City Chambers, Glasgow, by 10 a.m., 6th Feb.

The *Belfast* and Northern Counties Railway Co. invite tenders for stores, including telegraph iron work, batteries, signal fittings, &c. Tenders to Secretary, York-road Terminus, Belfast, by 13th inst.

The Governors of the District Asylum of *Enniscorthy* (Ireland) invite tenders for the installation of electric tell-tale clocks. Tenders by 8th prox.

Tenders are invited until the 16th inst. by the *French* Post and Telegraph Authorities for the supply of 46 kilometres of gutta-percha insulated electric cable. Tenders to Le Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

The *Norwegian* Telegraph Authorities invite tenders until Feb. 11 for the supply of 121 tons of telegraph wire, 5·3mm. diameter, and 80½ tons ditto, 4mm. diameter. Tenders to the Bureau des Telegraphen Directors, Karl Johansgade 14, Christiania.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been received by the London County Council:—

For the supply of dynamos, &c., required in connection with the electric lighting of the Victoria Embankment:

McClure and Whitfield	£3,726	Electric Construction Co. ...	£5,535
Mather and Platt.....	4,600	Safety Concentric Wiring Co.	5,625
Crompton and Co.	4,949	Electrical Co.	6,877

For the supply of gas engines required in connection with the electric lighting of the Victoria Embankment:

J. E. H. Andrew and Co. ...	£1,900	Crosley Bros.	£2,300
Campbell Gas Engine Co. ...	2,176	Fielding and Platt	2,378
Premier Gas Engine Co.....	2,260	Taylor and Sons	3,457
Safety Concentric Wiring Co.	2,260		

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The following tenders have been received by the Beckenham District Council for the supply of electric lighting plant :—

Section A (boilers).

Mechan and Sons	£1,687	Babcock and Wilcox	£1,450
R. Hornsby and Sons	1,675		

Section B (alternators, transformers and switchboard).

S. Z. de Ferranti (Limited)	£7,835	Johnson and Phillips	£6,180
Brush Co	7,184	Electric Construction Co.	6,000
Brit. Thomson-Houston Co.	6,570	John Fowler and Co.	5,934
Siemens Bros. and Co.	6,367		

Messrs. Crompton and Co.'s tender at £5,593 was stated to be irregular, as the type of alternator was not in accordance with specification. The tender of Messrs. John Fowler and Co. (Belliss engines) is recommended for acceptance in this section.

Section C (steam, &c., pipes, feed pumps and tanks).

C. S. Mallett and Co.	£1,927	Wenham and Waters	£1,593
John Spencer (Limited)	1,800	Babcock and Wilcox	1,584

Section D (arc lamps and posts).

Siemens Bros. and Co.	£736	Crompton and Co.	£555
Brockie-Pelt Arc Lamp (Ltd.)	661	W. Lucy and Co.	543
Brush Co.	646	British Blahnik Arc Light Co.	510
Johnson and Phillips	612	Gilbert Arc Lamp Co.	499
Oliver and Co.	568		

Messrs Lucy and Co.'s tender for the supply of arc lamps and posts is recommended for acceptance. A tender submitted by W. Macfarlane and Co. was for lamp posts only.

Section E (cables and street work)

	Concentric.	Triple Concentric.	Drawing-in System.
W. T. Glover and Co.	£16,657	£17,977	—
Western Electric Co.	16,573	18,538	—
Siemens Bros. & Co.	15,940	18,075	—
Felten and Guilleaume	13,982	15,612	—
Henley's Co.	13,777	15,284	£12,917
Callender Co.	13,596	—	—
British Insulated Wire Co.	11,763	13,116	11,763

Triple-concentric lead-covered cables are recommended for acceptance.

Section F. (travelling crane).

William Sellers and Co.	£507	Bolton, Fane and Co.	£187
Carrick and Sons	192	Chatteris Co.	145
Carrick and Ritchie	192	Southgate Engineering Co.	141
James Spencer and Co.	188		

The Buxton District Council have accepted the tender of Mr. H. Vickers, of Nottingham, for the erection of electricity generating station buildings.

The Brighton Town Council have accepted the tender of Messrs. Willans and Robinson for the supply and erection of two steam dynamos at £15,191.

The Sunderland Town Council have accepted the tender of the India Rubber Co., Silvertown, for the supply of three 125-kilowatt direct-current high-speed steam dynamos. Bellis engines were specified.

The St. Pancras Vestry have accepted the tender of Messrs. McDowell, Steven and Co., for the supply of 50 lamp columns (to an accepted design) at £9. 2s. 6d. each.

The Liverpool Corporation have accepted the tender of the British Thomson-Houston Co. for the supply of 20 additional cars for the electric tramways, at the same price as in the last contract.

The Derby Town Council have accepted the tender of Messrs. S. Z. de Ferranti (Limited) for the supply of a steam alternator at £7,000.

APPOINTMENTS VACANT AND FILLED.

The Littleborough Urban District Council require a consulting electrical engineer. An advertisement elsewhere contains additional particulars, and applications must be sent by Feb. 14 to the clerk, Mr. Geo. H. Wild.

The Corporation of King's Lynn require an electrical engineer to take charge of their electric lighting works. Commencing salary £150 per annum. Further particulars are given in an advertisement, and applications must be sent to the town clerk (Mr. T. G. Archer) by 15th inst.

The Morecambe District Council require a clerk for their electricity department. Applications to the electrical engineer, Mr. C. F. Parkinson. See advertisement.

The Lee District Board of Works require for one year the services of a consulting electrical engineer. Remuneration £100. Applications by 3 p.m., Feb. 8, to Mr. George Whale, Old Charlton, Kent.

The Governors of the Paisley Technical School require a Principal. Salary £300 per ann. Applications to the Secretary by Feb. 13.

Lancaster Corporation require a resident electrical engineer. Salary £200 per annum. Applications to the town clerk, Town Hall, Lancaster, by Feb. 7.

The Leyton District Council require an engineer-in-charge for their electricity department. Applications by 7th inst.

Yesterday (Thursday) the Electric Lighting Committee of the Wigan Corporation made their final selection in the appointment of a borough electrical engineer, and selected Mr. H. Collings Bishop, of Leyton. Mr. Collings Bishop was formerly at Bristol with Mr. H. Faraday Proctor, and was in 1896 appointed as chief electrical engineer at Leyton.

Mr. F. B. Spencer has been appointed electrical engineer to the Wimbledon District Council.

BUSINESS NOTICE.

Messrs. John S. Aris and William G. Higgs, trading as the Glasgow Electrical Engineering Co., 19, Robertson-street, Glasgow, have dissolved partnership. Mr. Higgs retires.

Messrs. J. G. Dixon and H. F. Clayton (trading as Dixon, Clayton and Co.), electrical engineers, &c., Penistone and Milnsbridge, Yorks, have dissolved partnership. Debts by Mr. Clayton.

The telegraphic address of the Victoria Rubber Co. (Limited), of the Victoria Mills, Edinburgh, has been changed from "Victoria Rubber Leith" to "Victoria Rubber Edinburgh."

BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against Frederick Jones, trading as F. Jones and Co., electrical engineer, 147, St. John's-hill, and 77, Davin-road, New Wandsworth, London, must be sent in by 13th inst. to the trustee (Mr. A. Mackintosh, O.R.), 24, Railway-approach, London Bridge, London, S.E.

Messrs. J. Edge and Harry Hitching (trading as the West Yorkshire Electric Lighting Co., Albert Court, Wakefield) have executed a deed of assignment to secure the payment by instalments of 10s. in the £. The following are among the creditors :—General Electric Co. £36, Western Electric Co. £18, Edison and Swan Co. £115, W. T. Glover and Co. £54, and Dixon, Clayton and Co. £14.

In the failure of Edwin Baldwin Pym, electrical engineer, late of Scarborough, the statement of affairs shows liabilities £3,482, assets £112. 10s. The estate is to be wound up in bankruptcy.

J. E. Stott, electrician, 9, Westfield-road, Huddersfield, has executed a deed of assignment with a view to the payment of his creditors in full by instalments during 1899. The creditors include :—British Blahnik Arc Light Co. £51, Kenyon and Moulding £12, Rhodes and Webster £52, Flather and Son £15, Beanland, Perkin and Co. £28, Simon Berry and Co. £56, Dixon, Clayton and Co. £28, W. T. Glover and Co. £12, and J. Rhodes and Son £11.

Personal.—Mr. W. J. Davy informs us that he has severed his connection with the Davy Electric Construction Co., and has started business as a consulting engineer at Finsbury House, Blomfield-street, London, E.C.

Plant for Sale.—Messrs. Fuller, Horsey, Sons and Cassell announce in an advertisement that they will offer for sale by auction on the premises, Bravington-road, Paddington, London, W., on Tuesday and Wednesday, Feb. 21 and 22, at 11 each day, a costly collection of nearly new engineering tools. Orders to view and catalogues may be had of Mr. S. H. M. Killik (Killik, Wright and Co.), 3, Gracechurch-street, E.C., and of the auctioneers, 11, Billiter-square, E.C.

Award.—The Improved Electric Glow Lamp Co., Limited, have been awarded a silver medal by the jurors at the recent Turin exhibition "for excellence and efficiency in their lamps, where increase of light or reduction of current is concerned." The jury's report states that a gold medal would have been awarded, but for the fact that the price of the lamp (owing to the heavy duty) was too high for the Italian market.

Ediswan Fittings.—A leaflet is issued describing the Ediswan patent "Chameleon" lamp envelope, for use with ordinary clear glass lamps, which, it is claimed, give all the effects of coloured reflection and ornamentation of the expensive fancy lamps.

"Hart" Accumulators.—Owing to a large increase in business, the Hart Accumulator Co. have found it necessary to considerably extend their manufacturing premises at Marshgate-lane, Stratford, E., by taking over a large adjoining factory, covering 13,000 sq. ft., which will enable the Company to cope with the extended demand for its manufactures.

Scrap Platinum.—Messrs. Derby and Co., of 44, Clerkenwell-road, London, E.C., are inquiring for scrap platinum, disused lamp tops, &c., for which they offer good prices. This firm have lately largely increased their plant and premises.——Another old-established firm, Messrs. W. and J. Jamieson, of Broad-street, Golden-square, London, W., are also desirous of obtaining platinum scrap of all kinds in any quantities.

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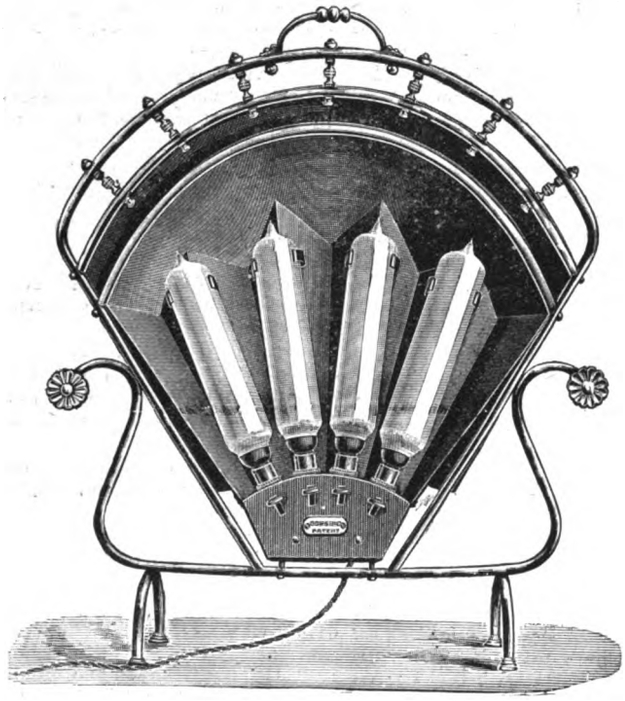
Electric Radiators.—The illustration herewith shows the latest form of Dowsing's patent luminous electric radiator, which is placed upon the market by the Dowsing Radiant Heat Co. (Limited), and for which claims of novelty and utility are made. It is pointed out that in this country warming the air only of a room is not approved, the open fire being most appreciated. With the new luminous radiator heat is obtained immediately the current is turned on, and no current is wasted. The appearance of the radiator, as will be seen from the illustration, is that of an open fire, but, of course, without combustion, fumes, or flues. These radiators can be used for all domestic purposes where radiant heat is required, such as roasting, grilling, toasting, warming food, heating domestic apparatus, &c., the fact that the heat is immediately obtainable being a strong



claim for this apparatus. The attention of electricity supply companies and corporations is called to these radiators, which, the makers urge, would speedily become popular wherever introduced.

Exhibition.—Mr. H. Greville Montgomery is holding a special exhibition of electrical appliances in connection with the biennial Building Trades Exhibition, to be held at the Agricultural Hall, London, N., from April 26 to May 6 next. The minor hall, of considerable extent, will be given over entirely to this purpose. The exhibition will afford an opportunity for electrical manufacturers and dealers to present their latest novelties to members of the building and allied trades of the country.

The Past Year's Work.—Among the firms who have been busy in electrical installation work, Messrs. Drake and Gorham, of 66, Victoria-street, Westminster, London, take a foremost place, the lighting of a large number of country and town houses and business premises having been entrusted to the firm during 1898. The long lists to which we give prominence annually has been swelled by the addition of numerous mansions in all parts of the country, and it must be that few of the residences of the leading members of British social circles remain without either large or small installations of electric light. In all branches of the electrical trade with which Messrs. Drake and Gorham are associated the past year has shown good results, and the demand for "D. and G." spring contact switches, the Jandus arc lamp, and other specialities continues to show satisfactory advance. The firm's branches at Manchester and Glasgow also report excellent progress.

Fire Office Electric Installation Rules.—We have received an advance copy of the copyright rules for electrical installations issued by the Royal Insurance Co. A feature of these rules is a number of illustrations showing types of enclosed motors, enclosed fan motors, inverted arc lamp, and diagrams of electrical connections, &c., recommended to be adopted by contractors in installation work.

Cassier's Magazine.—The February issue of this magazine contains the following articles:—"The Outlook in Marine Engineering," "Pneumatic Shop Appliances," "The Health Conditions of Coal Mining," "The Peletan-Clerici Process for Gold and Silver Extraction," "The Ventilation of Steamships," "Steam Laundry Machinery," "The Franklin Institute," and "Electric Utilization of Water Powers."

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Jan. 25 to Jan. 31, with the ports of destination:—

Australasia—Adelaide, £1,270; Melbourne, £212; Sydney, £787 (including £69 telegraph material). *Austria*—Trieste, £500 (telegraph material). *Belgium*—Antwerp, £225; Ghent, £32. *Chili*—Boca, £247 (telegraph material). *Canada*—Montreal, £42. *Ceylon*—Colombo, £16. *Eyypt*—Port Said, £135. *Germany*—Hamburg, £180. *Holland*—Amsterdam, £75; Rotterdam, £105 (including £55 telegraph material). *Hong Kong*—£561. *India*—Bombay, £265; Calcutta, £87. *Japan*—Hiogo, £134; Yokohama, £1,399. *Mauritius*—£94. *Peru*—Callao, £1,284 (telegraph cable). *Russia*—Reval, £434. *South Africa*—Cape Town, £257; Delagoa Bay, £144; Durban, £595; East London, £190. *Spain*—Bilbao, £282 (telegraph cable). *Sweden*—Stockholm, £218 (telegraph material). Total £9,770, against £15,454 in the corresponding week last year (Jan. 26 to Feb. 1).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Aberdeen.—The Tramway committee have unanimously voted in favour of the adoption of the overhead trolley system, and the burgh electrical engineer (Mr. J. A. Bell) and the surveyor have been instructed to prepare a report as to cost, &c., of carrying out the work. The initial experiment is be made on the Woodside route, upon which double deck cars are to be introduced.

American Trading in Russia.—It is announced that United States commercial enterprise will shortly establish in the south of the Russian Baltic provinces American commercial agencies as well as a permanent exhibition of American goods.

Bath.—The Electric Lighting committee are considering a proposal of the British Electric Traction Co. to construct and equip electric tramways in the city.

Bexhill.—The agreement between the British Electric Traction Co. and the District Council, for the construction of electric tramways from Kewhurst to St. Leonards, has been sealed.

Birkenhead.—The Town Council have decided to apply for a licence to supply electric current in the townships of Bidston-cum-Ford and Noctorum.

Brighton.—The Lighting committee recommend the Town Council to appoint an assistant manager of the electricity undertaking.

Camberwell (London).—The General Purposes committee of the Vestry have been considering a report of the vestry clerk and surveyor-engineer on the subject of the Bill of the County of London and Brush Provincial Co., now before Parliament, providing for the acquisition of lands and the erection of generating stations for electricity supply in various parts of the administrative County of London and their inter-connection. The Vestry have decided by resolution to oppose and petition against the Bill, on the ground principally that it affects the purchase clauses under the Camberwell electric lighting order owned by the same company, which provides for the purchase of the company's undertaking in Camberwell, at the Vestry's discretion, at certain fixed periods prior to the maximum of 42 years. Exception is also taken to the provisions in the Bill dealing with the keeping of accounts, &c. The Vestry, at the same time, have requested the London County Council to convene a conference of all the local authorities in the County of London interested in this Bill, in order that joint action may be taken.

Chelmsford.—Complaints having been made against the Chelmsford Electric Lighting Co. by consumers of current in that district, Mr. F. R. Reeves, secretary to the company, received permission to make a personal explanation before the Chelmsford Town Council last week, when he was able to satisfy the councillors that the bulk of complaints were due to causes outside the control of the company. At the conclusion of his remarks Mr. Reeves reviewed the case of electric lighting at Chelmsford generally. For years, he said, the electric lighting at Chelmsford did not pay, but now it was paying, and last year a profit of about £1,000 was made. Messrs. Crompton and Co. had money locked up in the Lighting company, and they wanted to put that money in their other concerns, where they could use it much more profitably, and he had decided, with the sanction of his directors, to invite other people to take the lighting concern off their hands. In fact, he had made arrangements, which were almost concluded, for placing the Lighting company in other hands, but he would ask the Council whether it was not in their interests, as representing Chelmsford, to secure the lighting of the town for themselves. The lighting was now paying; they had 750 applications for connections; they were going to erect a new bullding, and to extend their mains into Springfield. The capital of the Lighting company was about £42,000, and the Council could now purchase the interests of the company at cost price. If the Council, however, did not seize this opportunity, the

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concern would pass into other hands—a large company being formed to take a considerable number of undertakings in this country—and the Council would not be able to purchase the undertaking until 21 years had passed, and then only at a valuation. The offer is to be put before the Council for consideration in committee.

Claude Vautin.—It is announced that the Italian Government has granted an extradition order in the case of Claude Vautin, electro-chemist and metallurgist, who is charged with purloining quantities of valuable securities, and whose liabilities are roughly stated at nearly £90,000.

Edinburgh.—The Town Council are recommended to purchase, at a cost ef £15,000, land adjoining the Dewar-place station, for the purpose of extension. Repairs and extensions of the storage batteries are to be carried out at a cost of £2,200.

Electric Lighting Licence.—The Birkenhead Corporation give official notice that application has been made by them to the Board of Trade for a licence to supply electricity in the townships of B dston-cum-Ford and Noctorum, Cheshire.

Guernsey States and National Telephone Company Systems.—A London daily paper published early in the week some particulars from Mr. A. R. Bennett regarding the Guernsey telephone service, and among the statements made was one that nearly all the telephone apparatus and material used by the National Co. came from abroad. Mr. W. E. L. Gaine, manager of the National Company, writes denying that this is the case, "over 70 per cent. of the material used by the company being manufactured in Great Britain."

Hanwell.—The District Council have decided to approach the Ealing Council with a view to obtaining a supply of electric current for public lighting in Hanwell.

Hastings.—The poll of the ratepayers as to the advisability of establishing municipal electric tramways has resulted in a decisive majority in favour of the proposal.

Hospital Lighting.—The directors of the Ayr county hospital have decided to introduce the electric light.

Hoylake and West Kirby.—Mr. T. L. Miller has been appointed consulting electrical engineer by the District Council.

Hull.—On Friday the borough electrical engineer (Mr. A. S. Barnard) submitted estimates of the probable income and expenditure for the current year of the electricity department, showing an output of 800,000 units, which, at an average of 4½d. per unit, would produce £15,000. After providing for expenditure, there was an estimated profit of £1,545. The estimates are to be considered at the next meeting of the electric committee.

Kalgoorlie.—The *Financial News* states that the managers of some of the leading mines on the Kalgoorlie goldfields are urging their companies to combine in erecting a central electric power station for the supply of electric power to the various mines for stamping, hoisting, winding, and pumping purposes, thus following the action taken for the first time in Australia by the English companies engaged in working the deep leads in Victoria.

Lee (London).—On the recommendation of the General Purposes committee, the District Board of Works have appointed Mr. Albion T. Snell to advise them in their correspondence with the Board of Trade in reference to the electric lighting of the district by the Blackheath and Greenwich Electric Light Co.

Leeds.—The Beckett-street and York-road tramway routes are to be equipped electrically.

Light Railways.—It is now proposed to apply for powers to extend the authorised Ramsgate-Margate light (electric) railway from the latter town to Birchington.

A light railway inquiry was held at Redruth on Saturday into the application of the Camborne, Redruth and District Light Railway Co. for an Order authorising the construction of a light electric railway between Camborne, Redruth and Portreath. The Commissioners announced that the proposed line, in their view, entered into competition with the Great Western Railway to an undue extent, and, therefore, the application would be refused.

London County Council.—At Tuesday's meeting it was agreed to grant a loan of £4,800 to the Central London Sick Asylum District managers for the installation of electric light at an asylum at Hendon, when erected. Permission to the Vestry of Battersea for the construction of a generating station and works on a site in Lombard-road was refused.

Manchester.—A report from the Tramways committee, reaffirming its previous vote in favour of the overhead trolley system, was discussed at Wednesday's meeting of the City Council, and, after a brief debate, adopted.

Marylebone (London).—Last evening the Marylebone Vestry agreed, on the motion of Mr. T. W. Baker, "that it be referred to the Electric Lighting committee to consider the question as to whether the Metropolitan Electric Supply Co. are authorised by any consent of this Vestry or by their provisional order to lay down trunk mains through the area of St. Marylebone in order to supply the areas of other parishes, and to report to the Vestry thereon, and also to confer with the Paddington Vestry if in their opinion it may be desirable." At the same meeting Mr. Stringer moved that the Vestry's electric lighting bill should be withdrawn. He pointed out that the evidence before the Parliamentary Committee last year showed that the Vestry could obtain from the Metropolitan Company a supply of current at very low cost. If such were the case the Vestry would be throwing away its money in attempting to obtain a bill giving them powers to supply electric current. Sir E. Galsworthy strongly supported this proposal that the bill should be abandoned, but after a lengthy discussion the proposal was abandoned. The Vestry unanimously adopted a recommendation of the Electric Lighting committee that they should engage Messrs. Whamond, Williams and Co., accountants, to make an actuarial valuation of the Metropolitan Electric Supply Co.'s undertaking in the St. Marylebone area, "the same to be deducted from the Company's figures and returns after consultation with the committee."

Melbourne.—The City Council have approved the proposal to purchase the undertakings and interests of the Brush Electric Light Co. and the Alcock and New Australian Electric Light and Power companies within the city boundaries for £40,000.

Poplar.—The Board of Works have decided to apply to the London County Council for a loan of £79,000 in connection with electricity supply.

Private Bill Legislation.—A bill has been deposited for the incorporation of the North-West London Railway Co. to construct an underground electric railway from a junction with the Central London Railway at the Marble Arch to Cricklewood. The capital will be £2,333,333.

Bills 1 and 2 of the National Telephone Co. have failed to comply with the parliamentary standing orders, and will, consequently, have to go before the Standing Orders committee. The objections to the company's third bill were overruled.

Rotherham.—The Town Council have approved the electric lighting scheme prepared by Prof. Kennedy, and propose to advertise for tenders for plant and to apply to the Local Government Board for sanction to borrow £25,000.

St. Pancras (London).—We are glad to learn that an amicable arrangement has been come to for a conference between the representatives of St. Pancras and Islington on the subject of the deadlock in the Brecknock-road, Holloway, as to the authority responsible for the supply of current to the tradesmen in that thoroughfare whose premises have been for some time past wired for the electric light. The matter has, we understand, caused considerable trouble to both Vestries.

At Wednesday's meeting of the Vestry it was decided by 40 to 30 to take no action in the matter of granting permission to the National Telephone Co. for placing their wires underground in Gower-street, so as to enable the Western district of London to be connected up with the Euston district. A deputation from the National Company asked that this permission might be given, and stated that 27 of the London Vestries had already granted underground facilities to the company.

Speed of Electric Trams.—Major Sir F. A. Marindin has presented his report on the recent inquiry as to the speed of the Dublin-Dalkey electric tramcars. Between Haddington-road and Williamstown a speed of 10 miles an hour is to be permitted in future, but between the latter place and Dalkey the maximum speed is to remain as at present—eight miles an hour. With these maximum speeds certain limits are to be imposed at certain stopping places and junctions. In order that the car drivers may know at what speed they are running, and may be in a position to observe the limits of speed, every car is to be fitted with an efficient speed indicator.

Telephone Conference.—At the conference of London local authorities held at the Guildhall on Wednesday, to discuss the question of the municipalisation of the telephone, the resolutions set out in our issue of Jan. 27, page 484, were duly passed.

Timber-Seasoning by Electricity.—At the works of Messrs. Johnson and Phillips, Old Charlton, Kent, a private exhibition was given yesterday, and will continue to-day, of the Nodon-Brettonneau process of electric timber-seasoning and preservation. Concerning this process a pamphlet is available, giving particulars of its scientific and commercial advantages over the process known as "natural" seasoning.

Turkey.—An Imperial irade grants to a German firm a concession to lay and work a submarine telegraphic cable between Kustenji and Constantinople. The concessionaire in this case, it is contended, will in reality be the Administrator of the German telegraph and postal services. The new cable will form a connecting

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link between the special telegraphic line (the laying of which will be completed in the spring) between Bucharest and Berlin thus establishing direct communication between Berlin and Constantinople, enabling the Ottoman Administration to no longer depend exclusively on land lines *viâ* Serajevo and Sofia for its telegraphic communication with Western Europe.

Wigan.—A special meeting of the Electric Light committee was held yesterday (Thursday) to appoint an electrical engineer. Out of the various applicants, Messrs. H. Collings Bishop, of Leyton, and J. A. Jeckell, of South Shields, were selected to attend the meeting. Yesterday (Thursday) Mr. H. Collings Bishop received the appointment.

Telephone Concert.—A successful concert was given at the Westminster Town Hall, London, on Friday evening, Jan. 27, by the Telephone Athletic Association. In the absence of Mr. W. E. L. Gaine the chair was taken by Mr. S. J. Goddard. About 300 members of the telephone service and their friends were present.

BOOKS RECEIVED.

"The Official Gazette of the United States Patent Office," No. 3, Vol. LXXXVI. Published by authority of Congress. (Washington : Government Printing Office.)

"*Proceedings* of the Sixth Annual Meeting of the Society for the Promotion of Engineering Education," Vol. VI. (Boston, Mass : Published by the Society.)

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom all information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

January 12, 1899.

764. J. W. WILLMOT. London. Hollow or recessed punches, used in connection with Wheatstone's automatic telegraphy, or any other systems of automatic transmission.*

January 13, 1899.

813. J. C. SCHÄFER, E. RENZ, and P. LIPPOLD. Berlin. An improved electrical signalling and telegraphic apparatus.*
825. A. F. HARRIS. London. Improvements in electrical measuring instruments.
864. W. J. L. SANDY and T. GEER. London. Improvements in electric arc lamps.*

January 14, 1899.

903. A. ECKSTEIN and W. A. GUTHRIE. Salford. Improvements in telephone exchange switchboards.
906. G. W. T. SHRUBSHALL. Thornton Heath. An improved magnetic-electric generator and automatic pull and circuit closer.
907. A. SILBERMANN. London. Improvements in transmitting printed telegraphic messages.*
918. W. J. DAVY. London. Improvements in enclosed electric arc lamps.
925. M. DERI. London. Rotary converters for single-phase alternating currents.*
934. A. U. ALCOCK. London. Method of and apparatus for electrically transmitting orders, signals or indications from one place to another.

January 16, 1899.

947. J. BASTICK. Leeds. Improvements in or relating to electrical furnaces for the production of calcium carbide and other substances.
962. W. CRUDGINGTON. Birmingham. Improvements in electric arc lamps.
974. E. F. TERREY and C. H. I. PHILLIPS. Bournemouth. Improved prepayment electricity meter for continuous or direct currents whose action depends on deposition of copper in a balance against silver coins.
1,001. E. F. PORTER. London. Improvements in and relating to electric heaters.*
1,044. R. A. SLOAN and J. E. L. BARNES. Liverpool. Improvements in switches for electromotors and the like.

January 17, 1899.

1,047. G. W. SUTCLIFFE. Stockport. Improved construction of straight and curved underground conduits for enclosing electric conductors, haulage cables, and other means of communication allowing connection of vehicles, sledges and moving bodies to same, and allowing access below.
1,063. W. W. RICHARDSON. Halifax. Improvements in the method of and means employed for controlling the trolleys of electric cars.
1,087. F. W. SCHINDLER. London. Improvements in electric heaters.
1,100. W. G. WILSON and P. S. PILCHER. London. Improvements in electric light brackets.
1,105. A. CAMPBELL. London. Improvements in coin-freed electrical shocking machines.
1,106. M. BYNG and R. P. EIDSFORTH. London. Improvements in and relating to facia for electrical instruments.
1,141. H. A. WAGNER. London. A method of and means for deriving two or more alternating currents of different phase from a source of single phase electrical supply.
1,147. W. J. DAVY. London. Improvements in or connected with electric arc lamps.

January 18, 1899.

1,154. L. W. HEATH and J. H. FIELD. London. Improvements in or relating to the regulation of pressure of electric circuits and apparatus therefor.
1,156. C. W. G. LITTLE and A. J. IRELAND. Lincolnshire. Improvements in current collecting apparatus for electric tramways.
1,179. M. W. W. MACKIE. London. Improvements in the construction of dynamo electric machines and motors.
1,188. P. L. JONES. Liverpool. Improvements in guards for overhead electric conductors, such as trolley wires and the like.
1,201. A. WESTROP. Enfield. Electric generator of heat.
1,208. A. STERZA. Birmingham. Improved system of underground electric conductors.*
1,230. C. P. ELIESON and W. S. NAYLOR. London. Improvements in lighting trains by electricity.
1,232. H. P. J. J. THOMSEN. London. A process of and means for transforming "electric currents."*
1,233. F. J. BORLAND. London. Improvements in arc lamps.
1,234. A. L. C. NODON and L. A. BRETONNEAU. London. Improvements in the electro-capillary treatment of woody and other fibre and apparatus therefor.*

January 19, 1899.

1,266. A. MUSKER. Liverpool. Improvements in and connected with the manufacture of electrical cables or conductor conduits.
1,293. H. NEHMER and F. NEHMER. London. Improvements on portable electric lamps.
1,324. W. P. THOMPSON. Liverpool. Improvements in and in the manufacture of electrode plates for electric accumulators. (The Accumulatoren und Elektricitätswerke—A. G. vorm. W. A. Boese and Co., Germany.)*
1,334. W. L. CAMPBELL. London. Improvements relating to electrically-illuminated signs or advertisements.*

January 20, 1899.

1,371. C. MILES. Bristol. Improvements in electrically-governed feeding and drinking appliance for animals and live stock.
1,381. J. S. HOLME. Liverpool. Improved process in moulding, electrifying and hardening castings to withstand intense heat furnace bars for marine, locomotive, land boilers, other furnaces, and the like.
1,394. J. J. STOCKALL, Senior. London. Improved electric clock and general registering, or equal power maintaining or discharging machine.
1,427. W. ROWBOTHAM. London. Improvements in and relating to primary batteries.
1,431. F. WÜSTE, F. VON RUPPRECHT and C. VON RUPPERCHT. London. Improvements in supports for the active-material of accumulator electrodes.*

January 21, 1899.

1,438. S. D. NEILL. Belfast. An electric mechanism for driving turret and other clocks.
1,439. A. J. HOWARD and W. F. HOWARD. Taunton. An electric lamp-hour meter.
1,483. G. C. MARKS. London. Improvements in and relating to automatic electric railway signalling. (Irónée Mazel, France.)

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1897.

25,244. MERSCH. Arc lamps. (Date applied for under International Convention, October 11, 1897.)
27,749. DAVY and THOMAS-DAVIES. Arc lamps.
30,321. EGGER. Switching apparatus for preventing self-induction sparks from being formed during the operations of disconnecting and reversing electromotors.

1898.

2,420. KER. Means for controlling the working of lifts, motors and other appliances operated by electric energy.
22,419. BYNG. Telephone transmitters.
24,052. MURPHY. Electric railway Systems.
25,863. BRENNECKE and TIMAR. Method of heating electrically-propelled tramway cars and other vehicles.
25,863. SIEMIENS BROS. and Co., LTD. (Siemiens and Halske Aktien Gesellschaft). Radiating axles for electrically-propelled railway or tromway cars.

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COMPANIES' MEETINGS AND REPORTS.

Direct United States Cable Co. (Limited).

The 43rd ordinary general meeting of this Company was held on Tuesday at Winchester House, Old Broad-street, E.C., Mr. E. M. UNDERDOWN, Q.C. (Chairman of the Company) presiding.

The SECRETARY (Mr. T. Finnis) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, I have very few remarks to make beyond those contained in the report, but I will first draw your attention to the figures which we have placed before you. The revenue for the six months to December 31 last, after deducting outpayments, amounted, in round figures, to £54,366. The working and other expenses, including income-tax, absorbed £21,621, leaving a balance of £32,745 as net profit. This, with £3,388 brought forward from the previous half-year, makes a total of £36,133, which has been appropriated as follows:—An interim dividend of 3s. per share to September 30th last, £9,106. 10s.; another interim dividend of 3s. per share to December 31st, £9,106. 10s.; set aside to reserve fund account, £12,000; balance carried forward, £5,920; making up the above total of £36,133. Now, no doubt events have been favourable to us, so far as the enormous bulk of business that has been going on is concerned, and, consequently, our revenue has increased by £4,268, or more than 8 per cent., as compared with the corresponding period of 1897. A portion of this increase, however, as in the previous half-year, no doubt must be attributed to exceptional causes. I think there is every sign that communications between the United States and the rest of the world will not diminish in the future. The traffic during the current year, so far as we have gone, continues satisfactory. With regard to the expenses in London, and at the stations, you have them set out as usual under abstracts A and B in the printed accounts. The increased business has naturally led to some addition to the expenditure, but after making allowance for special outlay under the head of maintenance, due to necessary improved land-line transmitters and cable duplex apparatus, and extra expense for repairs of buildings, it will be seen that the expenditure has been kept at a very reasonable figure. During the whole of the six months we were fortunate in not having any cable repairs to do whatsoever, and I wish we could deal with that as a normal state of things, but we know we cannot; therefore, it is always prudent, and even necessary, for us to make proper preparation for such events which we know will happen from time to time. The only debit to reserve fund, therefore, is an item of £1,548, which has been written off the buildings account, and that is the final charge in respect of the buildings at our Irish cable station at Ballinskelligs, which is now in an entirely satisfactory and comfortable state for the residence of the staff. The reserve fund has been increased by £5,859 from interest, £768 from profit on securities sold, and by £12,000 from revenue, making the balance up to £368,534, taking the investments at cost only; but at present market values the reserve fund is represented roughly by the sum of £415,534, which is not unsatisfactory, I think. We have increased our investments during the half-year by the sum of £10,711. We have been fortunate in increasing our receipts, and that in common with our partners in the pool, and I am very glad to say that the increase continues. I do not know that there are any very particular topics that you would like me to refer to; but I notice in a report of the proceedings at the meeting last year of our ally, the Anglo-American Company, the question of amalgamation was touched upon, and I have received a letter from a shareholder on the same subject. I cannot possibly, at a public meeting, go into a question of that kind, but I think it must be very clear to everybody who knows what the state of things is in connection with our Company that, so far as business is concerned, we have already a practical amalgamation—the best kind of amalgamation, and that is the sharing of the profits. All of us are endeavouring to foment business, and we are engaged in what has been recently described as a friendly competition to obtain profits. It is not a friendly competition to take profits out of each other's pocket, but to do all that we can to increase the profits of the allied concerns. I think everybody who studies the question will see that there are considerable advantages in the alliance of the three companies - the Western Union, this Company and the Anglo-American, because they are to a certain extent, under different conditions of working, aiming at the same object. They have before them a common end, and very often it is desirable that there should be something like independence on the part of these companies *vis-à-vis* to the public, having regard to the outcries against monopolies, which are not infrequently heard. That being so, I think the present state of things is about as favourable, in the interest of all the parties, as I can conceive it could be. There is no doubt that there is one tempting object which hangs upon our tree, and it is that we have a very nice reserve fund, and, no doubt, anybody who wishes to amalgamate with us would like to share in the benefits of that fund; but I think, considering that the rights we have are dependent on the fact of our having a cable, that we must do all we can to put ourselves in a perfectly safe position for maintaining that cable, so as to continue to receive that share of the profits of the united companies to which, I think, we are fully entitled. Now, I am not sure there is anything else I need speak about. The Directors have nothing to do with the price of the shares, but it is interesting sometimes to look back and see what has occurred in that respect. Both our own shares, and those of our allies, were low at one particular period, about 1894, but I am glad to see, in 1899, that they are, in some cases, very much higher, and, with regard to one case, quite equal to what they were so long ago as 1883, when the circumstances were so different. I should like to say, with regard to our Board, that I have been successful in obtaining a promise, or rather, I should say, that we have elected Sir Spencer Walpole as a Director (hear, hear). That gentleman's large experience at the Post Office; his experience in America, in connection with postal matters; and his general standing before the world, make him an important addition to our Board. And I do not say that alone as regards this Board, but I hope his presence as a director will be profitable to the pool in general, because it is always my desire, and the desire of my colleagues, to do all that we can to promote the common interest. I do not think that I will detain you any longer, but conclude by moving—

"*That the report of the Directors, dated Jan. 10, 1899, together with the statement of accounts, to Dec. 31, 1898, annexed thereto, be and the same are hereby received and adopted.*"

Sir JAMES PENDER, Bart., M.P., seconded the resolution.

Mr. HANCOCK agreed that the question of amalgamation was a very large one, and that it would not be right to jump to any conclusion regarding it. He had no doubt, however, that it was a question which must eventually come about, and that it would be of advantage to the Company.

Mr. JOHN NEWTON said he was just old enough to remember that in the early years of these companies similar arguments were used as to the wonderful benefit which would accrue if the Anglo-American Company amalgamated with the French Atlantic Company. They amalgamated, and the result was the establishment of the Direct Cable Company, with a clause that under no conditions should it be possible for this Company to amalgamate with any other company. He believed if the companies were to amalgamate it would be a source of weakness to them. He would remind the Chairman that he had said nothing about the proposed German cable.

The CHAIRMAN: I can assure both gentlemen who have spoken—and I know that Mr. Newton has had a long experience in the affairs of this and other companies—that the question which has been raised has been always before the Board. It certainly has never escaped our attention. I suppose that I, personally, have had as much to do with traffic arrangements, and working arrangements, and amalgamations as anybody living. All amalgamations, of course, are possible under certain circumstances. I do not mean to say that if somebody came to us and said that they would make an amalgamation with us, and give £20 a share in sovereigns for our shares, that the Board would, in defence of their small interest, do anything to prevent an operation of that sort. We should not think of doing so for a moment, nor should we think of rejecting any other proposition which was likely to benefit the shareholders generally. This matter is a very difficult one to explain, but I can assure you that the existence of independent companies, as regards their separate organisations, but with a bond of union between them and other companies for the purpose of making profits, is perhaps the very best arrangement you can have at present for dealing with the public, and various foreign nations and foreign relations. One does not like to go into too many reasons, and then conclude, like the famous Dutch general, who, after giving a number of reasons for not firing a salute, ended by stating that he had no guns. One reason against amalgamation is that it would be extremely difficult, because we have another partner besides the Anglo-American Company, and any alterations in our position towards the Anglo-American Company would be difficult to bring about without affecting our relations with that other Company. At the same time it would be extremely unwise to expect the traffic at present obtained by our cable to remain with that cable under an amalgamation. The probability is that a very considerable proportion of it would find its way to the cables of our competitors. I do not think that I should have any difficulty in showing Mr. Hancock that the best thing he and the other shareholders can do is to sit down tight on the reserve fund. This Company is quite content; and my friends connected with the Anglo-American Company will understand me when I say that the participation we have got in the combined profits is not unsatisfactory, and if anything like an amalgamation were to take place very great care would have to be taken, or it is possible that the scheme might be less favourable to us than is the present arrangement. That, in itself, I think, is a pretty good answer to the question of amalgamation, as far as we are concerned. I have nothing to do with the policy of other companies. We have followed one sound and constant policy. We have decided that we must build up a reserve fund sufficient to put us, practically, in as good a position as we now are if our cable were swept away to-morrow. The cost of replacing the cable at this moment is considerably enhanced on account of the rise in the price of materials. When you come to a rise of something like 20 per cent. upon large sums like £500,000 and £600,000 you will see that it is a very serious matter indeed. Therefore, we shall continue to recommend the shareholders to go on piling up the reserve fund, and we hope that it will not be impinged upon more than necessary to keep our cable in good condition. I had almost forgotten the question asked me regarding the German cable. We see that there is a statement to the effect that these gentlemen have got 20,000,000 marks, which is £1,000,000, in connection with the laying of a German cable. Well, the arrangement of our sister company, the Anglo-American, with the Germans terminates, I believe, at the end of this year; and you will find a very long statement made by me some years ago, to the effect that we must look forward to the termination of that arrangement. As I then said, we cannot keep all the nations of the world dealing entirely with us, and we have to be prepared for a change. That event which I foreshadowed seems to be now nearer than ever, if we are to judge by the announcement which we read in the newspapers. Whether that cable will go by way of the Azores, or some other way, I do not know. If it takes some of the traffic, no doubt it will not do us any direct good, but it is no use fighting against the inevitable, and the only consolation that we can give ourselves is the one that I alluded to in the early part of my speech, and that is the improving traffic. For some time past the business has increased so steadily and regularly that we may perhaps view an additional cable in the Atlantic with more equanimity now than would have been possible a few years ago. In the old days we said it was impossible that so many cables as then existed could pay, but we have been getting on very well with additional cables because the traffic is so good that the cables during the business hours of the day are practically fully occupied. Therefore, we must look upon increased com-

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petition with all the composure we can, and try, by pleasing the public and by getting ourselves in a position of equality with others, to hold our own, and I do not think we need have any fear for the future.

The resolution was carried unanimously.

The proceedings then terminated with a vote of thanks to the Chairman, proposed by Mr. HANCOCK and seconded by Mr. NEWTON.

Amazon Telegraph Co. (Limited).

The fourth ordinary general meeting of this Company was held at their offices on Friday, under the presidency of Mr. W. S. ANDREWS.

The SECRETARY (Mr. R. M. Cunningham) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, we do not meet on this occasion quite so soon as we could have wished, but the reason of this is to be found in the difficulties we have had to contend with, and the necessity of making some sort of financial arrangements—or of seeing our way to make them—before we could have had the pleasure of meeting you. To deal with the receipts, in the first place, they are not so discouraging as they might have been, because, notwithstanding interruptions in the main revenue-producing sections of the system, they are £29,446, or £4,148 more than they were for the previous year, which, however, was also an interrupted period, although perhaps, not so badly interrupted as the past year has been. The working expenses have been £18,494, and they compare with £20,164. There is a reduction, therefore, in the expenses, combined with an increase in the receipts; but, of course, although these figures are in the right direction, they are eminently unsatisfactory as a whole to us, and I am afraid they must necessarily be equally unsatisfactory to the shareholders; for they show that the enterprise of the Company, from circumstances the shareholders are aware of, has not been for any length of time in a proper revenue-earning condition. We have had, besides, an unusually heavy flood period—remarkably heavy—which has impeded our efforts in repairing operations, and caused difficulties of various kinds. In fact, owing to the constant interruptions there has been no possibility of developing the traffic. That the trade is there there is no doubt, and with the lines working properly the undertaking will certainly prove its remunerative character. That we believe most fully. Our difficulty is one, and one only. Everything promises well for the concern if we can only keep our lines permanently at work, and this is what the Directors have been doing their utmost to accomplish. We have at last apparently confined our difficulties to certain localities only. These we have now alone left to conquer, and if we can do that, our prospects will be exceedingly hopeful. We have relaid certain sections in the furos instead of in the main river, to get round and circumvent, so to say, dangerous parts of the main stream. We have sent out aërial insulated wire cable to bridge over by land impossible spots, and we are sending out more of this cable, and are also arranging surveys in places for the substitution of overground wires for the submerged cable. We think we may require all these things in the different places owing to the varied troubles we have had to contend with, and we believe that by these means we may be able to succeed. We cannot prophesy, because we don't know, but we believe that we are on the right track to overcome these difficulties of the main stream should they prove to be here and there insurmountable, or, at all events, insurmountable unless at a prohibitive cost. We must even then exercise our wits not to undertake the impossible, but by changes, trials and inventiveness, to establish our system in the best way we can. We believe that the authorities recognise the hard struggles we have had and are having, and sympathise with our continued efforts. All they want is the telegraphic communication, and if we can give them this they will be satisfied. If there is anything in determination to try, and in trying all known means and adopting every method we can think of, we mean to do our utmost to succeed, and we hope eventually to do so. Meanwhile we are doing our best to reduce expenses. The Directors are taking no fees, leaving these to be paid when the prosperity of the Company shall provide for this. The only exception to this arrangement is Mr. Keith, because that gentleman has been giving so much attention to the Company's affairs that it was felt that it would be improper and unfair to expect him to submit to this sacrifice while concurrently making the same demands upon his time and energies. I now move the adoption of the report and accounts.

Mr. GEORGE KEITH seconded the resolution.

The CHAIRMAN, in reply to questions and remarks by Mr. Ridge and Capt. Goodsall, said that the Directors, as shareholders, would be very sorry to think that the Company was going into liquidation. The original capital was not "swallowed up," because there was a large length of cable still working in the Amazon to represent it. They were also earning a revenue—not sufficient to pay a dividend, but at least to pay all expenses and rather more. If they were successful in their efforts to re-establish the connection and to maintain it, they had no doubt whatever that the revenues of the Company would be most satisfactory. The only thing that they had to do was to keep the communication open, and the public and trade and commerce would do the rest for them. They would consider the question of sending out an interim report. There were several breaks in the cable, but the distances between each varied. They had not lost sight of the question of wireless telegraphy; but the difficulty was to induce people to make experiments which would be satisfactory, because they themselves did not want to spend the Company's money in making experiments themselves. He then put the resolution, which was carried unanimously.

Mr. W. S. Andrews and Mr. G. Keith were re-elected as directors, and Messrs. Deloritte, Dever, Griffiths, and Co. re-appointed as auditors, and after a vote of thanks to the Chairman and Directors, the meeting terminated.

City and South London Railway Co.

The twenty-ninth ordinary general meeting of this Company was held at Winchester House, Old Broad-street, on Tuesday. Mr. CHARLES GREY MOTT presided.

Mr. W. F. KNIGHT read the notice convening the meeting. The report was taken as read.

The CHAIRMAN, in moving the adoption of the report and accounts, said it was very pleasing to them to have to report that the past half-year was a record, as had been the case before, of steady and uninterrupted progress in the dividend-earning power of the company. They had been enabled to declare—or recommend the shareholders to declare—an increased dividend of ¼ per cent., making 2 per cent. for the past half-year, which, with the dividend declared last midsummer, made a rate of 2⅛ per cent. for the whole of last year. That dividend, although it was not a very large one, was certainly an improvement, and they might look forward to the time not very far distant when they hoped that it would be considerably larger. If the shareholders reflected that the cost of this line before they incurred any expenditure upon the extensions—which extensions were now going on—was a little over £800,000, and that the earnings for the last year—the nett earnings—were over £24,000 they would see that they were earning now upon the whole cost of the line about 3 per cent. per annum. Well, of course, the Debentures and the Preferences were being paid a higher rate than was distributed upon the Ordinary shares—and a higher rate than 3 per cent., and therefore up to the present, as he had said, their ordinary capital was only receiving 2⅛ per cent., but there was no doubt that they certainly had a growing traffic and improving dividend, and he thought that they might fairly say this, that the Company had proved itself to be a financial success and a success sufficient to justify the expenditure of additional capital in regard to other electrical lines—not their own, but other electrical lines throughout the metropolis. This was a very important thing for London, and it showed that capital invested in a concern like this Company could return 3 per cent. upon its outlay, and it justified in the future the provision of additional lines for the accommodation of the public in London, which were now coming forward. This Company had done that much for the public benefit, and he hoped that the time would come when they would feel that they had not invested their money foolishly in that line, and when they would receive a return which would be satisfactory to the shareholders. They had been making during the past half-year very considerable progress with the extensions, and the whole of the extension works under the City were now completed, or practically completed; there were only the finishing touches to be given to them, and what now remained to be done was that they should complete the lifts and surface stations, the signals and various other small matters, and he hoped that by the time of their next half-yearly meeting they would be able to announce that that line had been already opened for traffic, or at any rate to announce the date upon which it would be opened. The Clapham extension was going on with great rapidity. They had an energetic contractor upon it, and he had made very rapid progress, and they were, therefore, in hopes that that line would be finished and opened almost simultaneously with the opening of the extension to Moorgate-street through the City. He thought that they would agree that that was very satisfactory progress for work—and it was very difficult work—of this kind. During the half-year their traffic, as he had said, had considerably increased. The number of passengers carried showed an increase of 124,953, and they had increased receipts from these passengers of £825, and the increase from season tickets was £22, making a total increase of £847 in the half-year. He did not know that they required further detail upon that point, but he would deal with the accounts later. He supposed that they would prefer him to deal with the exact position of the works at the present time. The subway between themselves and the Central London Railway at the Bank was now completed, and he was in hopes that that line would have been ready for opening almost simultaneously with the opening of their own extension, but he was afraid from what he had seen in the papers that there was likely to be some further delay; however, that delay was not likely to be very long, and he thought they might assume that there would be a very large exchange traffic between their own system and the Central London system at that point. There was a further subway, to which reference was made in the report in regard to the London, Brighton and South Coast Railway Co., at London Bridge, and this Company's station there. That subway had not yet been commenced, but they were in active negotiation with the London, Brighton and South Coast Company, and matters were very nearly completed, and he believed that they would soon come to some definite arrangement with them as to the construction and working of that subway. He hoped that it would not be very long before the works there would be commenced. There was another line, which had been started, and which was going to be made, and that was the Great Northern and City Railway. That railway was now being proceeded with actively, and he believed that its terminus would join the terminus of this Company at Moorgate-street station in Finsbury-pavement, and he hoped that they would be able to arrange with that railway company to construct a subway from their platforms to the platforms of this Company down below, and there was also another line, the Chingford, Walthamstow and Epping Forest line, which was to have a terminus at almost the same place. As they would have a connection with the Metropolitan system at Moorgate-street station, and these other two railways, to which he had referred, they ought to obtain a very large exchange traffic at Moorgate-street station. It would be seen that they would get the advantage of the exchange traffic from all these different sources which were bringing it into the City, and, at the same time, they would have subways from platform to platform, which must prove of enormous public convenience to the travelling population of London. Of course, in the working of this system of railways, they required increased power, and they had provided it at the depôt at Stockwell, where, as he had before

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told them, they had bought an additional block of land where they were erecting works—new engine works and a new boiler house, and also plant for the generation of electricity upon a larger scale. These works were making very rapid progress, and they would be in a position, as he had already stated, of efficiently working this additional traffic. They had ordered new rolling stock for the purpose, and they were constructing new engines and new carriages, so that everything would be ready in time. Some of the engines were already in hand, and others were contracted for. Well, of course, their railway through the City was a very important piece of line. It ran through the heart of the biggest city in the world, just at its very centre, and the stations were in the very best position that they could possibly have for a traffic of that kind. It had undoubtedly cost them more money per mile than any other part of the line, but that was only to be expected. You could not go through the heart of the City of London without its costing you somewhat more, but still it would not be an extravagant cost, although it was more expensive. Now, it was to the interest of the Company to make the utmost possible use of every possible bit of line. They had got the line extended to Clapham Common, and they had now this piece of line which would bring them a very heavy traffic from the north of London. Anyone who knew the Angel and the Upper-street, Islington, would be aware that that was one of the busiest centres, apart from the City, in the metropolis, and they felt perfectly certain that it would bring to them a very large traffic over their line. It was upon that account that they were considering the Islington extension. They believed that six months from now the extension which they were now working upon would be completed and opened, and then they proposed to take the earliest opportunity, when they could arrange financial and other matters satisfactorily, to complete the line up to the Angel, in order that they might have a big traffic, both north and south, flowing into the City. And they had made ample lift provision to deal with the traffic at the Lombard-street station. He had no doubt whatever that when that extension was made they would derive a very considerable profit from it. The line was not a long one, and it would not be so expensive as the line through the City. As a matter of fact, it would cost them very much less, and they had made the necessary provision for working it, and they could work it, at a very moderate cost. This was why they told them in the report that they proposed, as soon as they could make satisfactory arrangements to proceed with the extension of that line for about a mile and a-half to the Angel. They believed that the result would be highly satisfactory. There was one other line to which the report referred on which he would like to say a few words, and that was the City and Brixton line. It was essential in all these underground railways that their capital should first of all be kept down within as moderate a limit as possible, and secondly, it was essential that they should be worked with the utmost possible economy. Now, as regarded the City and Brixton railway, its capital was a very moderate one, and they believed that they would be able to work it very economically. And in order to commence working it with the greatest possible economy, they had arranged with that Company that they should apply for powers to make a small tunnel from their line into this Company's depot, instead of providing, as at first proposed, a separate depôt for the working of their own line. He felt that this would result in very decided economy in the working, and enable them to make the thing successful. They had, therefore, arranged with the City and Brixton Company to make this slight addition, and they had also discussed some small modifications in regard to the agreement, which were not yet completed, but when they were completed, the Directors proposed to call a special meeting of the shareholders, and submit them to them for their approval. They believed that that line would have a very heavy traffic upon it, and it would have a joint station with their Denman-street station at London Bridge, which would thus give four lines into the City. They thought that the line would be a very profitable one to this Company to work on the whole. They had looked very carefully into the matter before undertaking the responsibility, which responsibility they recommended the shareholders to undertake at the last meeting, and upon the statements then submitted they agreed to do so. Another important feature in connection with that line was that it would enable them to utilise that portion of the line under the Thames which would be thrown out of use so soon as the present extensions were brought into play. He must now ask them to turn to the accounts, and, as regarded the capital account, it would be seen that they had received during the half-year, in round numbers, £71,000 in shares, £20,000 in debenture stock, and £13,000 in premium, making a total of £104,000; but they had expended during the same period £157,000, so that they had expended £53,000 more than they received, but that account had now been set right, they having received the necessary funds for the purpose. With regard to the revenue statement, the passengers, as he had told them before, had shown an increase of £847, parcels an increase of £26, rents of property an increase of £238; but, on the other hand, there was a decrease of £28 in transfer fees, and £24 in sundry receipts, so that the net increase in their earnings was £1,059. In this half-year they had had increases in their expenditure to some extent; for instance, in maintenance there was an increase of £214, carriage repairs £92, traffic expenses £180, and law charges £1, but on the other hand they had a decrease in locomotive expenses of £88, and in rates and taxes of £35. The decrease in rates and taxes was more a book-keeping than an actual decrease, and could not be looked upon as an actual permanent decrease in the taxes. The net increase in the expenditure was £462, which deducted from £1,059 increase in receipts, gave a net profit of £597, and they had also an increase in bank interest of £36, and decreased debenture interest of £431, which made up £1,064. The increased dividend on the Preference shares absorbed £338 more, leaving a balance of £726, and if they added decreased balance carried forward £92, less decreased balance for last half-year, £30—leaving £62, it made up a total of £778, which was exactly the ¼ per cent. extra dividend which they now suggested. They would have observed that during the past half-year, as regarded the balance which they brought in and the balance which they carried out, there was a difference of about £400, which meant ½ per cent. upon the capital during the half-year, and, therefore, they carried forward a larger balance—some £1,400 or £1,500 to the credit of the present half-year. No doubt the shareholders would wish to hear something as to the ordinary percentages of their working during the half-year, and he might tell them that the number of trains run had increased from 73,142 to 74,339. All the comparisons he was now making were with the corresponding period of the previous year. The number of passengers per train had increased from 45·64 last year to 46·58 this year, or an increase of one passenger per train thoughout all the trains. That was a very satisfactory element in the question of profit on lines like those. The receipts per train had increased from 7/3·4 to 7/5·6, and per train mile they had increased from 2/3·63 to 2/4·48. The receipts per passenger remained about the same. The ratio of working expenses had decreased from 56·68 to 56·18 per cent., or ½ per cent. He had explained before now that they did not compare with ordinary railways in this matter, because ordinary railways had only to perform one operation, that of carrying their passengers backwards and forwards; but this Company had to perform two operations, viz., carrying them backwards and forwards, and also up and down by means of lifts. If they deducted the cost of the lifts, their expenditure would work out at about 49 per cent. The decrease in locomotive charges was a very satisfactory one, and spoke well for their officers in the management of the traffic. As regarded the increase of 125,000 passengers in the half-year, these passengers were short distance passengers, to the extent of half of them; they only paid a penny fare which meant midday traffic, which was of great advantage to them, because there was a large amount of unfilled space in the middle of the day, which could be well filled up without the necessity of running additional trains, and, therefore, no additional expense was incurred. He believed that he had now dealt with all matters of interest, and subject to any questions, he begged to move the adoption of the report and accounts.

Mr. SAMPSON HANBURY seconded the motion.

Mr. JAMES DRAKE congratulated the Board on the result presented, which was the outcome of intelligent perseverance. He paid a high tribute of praise to the services of everyone connected with the Company, naming especially Mr. Jenkin, their general manager, and Mr. Knight, their secretary. He had every confidence in the continued progress and prosperity of the undertaking.

Sir PEARCE EDGECOMBE endorsed the words which had fallen from Mr. Drake, and thought the shareholders were to be congratulated upon the position of the Company, and upon the fact that year after year, like a snowball, it had gone on increasing.

The CHAIRMAN having replied to various questions, the dividends were declared, the retiring directors (Mr. C. Grenfell and Mr. Edwin Tate) re elected, the auditors reappointed, and the meeting terminated with a vote of thanks to the Chairman, Directors, manager, secretary and staff.

Westminster Electric Supply Corporation (Limited).

The report of the Directors of this company for the year 1898, issued yesterday, stated that the supply of current which, on Dec. 31, 1897, was provided for the equivalent of 290,561 8 c.p. lamps, had increased by Dec. 31, 1898, to the equivalent of 339,986, and at the present time there are on circuit the equivalent of 343,617, and applications have been received for a further 8,134 lamps of 8 c.p. The length of roadway in which mains have been laid now exceeds 48 miles, making about 197 miles of ways, into which upwards of 168 miles of copper (strip and cable) have been drawn.

The Directors have taken special steps to encourage the use throughout the system of supply of 200 volt lamps. The effect of this change, when completed, will be to increase very greatly the capacity of the existing mains and to reduce future capital expenditure under this head.

The extensions of the stations at Davies-street and Eccleston-place have been completed, and the plant is at work. The plant and machinery have been working satisfactorily throughout the year, and have been fully maintained from revenue.

Owing to the continued increase in the applications for current the station at Davies-street is now practically equipped for its maximum supply, while the space available at other stations will shortly be utilised. As it has been found impossible to obtain a further suitable site for extension or the provision of a new station within the corporation's authorised area, the Directors have united with the board of the St. James' and Pall Mall Co. in promoting a bill for a joint station outside the companies' areas for the purpose of supplying current in bulk to the existing stations of this corporation and of the St. James' Company. The capital invested in this undertaking is at present unremunerative.

The late prolonged strike in the South Wales coal fields and unforeseen difficulties in the completion of Millbank-street station have caused very considerable additional expense during the year.

The Directors consider that they may congratulate the shareholders on the fact that, notwithstanding these difficulties and the extra rebate allowed to consumers which came into force on Jan. 1, 1898, the total cost per unit remains about the same, and there is no decrease in the amount available for dividend. An interim dividend, at the rate of 10 per per cent. per annum, for the half-year ended June 30, 1898, has been distributed. After allowing for depreciation, sinking fund, &c., the net balance available for dividend is £28,033. 6s. 4d., and the Board recommend payment of a dividend at the rate of 14 per cent. per annum, less tax, for the past half-year, making 12 per cent. for the year to Dec. 31, carrying forward £1,000. 9s. 8d.

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St. James' and Pall Mall Electric Light Co. (Limited).

The report of the Directors of this company for the year ended Dec. 31st last states that the Carnaby-street and Mason's-yard stations have been working satisfactorily throughout the year; but to enable the company to meet the growing demand for electrical energy it has become necessary to further extend the former station, and for this purpose the Directors are promoting a bill in Parliament to acquire by compulsory purchase certain adjacent property. To meet future requirements the Directors have, by agreement, arranged with the Westminster Electric Supply Corporation (Limited) for the promotion in Parliament, under the title of the Central Electric Supply Co. (Limited) of a bill authorising the establishment of a station on certain property to be acquired in the parish of St. Marylebone. This will secure to the two companies an ample supply of electrical energy in bulk.

The capital of the company has been increased to £300,100, and 12,000 new Ordinary shares of £5 each have been issued at par to holders of the 100 Founders' shares of £1 each. These Founders' shares are now vested in a trustee for the company. Steps are now being taken to reduce the capital by cancelling the 100 Founders' shares. So soon as further capital is required the Directors propose to issue the remaining 8,020 Ordinary shares to the shareholders in proportion to the shares held by them, at a premium, which will enable a substantial addition to be made to the reserve fund. The £50,000 Four per Cent. Debenture stock is now being paid off.

The net earnings during the past year have amounted to £29,889. 19s. 1d. Of this sum, £11,495 was distributed in August last in payment of an interim dividend at the rate of 10 per cent. per annum for the half-year to June 30, 1898, on the Ordinary shares, and at the rate of 7 per cent. per annum on the Preference shares. The balance, £18,394. 19s. 1d., with £384. 10s. from last account, leaves £18,779. 9s. 1d. now to be dealt with, and the Directors propose to divide this amount as follows:—

Dividend at the rate of 7 per cent. per annum on the Preference shares	£3,500	0	0
Dividend on the Ordinary shares of 7s. 6d. per share, and a bonus of 2s. per share, making, with interim dividend, a total distribution of 14½ per cent. for the year	15,190	10	0
Amount carried forward	88	19	1
	£18,779	9	1

Anglo-American Telegraph Co. (Limited).

The report of the Directors of this Company for the half-year from July 1 to Dec. 31, 1898, states that the total receipts, including £17,580. 6s. 2d. brought forward, amounted to £212,493. 2s. 1d. The traffic receipts show an increase of £14,418 compared with the half-year to Dec. 31, 1897. The total expenses of the half-year, including repair of cables, &c., amounted to £63,404. 18s. 6d., an increase of £5,032. 14s. 1d. over the corresponding period of 1897. The Directors have, before declaring the net profits, set apart £12,000 to renewal fund, leaving a balance of £137,088. 3s. 7d. Interim quarterly dividends of 15s. per cent. on the Ordinary and £1. 10s. per cent. on the Preferred stock, were paid on Nov. 1 last, absorbing £52,500, leaving £84,588. 3s. 7d., out of which the Directors recommend final dividends of £1. 4s. per cent. on the Ordinary, £1. 10s. per cent. on the Preferred, and 18s. per cent. on the Deferred stock, absorbing £84,000, making a total distribution for the year 1898 of £3. 9s. per cent. on the Ordinary, £6 on the Preferred, and 18s. on the Deferred stock, carrying forward £588. 3s. 7d.

Liverpool Overhead Railway Co.

The report of the Directors for the half-year to Dec. 31 last states that the gross receipts amounted to £40,840. 3s. 2d., and the working expenses to £24,717. 15s. 4d. The number of passengers carried during the last two years show an increase in each class, the yearly totals being:—1897, 8,736,750; 1898, 9,367,862. With a balance brought forward of £3,863. 13s. 7d. there is available for dividend £16,586. 1s. 5d., out of which the Directors recommend dividends at the rate (less tax) of 5 per cent. per annum on the Preference shares and 4 per cent. on the Ordinary shares, taking £12,000, leaving £4,586. 1s. 5d. to be carried forward. A basis of agreement has been arrived at with the Waterloo-with-Seaforth and Great Crosby District Councils (subject to sanction of shareholders and confirmation by Parliament) for the Company to equip and work the tramways already authorised within those districts.

Waterloo and City Railway Co.

The report of the Directors for the half-year ended Dec. 31st, to be held at the Waterloo Station, London, on Thursday, Feb. 9, 1899, at two p.m., informs the shareholders that the railway was opened for traffic on Aug. 8th last, since which date the train services have been carried on by the London and South-Western Co. in accordance with agreement. The City terminus subways and connecting approaches are being proceeded with by the Central London Railway Co. and will, it is hoped, be completed by the end of the current year.

The capital outlay shows total outlay £549,456. 15s. 9d. at Dec. 31st last, and the further estimated expenditure of £52,000 is amply provided for by the capital powers.

The gross receipts amounted to £10,887. 11s. 9d. From this amount the London and South-Western Co. have retained £4,119. 1s. 1d. in respect of working expenses, leaving £6,768. 10s. 8d. payable by them in order to provide for a dividend at the rate of 3 per cent. per annum from Aug. 8th to Dec. 31, 1898, on the ordinary and borrowed capital. To this sum has been added bankers' and general interest and a portion of the profit on the sale of consols, representing the Parliamentary deposit, which enables the Directors to recommend the payment of a dividend at the rate of 3 per cent. per annum for the full half-year, payable Feb. 18.

A report by Messrs. W. B. Galbraith and A. B. W. Kennedy, the Company's engineers, states that since the opening for traffic in August the railway and station works have been well maintained, and the line is worked with four trains, and a fifth complete train with two additional motor carriages is held in reserve. The power provided at the generating station and the capacity of the motors on the trains continue to be found amply sufficient. Some electrical difficulties occurred in the initial stages of working, but these have been overcome, and the plant is now working regularly and satisfactorily. It is expected that a staircase in Mansion House-place will be ready for use about the end of March.

NEW COMPANIES, STATUTORY RETURNS, &c.

ELECTRIC CANAL HAULAGE CO. (LIMITED).—This company was registered on Jan. 27 with a capital of £3,000, in £1 shares, to enter into an agreement with Messrs. Benjamin H. Thwaite and George Cawley, to establish electric generating stations for the distribution and use of electric energy for the purpose of hauling vessels, &c. The first subscribers are:—George Cawley (consulting engineer), C. A. Embleton (engineer), J. Cawley, Miss A. M. Cawley, Benjamin H. Thwaite (consulting engineer), H. Allen (civil engineer), and T. J. Denny.

RUBBER AND VULCANITE CO. (LIMITED).—This company was registered on Jan. 20, with a capital of £12,500, in £1 shares (of which 3,500 are Preferred), to manufacture, sell and deal in rubber, gutta-percha, vulcanite and similar substances, and to generate and use electricity, &c.

SUSPENDED ELECTRIC RAILWAY CO. (LIMITED).—This company was registered on Jan. 20, with a capital of £60,000, in £1 shares, to enter into an agreement with Christian de Thal and Romain Weiss, to construct, equip, develop, maintain, control or work by electricity or any other power, any railways, tramways, motor cars or other vehicles, and to carry on the business of railway, tramway and motor car proprietors, carriers of passengers and goods, suppliers of electricity, manufacturers of and dealers in carriages, trucks, accumulators and dynamos, &c. The first subscribers are:—Count Christian de Thal, R. Weiss, J. Gaskell, E. C. Fowler, J. W. Jenner, J. Cunningham and E. Hinton.

TRAFFORD POWER AND LIGHT SUPPLY CO. (LIMITED).—This company was registered on Jan. 24 with a capital of £100,000, in £1 shares, to enter into an agreement with W. P. James Fawcus, for the acquisition of a concession for the sole and exclusive privilege to supply electricity and fuel gas for lighting, traction, heating, motive power or other purposes to the whole of the roads, streets and premises in Trafford Park estate, Manchester, and to carry on the business of electricians, engineers, suppliers of electricity, manufacturers and suppliers of gas, iron and brass founders, tool makers, machinists, boiler makers, &c. The first subscribers are:—W. P. James Fawcus (engineer), J. Nasmith (engineer), Godfrey B. Samuelson (manufacturer), Henry Edmunds (manufacturer), Frederic Smith (wire manufacturer), J. E. Baxter (rubber manufacturer), and George W. Lowcock (engineer). The first Directors are to be nominated by the subscribers. Qualification £250.

BERRY'S ELECTRICAL CO. (LIMITED).—The statutory return to Dec. 26 gives the capital as £3,000, in £1 shares, of which 888 have been taken up. The full amount has been called and paid.

BINKO, RIDSDALE AND CO. (LIMITED).—The statutory return to Oct. 25 has been filed. The capital is £24,000, in £1 shares, of which the whole has been taken up and issued as fully paid.

BRIGHT'S LIGHT AND POWER (LIMITED).—The statutory return to Dec. 5 has been filed. The capital is £200,000, in £1 shares, of which 66,667 have been taken up. £1 per share has been called on seven shares, and 5s. per share on the others.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (Feb. 2, 1899). Price of silver 27 7/16d. per oz. (Feb. 2). Consols (2¾ per cent.) 111—111¼ for money, 111⅛—111⅜ for account; 2½ per cent. 103¾—104¼ (Feb. 2). Stock Exchange Settling Days: Consols, March 1; Stocks and Shares Continuation Days, Feb. 8 and 22; Ticket Days, Feb. 9 and 23; Pay Days, Feb. 10 and 26; Mining Share Carry over Days, Feb. 7 and 21.

AUTOMATIC TELEPHONE CO. (LIMITED).—The adjourned general meeting of this company was held on Wednesday, with Mr. Max Margowski in the chair. Mr. Parker rose, directly the notice convening the meeting had been read, and said that as he and other shareholders were going to impugn the conduct of Mr. Margowski, in connection with his dealings with the company, he proposed that Mr. Percy Barlow should take the chair. Mr. J. White seconded. The Chairman replied that as no notice had been given of the motion it was out of order. The motion was, however, carried. This lead to a scene of indescribable uproar, the Chairman's efforts to restore order being futile. Amid the din he was understood to say that the company's principal patent had now been granted. After stating that the accounts were adopted, and that a resolution for removing Mr. Maurice Alexander from the Board was carried he declared the meeting closed.

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Mr. Barlow afterwards presided, and Mr. Gibbs, a director, read a letter from Mr. Seligmai Lui, the company's engineer, who complained of the manner in which he had been treated by Mr. Margowski, and stated that he declined to have any further connection with the company until the management was put on a different footing. Mr. Alexander said that he and Mr. Gibbs had striven for 18 months to obtain fair play for the shareholders. Without Mr. Lui there might be said to be no company. After further discussion resolutions were carried rejecting the accounts, as submitted, expressing a want of confidence in Mr. Margowski and requesting him to retire from his position as chairman and managing director; appointing a committee of shareholders to examine the affairs of the company and make recommendations for the election of a new Board and for carrying on the business in the future; and instructing the auditors to prepare a proper balance sheet of the company up to Dec. 31st last.

BRITISH AND FOREIGN OXOLIN CO. (LIMITED).—A prospectus is issued inviting applications for 66,667 shares of £1 each in this company, which has been formed to introduce commercially an invention for manufacturing a rubber-like substance called oxolin. It is stated that freehold works have been already established at Mitcham (Surrey), and that a German manufacturing company has also been formed, some shares in which are acquired by the present company. Among the users of this material the name of the Brush Co. is included, and it is claimed that the material is suitable for insulation for wires and cables and other electrical pnrposes.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LIMITED).—The Directors, after providing £7,000 for depreciation, carrying forward £3,500, and subject to audit, have decided to recommend a dividend for the half-year ended Dec. 31 at the rate of 10 per cent. per annum, making (with the interim dividend of 6 per cent. per annum) a dividend payable for 1898 of 8 per cent. on the ordinary share capital.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING CO.—Subscriptions have been invited this week for a first issue of £200,000 Four and a-Half per Cent. Debenture stock of this company, at £108 per cent.

DUBLIN AND LUCAN STEAM TRAMWAY CO.—The Directors report that the delay in the electrical equipment of the line has been due to the difficulty in procuring a suitable site for a generating station. This has now been got over, and the Directors anticipate that the line will be fully equipped before the next half-yearly meeting.

ELECTRICAL ENGINEERING IN SIAM.—The Siam Electric Co. has been formed in Copenhagen to establish electricity supply works in Siam. Messrs. Siemens and Halske, of Berlin, are reported to be interested in the new venture.

GREAT NORTHERN TELEGRAPH CO. (LIMITED).—This company notify that they are prepared to repay all outstanding debentures (series B, 1883), on the 1st prox. Debentures, with coupons, should be presented to Messrs. C. J. Hambro and Son, and left three clear days for examination.

JAMAICA ELECTRIC LIGHT AND POWER CO. (LIMITED).—The Directors of this company recently declared a dividend of 1s. per share, the total net profit for the year being £635.

PAISLEY TRAMWAYS CO. (LIMITED).—At the meeting of shareholders the chairman said the Company had paid 3½ per cent. on outstanding accounts, according to their agreement with the British Electric Traction Co., and had declared a dividend of 2½ per cent. The time had come when he could congratulate them upon the disappearance of the dark cloud which had so long hung over their undertaking. If their agreement with the British Electric Co were confirmed by Parliament granting the powers sought by the Traction Co. they would be sure of a dividend in future.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT CO. (LIMITED).—The share transfer books of this company are closed from 1st to 15th inst. inclusive, preparatory to payment of dividends.

STOCK EXCHANGE NOTICE.—Applfcation has been made to the Stock Exchange Committee to appoint a special settling day in, and to grant a quotation to 10,000 vendors' Six-per-Cent. Cumulative Preference £5 share fully paid (Nos. 1 to 10,000) of the New General Traction Co. (Limited).

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Jan. 28	3,690	+ 112	...	...	...
Blackpool Corporation...	...	...	...	...	...	...
Blackpool and Fleetwood Co.	" 28	154	...	4	564	...
*Bristol Trams & Carriage	" 27	2,382	+ 38	4	10,024	+ 470
City & South London Ry.	" 29	1,134	+ 75	5	5,553	+ 160
Dover Corporation	" 28	132	+ 45	43	7,785	...
Dublin United (Southern)	" 27	604	+ 150	4	2,354	+ 634
Liverpool Overhead Rly.	" 29	1,258	– 79	5	6,551	– 296
*Sheffield Tramways.....	" 29	1,163	+ 195	4	4,862	+ 933
*South Staffs. Trams......	" 27	542	– 26	4	2,308	– 46

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Jan. 25.		Price Wednesday, Feb. 1.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Week Ending Feb. 1. Highest.	Lowest.
			TELEGRAPHS					£ s. d.			
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	101	104	101	104	3 16 11	January and July	..	..
25,000	10	–	Amazon Telegraph	3	4	3	4	–	–	–	..
£125,000	100	5%	Do. 5 per Cent. Debentures	87	92	87	93	5 6 5	–	–	–
£505,5[illegible]	Stock	15,0	Anglo-American	67	69	68	70	4 19 8	Feb., May, Aug., Nov.	68½	
£3,047,[illegible]	Stock	30/0	Do. Preferred	119½	120½	120	121	5 0 6	" "	120¾	120
£3,047,9[illegible]	Stock	5/0	Do. Deferred	16¼	17	16¼	17	–	–	17⅛	16 9/16
180,000	10	3/0	Brazilian Submarine	15¾	16½	15½	16½	4 6 2	Mar., June, Oct., Dec.	16¼	[illegible]
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	110	114	110	114	4 7 9	June and December	..	..
10,000,000	$100	$2¾	Commercial Cable Capital Stock	180	190	180	190	4 4 3	Jan., Apr., July, Oct	..	..
£1,33[illegible]	Stock	4%	* Do. 4 per Cent. Debenture Stock	104	106	104	106	3 15 8	" "	103¾	10[illegible]
16,000	10	8/0	Cuba Submarine Ordinary (Deferred)	9½	10½	9¾	10½	6 13 4	February and August	10 1/16	9¾
6,000	10	10/0	Do. Preference 10 per Cent.	17	18	17	18	5 11 1	" "	–	..
12,931	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October	..	–
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	10½	–
£80,000	50	4½%	Do. 4½ per Cent. Debentures	104%	107%	104%	107%	4 4 1	January and July	..	
[illegible]	20	3/0	Direct United States Cable ... xd	12	12½	12¾	12¾	5 2 0	Jan., Apr., July, Oct	12 13/16	12 7/16
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	102	105	102	105	4 5 9	..	..	
£4,000,000	Stock	6%	Eastern Ordinary	174	179	175	180	3 18 0	Jan., Apr., July, Oct.	179	176
£[illegible],296,000	Stock	3½%	Do. 3½ per Cent. Pref. Stock	103	106	103	106	3 6 0	" "	105¾	104
[illegible]	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	125	129	125	129	3 2 4	May and November	127½	12[illegible]
£80,000	100	5%	* Do. 5 per Cent. Debentures, 1899 ... xd	101	104	99	102	4 18 0	February & August	–	..
[illegible]	Stock	–	Do. Provisional Certificates (all paid)	103	106	103	106	..	..	..	..
250,000	10	2/6	Eastern Extension	17½	18	17¾	18¼	3 16 9	Jan., Apr., July, Oct	18 1/16	17¾
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock ... xd	126	130	124	128	3 2 6	February & August	–	..
£16,200	100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Deb. 1900 (reg.)	99	103	99	103	4 17 1	January and July	..	..
[illegible]	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	" "	..	–
£35,100	100	5%	*Eastern and S. African 5 p.c. Mor. Deb., 1900 (reg.)	99	103	99	103	4 17 1	" "	–	–
[illegible]	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	" "	..	..
£600,000	100	4%	* Do. 4% Mortgage Debentures, 1909 ... xd	104	107	102	105	3 17 8	February & August	..	–
£100,000	25	4%	Do. 4% Mauritius Sub. Debs. (red.)	104%	107%	104%	107%	3 16 2	May and November	..	.
180,227	10	1 9	Globe Telegraph and Trust ... xd	12½	13	12¾	13¼	3 17 4	Jan., Apr., July, Oct	13	12¾
180,042	10	6%	Do. 6 per Cent. Preference ... xd	16½	17½	16¾	17½	3 9 7	" "	17½	16¾
150,000	10	5/0	Great Northern of Copenhagen	28½	29½	29	31	3 6 8	January, April, July	28¾	..
£150,000	100	5%	* Do. 5 per Cent. Debs., 1883 issue Series "B"	101	104	101	104	4 17 7	March & September	101½	–
£97,800	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red)	99	102	99	103	4 8 6	June and December	..	
17,000	25	13/6	Indo-European	57	60	58	61	4 2 0	May and November	60	59½
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904	109	112	109	112	5 7 7	March & September	..	–
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red)	104	107	104	107	3 14 9	June and December	–	–
11,839	8	4/0	Reuter's	6½	7½	6½	7½	5 6 8	April and October	6¾	–
3,381	£100 Cert.	6%	Submarine Cables Trust	136	141	138	143	4 4 11	" "	–	..
15,000	10	–	West African Telegraph	–			..	..	–	–	–
£100,000	100	5%	* Do. 5 per Cent. Debentures (red.)	100	103	100	103	4 18 6	March & September	–	–
80,008	2½	–	West Coast of America	½	1	½	1	..	–	–	–
£1[illegible]0,000	100	4%	* Do. 4 per Cent. Debentures	102	105	103	106	3 15 9	June and December	–	..
88,82[illegible]	10	1/6	West India and Panama	1¾	1¾	1½	1¾	–	May and November	1¾	1 9/16
34,563	10	6/0	Do. 6 per Cent. 1st Preference	10½	10¾	10¼	10¾	5 11 7	" "	10½	10¼
4,66[illegible]	10	6/0	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	" "	..	–
£80,900	100	5%	* Do. 5 per Cent. Debentures	104	107	104	107	4 13 6	January and July	..	–
64,269	15	6/0	Western and Brazilian Ordinary	11½	12¾	12½	13¾	4 13 2	May and November	..	–
33,121	7½	3/9	Do. 5 per Cent. Preferred Ordinary	8	8½	8	8½	4 8 2	" "	–	–
33,120	7½	1/3	Do. Deferred Ordinary	4	4½	4	4½	–	" "	..	–
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	105	108	105	108	3 14 1	June and December	–	..
1,168,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	–		..	–	6 7 10	Feb., May, Aug., Nov.	–	–
£158,100	100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	98	103	98	103	5 16 6	March & September	..	–

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Jan. 25.	Price Wednesday, Feb. 1.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Feb. 1. Highest	Lowest
			TELEPHONES.						
44,000	£5	4/0	Chill Telephone (fully paid)	2⅜ 3⅛	2⅜ 3⅛	6 3 1	August	–	–
224,850	10/0	1½d.	Consolidated Telephone Const. & Manufacturing	1/16 1/16	1/16 1/16	6 7 0	July	–	–
28,000	5	4/0	Monte Video Telephone 6 per Cent. Preference	..	–	–	October	–	–
490,000	5	3/0	National	5½ 6	5½ 6	5 0 0	February & August	6	5⅝
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	14 16	14 16	3 15 0	" "	15½	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	13 15	13 15	4 0 0	" "	14½	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	5⅛ 5⅜	5⅛ 5⅜	4 5 1	" "	..	..
1,229,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	99 102	99 102	3 8 8	June and December	100½	–
171,504	1	0/4	Oriental	⅜ ½	⅜ ½	6 13 4	April and October	–	–
58,000	5	6/0	United River Plate	4⅜ 5⅛	4⅜ 5⅛	5 14 3	July	..	–
£151,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103 106	103 103	4 14 6	June and December	–	–
			ELECTRICITY SUPPLY COMPANIES.						
100,000	1	–	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (10s pd.)	–	⅜ ⅜	..	–	–	–
6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	12½ 13½	12½ 13½	–	–	12⅜	–
6,000	10	6/3⅝	Do. 4½ per Cent. Cumulative Pref.	10⅜ 11½	10⅜ 11½	4 4 0	–	11½	–
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	11 12	11 12	2 18 4	February & August	11⅜	–
20,000	5	2/3	Do. 4½ per Cent. Preference	6 6⅛	6 6⅛	3 9 3	" "	–	–
£34,000	5	2/6	Chelsea Electricity Supply Ordinary	8½ 9½	9 10	3 0 0	March	9½	–
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	113 115	113 115	3 18 3	June and December	..	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red)	103 105	103 105	4 15 8	..	..	..
50,000	10	5/0	City of London Elec. Lighting Ord. 40,001 to 90,000	23½ 24½	23½ 24½	5 2 1	February & August	25⅜	23⅝
10,000	10	1/9	Do. Ordinary 90,001 to 100,000	23 24	23 24	..	..	..	..
40,000	10	6%	Do. 6% Cumulative Pref.	15½ 16½	16½ 16½	3 12 9	January and July	..	–
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	125 130	125 130	3 18 11	June and December	–	..
30,000	10	–	County of London & Brush Prov. Ord. (1 to 30,000)	12½ 13½	12½ 13½	–	–	13⅜	13
10,000	10	..	Do. (30,001 to 40,000)	12 13	12 13	..	–	..	–
20,000	10	6/0	Do. 6% Cumulative Preference	14½ 15½	14½ 15½	4 0 0	March & September	14½	–
15,660	5	2/6	House-to-House Electric Lighting Supply Ord.	9 10	9 10	2 0 0	–	–	–
12,000	5	3/6	Do. 7 per Cent. Preference	9½ 10½	9½ 10½	3 6 8	March & September	–	–
15,000	5	10%	Kensington and Knightsbridge Ord. xd	13 14	13 14	3 18 7	..	–	–
10,000	5	6%	Do. 6% 1st Pref. xd	7⅞ 8½	7⅞ 8½	3 12 9	January and July	..	–
110,000	3	–	London Electric Supply Ordinary	3⅞ 4	3⅞ 4⅛	–	–	4⅛	3⅞
48,050	5	–	Do. Preference	6½ 7	6½ 7	–	–	6⅝	6½
£100,000	Stock	..	Do. 4% 1st Mort. Deb.	102 104	103 105	3 16 2	Mch., June Sept., Dec	104⅛	104
62,500	10	5/0	Metropolitan Electric Supply Ordinary	19 20	19 20	3 0 0	April and October	20	19½
27,500	10	–	Do. (£4 paid)	12 13	12 13	..	–	..	..
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	118 121	118 121	3 14 7	June and December	121	–
6,452	10	6/0	Notting Hill Electric Ordinary	17 18	17 18	3 6 8	March	–	–
10,000	5	–	Oxford Electric Ordinary	6½ 7	6¾ 7½	..	–	–	..
275,000	1	–	Rand Electric	–	1 1⅛	–	..	–	..
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb	83 91	86 91	5 9 1	–	–	–
150,000	$100	$2	Royal Electric Company of Montreal Shares	180 189	180 189	4 9 5	–	..	–
130,900	100	4½%	* Do. 4½% 1st Mort. Debs.	105 107	105 107	4 5 10	April and October	..	..
31,980	5	5/0	St. James and Pall Mall Electric Ordinary	17 18	17 18	4 9 0	February & August	17⅝	17⅛
20,000	5	3/6	Do. 7 per Cent. Preference	9 10	9 10	3 10 0	" "	9⅛	–
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.)	.. ..	.. ..	..	June and December	..	–
65,000	5	..	South London Electric Supply Ordinary (£3 paid)	3 3⅛	3⅜ 3⅝	..	..	1⅛	3⅜
79,900	5	5/0	Westminster Electric Supply Ordinary	15½ 16½	15½ 16½	3 18 9	March & September	16	15⅛
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
90,000	2	1/2⅜	Brush Electrical Engineering	1⅞ 2⅛	1⅞ 2⅛	2 16 5	–	1⅞	1⅞
90,000	2	1/2⅜	Do. 6 per Cent. Pref. Non-Cumulative	2⅛ 2⅜	2⅛ 2⅜	5 1 1	–	2⅜	2⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	111 115	111 115	3 19 0	February & August	–	–
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101 104	101 104	4 6 7	June and December	–	–
£20,000	5	5/0	Callender's Cable Construction	9½ 10½	9½ 10½	6 8 7	" "	10½	–
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	110 113	110 113	3 19 8	November and May	..	–
300,000	1	9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛ 1⅜	1⅛ 1⅜	5 16 5	–	1⅜	–
50,000	1	–	Chadburn's Ship Telegraph Ordinary	1⅛ 1⅜	1⅛ 1⅜	–	–	..	–
50,000	1	7½d	Do. 6 per Cent. Cumulative Pref.	1 1⅛	1 1⅛	4 16 0	–	–	–
32,098	3	1/6	Crompton and Co. (Nos. 1 to 32,098)	2½ 3	2⅝ 3	5 0 0	–	–	–
£82,850	100	5%	* Do. 5% First Mort. Deb. (red.)	94 99	98 101	4 19 8	January and July	–	–
99,261	5	2/1½	Edison and Swan United ("A" Shares) (£3 paid)	2½ 3	2½ 3	6 13 9	February & August	2½	–
17,139	5	3/1½	Do. (£5 paid)	4 5	4 5	6 0 0	" "	..	–
£194,023	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	97 99	97 99	4 1 0	June and December	99	98½
17,400	5	5%	Edmundson's Electric. Corporation Ord (fully pd.) xd	5 5½	5 5½	4 10 11	Half-yearly	5⅜	–
112,100	2	1/2⅜	Electric Construction Co. (Limited) xd	2½ 2⅝	2½ 2⅝	4 12 0	January & July	2⅝	–
25,000	2	2/9⅛	Do. 7 per Cent. Cumulative Pref.	3 3½	3 3⅛	4 0 0	July	3⅛	–
£140,000	Stock	4%	Do. 4% First Mortgage Deb. (red.)	103 105	103 105	3 16 2	January and July	104½	–
91,196	1	–	Elmore's Patent Copper Depositing	¼ ½	⅜ ⅝	..	–	–	–
12,500	10	8/0	Henley's Telegraph Works Ordinary	24 25	25½ 25½	5 2 0	February & August	25½	24⅝
3,000	10	7/0	Do. 7 per Cent. Preference	18½ 19½	18½ 19½	3 11 10	" "	–	–
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110 115	110 115	3 18 3	" "	–	–
60,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21 23	22 23	4 6 11	" "	22⅞	22½
300,000	100	4%	Do. 4% First Mortgage Debentures (red.)	102 106	102 106	3 15 6	March & September	–	..
37,350	12	12/0	Telegraph Construction and Maintenance	37 41	37 41	4 6 2	March and July	39⅜	..
£150,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	.. ..	.. ..	..	January and July	..	..
£19,400	5	..	Do. Manufacturing Ordinary	8½ 9	8½ 9	–	–	–	–
13,470	5	..	Do. 5% Cum. Pref.	5½ 6	5½ 6½	4 0 0	–	..	–
£90,000	5	4/0	Williams and Robinson Ordinary	8¼ 8½	8¼ 8½	4 11 5	April and October	8⅝	–
£30,000	5	3/0	Do. 6% Cumulative Preference	6¾ 7¼	7 7⅛	4 0 0	" "	7⅜	6⅞
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	106 108	106 108	3 18 8	May and November	–	–
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	..	Blackpool and Fleetwood Tramways	23 24	20 21	..	–	–	–
25,000	10	6%	Bristol Tramways and Carriage	21½ 22	21½ 22	2 14 7	–	..	–
25,000	10	6%	Do. (£7. 1s. paid)	18⅜ 18⅝	18⅜ 18⅝	1 14 1	–	–	–
£90,410	Stock	4%	Do. 4% Debenture	120 121	120 121	3 6 2	–	–	–
80,000	10	..	British Electric Traction Ordinary	17⅛ 18⅛	17½ 18½	..	–	18	–
10,000	10	2/4 7/8	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm.pd.)	13½ 14	13½ 14	4 5 9	–	..	–
£100,000	Stock	6/2 3	Do. 5% Perp. Deb.	119 121	120 122	4 2 4	–	120½	120½
40,000	5	..	Buenos Ayres & Belgrano 6% Cum. Pref. (£3 paid)	2½ 3½	3⅛ 3⅜	..	–	3⅜	3½
27,500	5	..	Do. do. do. (fully paid)	3⅜ 4½	3½ 4½	..	–	..	..
£260,000	Stock	..	Do. do. 5% Deb.	105 109	105 109	4 12 0	..	107½	10.½
£35,250	10	3/0	Central London Ordinary	9½ 10½	9⅞ 10¼	2 18 6	June and December	10⅜	9⅛
178,303	10	1/9⅜	Do. (£8 paid)	7⅜ 8½	7⅜ 8½	2 13 2	" "	–	–
£620,000	Stock	2½%	City and South London Railway Con. Ordy.	69 71	69 71	2 17 2	January and July	70½	69½
22,500	10	..	Do. Ordinary (£4 paid)	3½ 4	3½ 4	..	..	¼	–
9,251	10	5%	Do. 5% Perpetual Preference	14½ 15½	14⅛ 15½	3 4 6	January and July	–	–
£187,701	Stock	4%	Do. 4% Perpetual Debenture	133 135	133 135	2 19 7	May and November	..	..
20,000	10	6%	Imperial Tramways Ordinary (old £6 shares	18½ 18¾	20½ 21	2 17 2	March & September	21	19
10,000	10	6%	Do. 6% Preference	15½ 15¾	15⅞ 16	3 15 0	" "	16	15½
£70,000	Stock	4½%	Do. 4½% Debenture	118 119	118 119	3 15 8	..	..	–
87,500	10	3%	Liverpool Overhead Railway Ordinary	10⅜ 10⅝	10½ 10⅝	3 1 11	February & August	–	–
10,000	10	5%	Do. 5% Preference	14½ 15½	14½ 15½	3 5 7	" "	–	–
168,000	Stock	4%	Do. 4% Debenture	106 108	106 108	3 14 1	January and July	–	–
20,000	5	3,3⅛	New General Traction 6% Cumulative Pref	4⅜ 5½	4⅜ 5½	5 14 3	–	–	–
£540,000	Stock	3%	Waterloo and City Ordinary	108 111	109 112	2 15 1	June and December	111	110⅜

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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CONTENTS OF THE CURRENT NUMBER.

Notes	523	Reviews	537
Meetings of Scientific Societies	526	The Le Sueur Process for the Electrolytic Production of Alkali and Chlorine. Illus.	539
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe. Illustrated	527	The Paris-Aubervilliers Electric Tramway	540
Induction Motor Diagrams. By C. C. Hawkins, M.A. Illus. Continued	528	Electric Inter-communication in Railway Trains. By W. E. Langdon. Illustrated	540
A New Air-Space Telephone Cable	529	New Works of Messrs. Williamson and Joseph, at Canonbury. Illustrated	543
Effects of Prolonged Heating on the Magnetic Properties of Iron. By S. R. Roget, B.A. Illustrated	530	Nernst's Electric Light. By James Swinburne	545
Rules for the Regulation of the Wiring of Premises for Connection to Public Supply Mains. By J. Pigg. Illus.	531	Correspondence	547
Electrolytic Alkali and Bleach	536	Legal Intelligence	547
		Trade Notes and Notices	548
		Companies' Meetings & Reports	554
		New Companies, &c.	556
		City Notes	558

NOTES.

Mr. James Swinburne's Paper on "Nernst's Electric Light," read at the Society of Arts on Wednesday evening, was, with justice, considered by many present to be a landmark in the history of electric lighting. Brief particulars have already been published as to the principle of the Nernst lamp and of the description of it in the fundamental patent (see *The Electrician*, Vol. XL., p. 614, and Vol. XLI., p. 672), but on Wednesday some samples of these lamps fed from the public supply mains were exhibited for the first time in public. A reprint of Mr. Swinburne's paper will be found in another column, and it seems probable that we may expect at any rate a high candle-power lamp to be placed on the market shortly. Such a lamp, with its efficiency of at most 1·5 watts per candle power, would probably far out-distance both the large glow lamp and the Welsbach gas lamp, and be a keen competitor to the arc. For domestic lighting the Nernst lamp should also have a future, but here first price will play an important part. Mr. Swinburne's suggestion may be acted on, that one might use a single automatically lighted lamp in each room, controlled from a switch near the door, the other lamps in the room being of the cheaper pattern lighted by a match or spirit-lamp; but it would be simpler and cheaper to have an ordinary carbon-filament lamp as a "pilot" lamp, which could be turned out again as soon as the Nernst lamps were in operation. For bedrooms, &c., where lamps are only used for short periods of time, the carbon-filament lamp will no doubt continue to hold its own.

As regards the deterioration and replacement of the rods in the Nernst lamp, if Mr. Swinburne's assurance that the rods will last 500 hours be borne out in practice, there need be no fear on this score, as the renewals will cost very little. With regard to the relative merits of the lamp on alternating and continuous-current circuits, however, Mr. Swinburne was very reticent. The samples shown at the meeting were connected to the alternating-current mains, and Mr. Swinburne merely said that the lamp would work with continuous currents. It appears, however, that electrolysis must take place, and that, therefore, in the continuous-current lamp more frequent renewals would be necessary. A possible explanation of the duration of the magnesia rods in this case may be that the product of electrolysis, magnesium, is immediately oxidised on its coming into contact with the air, and that owing to the high temperature the newly-formed magnesia is carried back along the rod by the diffusion which Mr. Swinburne stated takes place. This would explain the inability of the continuous current lamp to burn in a vacuum, as alluded to by Mr. Swinburne in his reply to the discussion.

The introduction of the Nernst lamp, Mr. Swinburne thinks, may enable a wider range of pressure variation to be permitted on supply networks, and so revolutionise central station design. We are of opinion, however, that even if the carbon-filament lamp were a thing of the past, the Board of Trade would still sufficiently consider the makers and users of motors, arc lamps, and meters to relax nothing in their regulation for the maintenance of constant pressure. But by the time the carbon-filament lamp is no more there may no longer be a Board of Trade.

The Chairman of the Manchester Electricity Committee, Mr. Alderman Higginbottom, exhibits wisdom and prudence in his preference for the trolley as opposed to the conduit system of electric traction for Manchester tramways. In a recent discussion on Mr. Parshall's Paper before the Royal Society of Electrical Engineers, Mr. Higginbottom, Mr. Wordingham and other speakers touched upon several reasons why this choice, at the present juncture, is a judicious one; but the principal reason was not brought out as clearly as it might have been. It is this: Successful as the conduit system undoubtedly has proved in many places, it has by no means attained its limit of perfection; in every new conduit line important structural improvements are introduced. To put the conductors underground now—instead of waiting for

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the time predicted by Mr. FERRANTI, when they will be compelled to go underground, as telephone and electric light conductors have been—would commit the tramway authorities to a costly system that it might be impossible to adapt to any radical improvement in the future. On the other hand, the trolley system is sufficiently far developed to offer a serviceable and effective system of traction, while its cheapness of construction would render of no serious moment, financially the conversion to a better system later on, The non-arrival of the perfect conduit, however, need not delay matters nor frighten the timorous; the overhead trolley is amply sufficient for present needs.

IT has been suggested to us that a conference between delegates of municipal authorities and companies might lead to a satisfactory compromise, as regards the exercise of powers for electrical supply. We recognise in the suggestion a laudable desire to rescue the electrical industry from the unprofitable consequences of the prolonged strife portended by the existing attitude of contending parties. At the same time, we fear there may be some difficulty in arriving at a basis of negotiation, without which essential the combatants can only agree to disagree. Concessions, in several important respects, have already been proffered by the companies; it is to be hoped local authorities may reciprocate.

POSSIBLY a basis might be found in the suggestion thrown out by Mr. SYDNEY MORSE during the discussion on municipal enterprise at the Society of Arts, viz., that the statutory limit for municipal trading should now be fixed by Parliament once and for all. It is too late to combat the whole practice of municipal trading, for the reason that to a considerable extent it is already sanctioned by law. At the beginning of the Victorian era it was absolutely illegal for local authorities to make any profit or risk any loss; but, for many years past, this principle of law has been over-ridden by a series of special Acts, and at the present time many industries—*e.g.*, water supply, tramways and lighting—are extensively undertaken by local authorities. The Tramways Act contemplated the acquisition, but not the working, of tramways by local authorities—except where an authority failed to obtain a lessee for its lines; but the Electric Lighting Acts went much further and made provision for the actual working of electric supply undertakings by these authorities, either at first hand or after purchase from a company. This being the present state of affairs, it remains to be settled to what extent municipal trading enterprise is to be allowed to expand, and herein might be found a common ground for conciliatory discussion.

Cable Interruptions and Repairs.—

	Date of Interruption.	Date of Repair.
Para—Maranham	Nov. 15. 1898 ..	Feb. 4, 1899
Dakar Bathurst	Feb. 9, 1899 ...	—

The Royal Society.—Among the Papers down for reading yesterday were:—"On the Reflection of Cathode Rays," by Mr. A. A. C. Swinton; and "On the Recovery of Iron from Overstrain," by Mr. James Muir.

An International Physics Congress in 1900.—The Council of the Société Française de Physique has decided to convene an International Physics Congress at the 1900 exhibition. The date has already been fixed, viz., July 16th to 21st.

Waterloo and City Railway.—Some of the civil engineering features of the Waterloo and City Railway are described in an illustrated article in the *Engineer* of the 27th ult. The electrical features of this railway have already been described and illustrated in *The Electrician*, Vol. XLI., p. 888, and Vol. XLII., p. 365.

Storage Batteries in the United States.—According to the *Electrical World*, there are now in use in the United States about 2,500 tons of storage battery plates. The greatest demand has been from continuous-current central stations, and the largest battery in the States, viz., one in Chicago, weighs 500 tons, and has a storage capacity of over 8,000 Board of Trade units.

Further Development of Niagara Power.—According to the *Electrical World*, of New York, a syndicate has been formed at Buffalo for the purpose of further utilising Niagara Falls to the extent of 30,000 electrical horse-power. A canal about a mile long is to be constructed along the bank of the New York side of the river, and the power-house will be located at the bottom of the cliff, some distance down the gorge. This will necessitate the reconstruction of a considerable portion of the Niagara Falls and Lewiston electric railway, popularly known as the "gorge road."

Proposed Association of School Governors.—It is proposed to form an association of the managers and governors of schools and polytechnics for the working classes in the United Kingdom. Having regard to the interest which is being taken in national education, and the near approach of the time when the Board of Education Bill will be discussed in Parliament, it has seemed an appropriate time for introducing to public notice the proposals which are contained in a document, a copy of which has been sent to us. The headquarters of the Association are at Sevenoaks, Kent.

Society of Engineers.—The first ordinary meeting of the Society of Engineers for the present year was held on Monday evening, Feb. 6, at the Royal United Service Institution, Whitehall. Mr. W. Worby Beaumont, the President for 1898, occupied the chair, and presented the premiums awarded for Papers read during that year. Mr. Beaumont then introduced to the meeting the President for the present year, Mr. John Corry Fell, and retired from the chair. Mr. Fell then proceeded to deliver his inaugural address, dealing principally with matters relating to patent law and practice.

Glasgow Corporation New Electric Supply Works.—With reference to our account of these works in our last issue, our remarks as to the position of the undertaking in 1896 may have led our readers to suppose that nothing had been done to prepare a further scheme for extensions. This, however, is not the case, as a report was drawn up in May, 1896, by the then Corporation electrical engineer, Mr. Arnot, which proposes a scheme practically on the lines of the present scheme which has been adopted by the Corporation, and the two sites that are now being used for the new generating stations were purchased by the Corporation some eighteen months ago. We are also informed that Messrs. Laing, Wharton and Down supplied the Ball and Wood engine and Walker dynamos mentioned in our article.

A Telephonic Coup d'Etat.—The following story is told by the *Electrical Engineer*, of New York:—

This is to tell how Gutierrez lost the presidency of Salvador. General Tomas Regalado had been placed by President Gutierrez in command of the national military forces, stationed in San Salvador, the capital city of the republic. General Regalado knew that the Salvadorians were intensely hostile to the idea of their country being handed over to the schemes of Zelaya and Bruilla, the Presidents of Nicaragua and Honduras respectively, and he saw his chance to bring about a revolution and make himself Chief Magistrate of his country. Having first come to an understanding with his subordinates, General Regalado from the artillery barracks, on the evening of Nov. 14, "called up" President Gutierrez on the telephone, and boldly said to him: "Ya Ud no es Presidente, todos los cuarteles estan conmigo!" ["You are no longer President! All the battalions are in my favor!"] This was enough for Gutierrez, who with a single "Hello," accented acutely on the first syllable, left the presidential palace instanter, fled to Honduras, and yielded place and preferment to his shrewd but unseen interlocutor.

Electric Traction for the New Union Station at Boston.—Electricity is exclusively used not only for lighting purposes but for operating the elevators and lifts—of which there are 19 distributed throughout the various departments—of the

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new Southern Union Railway Station at Boston, U.S.A. *Electricity*, of New York, states that it is now proposed to work the entire suburban railroad traffic into and out of this station by means of electrical power, shunting electric locomotives being employed for the purpose. The power house associated with this railway station is a two-storey brick building, 369ft. long and 40ft. wide. Here is generated the current that supplies no less than 6,000 glow lamps and 235 arc lamps, beside the power for the passenger and goods elevators. The generating plant is divided into four direct-coupled multipolar Westinghouse continuous current generators.

Power-Brakes for Street Cars.—We learn from the *Electrical Engineer*, of New York, that the New York State Railroad Commission is making an effort to secure power-brakes for surface electric street cars, on which class of car there is used at present the ordinary hand-brake. With the increased rates of speed and the weight of the street cars now in operation, the Commission considers the brakes in use insufficient. The reason why the street cars have not been fitted with power-brakes is because no brake of that character has yet been invented which meets the necessary requirements. In order, therefore, to secure, if possible, some invention which will approach the required standard, the State Railroad Commission has sent out inventions to all persons interested in power-brakes to participate in a test of brakes of this character. These tests, which will be made in New York, on one of the lines of the Metropolitan Street Railway Co., will take place probably within the next two months.

Telephoning over Railway Telegraph Wires.—Some trials of simultaneous telegraphing and telephoning have recently been made over the telegraph wires of the Chicago Great Northern Railway Co. The *Railway and Engineering Review* announces that the experiment was made, under very adverse conditions, on one of the regular No. 9 gauge iron telegraph wires, stretched over a distance of 52 miles. Notwithstanding the disturbances from high voltage light and power currents, and the fact that the wire on which the trial was made was among a number of other telegraph wires on the same poles, the experiment is stated to have been in every way successful. It was found that the noises produced by the telegraph signals and other currents in the circuit could not be entirely eliminated where a single wire and grounded circuit was used, but it is thought with a complete metallic circuit the conditions would be decidedly more favourable. The experiments were merely made to demonstrate the feasibility of the scheme and its utility for general use in emergencies.

Obituary.—We regret to record the death, on January 31st, suddenly from heart disease, of Mr. W. G. Forster, at the age of 54. After serving ten years in the Electric Telegraph Company, Mr. Forster entered the service in 1868 of the Anglo-Mediterranean Co. (afterwards amalgamated into the Eastern Telegraph Co.), and after being stationed some time at Florence, was placed in charge of the Company's clearing house, first at Malta and subsequently in London. He was afterwards appointed superintendent at Zante, where he made a study in his leisure of Levantine seismography, and became an authority also on the subject of earth currents. In 1894 he was appointed superintendent at Manchester, and in the same capacity was transferred to Cadiz in 1895 and to Aden in 1897, being at the time of his death at home on leave. He was a well-known figure in the service, and leaves a wide circle of friends to regret his loss.——We regret also to record the death of Mr. Hugh Ross McDonald on January 30th, at the age of 65. Mr. McDonald entered the accountant's office, in London, of the Eastern Telegraph Co., in 1878, and retired from the service in June, 1898.

The "Meissner" Electric Rock Drill.—A good deal of interest, says *The Engineering and Mining Journal*, has been felt in the "Meissner" electric rock drill, on account of the fact that the motor is separate from the drill itself, and can be transported separately, the connection between motor and drill being made by a flexible shaft. Power is transmitted from the electric motor through gear wheels at a reduced speed to a flexible shaft, which is connected by means of a coupling with the shaft of a bevel wheel, gearing with another bevel wheel which carries a flywheel. This flywheel in turn imparts to the plunger the necessary reciprocating motion. An automatic device for feeding the plunger forward to its work is fitted to the apparatus. In view of the necessity for using the drill at different heights and angles an arrangement is provided which permits the drill to be connected to the flexible shaft without necessitating too sharp bends in the latter. It will be seen by the above that it is possible to employ an electric motor of the highest speed and, therefore, of the highest efficiency.

Electrical Utilization of the Chicago Main Drainage Tunnel.—The Chicago City electrician has presented a definite scheme providing that the water power available from the new drainage canal should be utilised for an electric power station for the city lighting, which is now run from three municipal steam-power stations. The following figures are given in the electrician's report:—There are now in use 2,981 arc lamps, of which 2,450 are run from the municipal stations. Coal for these costs 8s. 4d. per ton, making the full item a large proportion of the total expenses per lamp, this total being nearly £14 per annum. To light the city properly by arc lamps would require altogether 13,000 lamps, necessitating about 13,000 H.P. at the water power station at Joliet. Assuming the hydraulic power to be available at £3 per horse power year, as against £9 for the steam power now used, a considerable saving is anticipated. It is estimated that with an expected flow of 600,000 cubic feet of water per minute between Lockport and Joliet, 60,000 H.P. was available. If put into effect, this scheme would be the largest municipal electric lighting undertaking in the United States.

Refrigerating Plant for Central Station Day Loads.—Efforts are being made by American central station managers to flatten their load curve in various ways, the difficulty of the peak being nearly, if not quite, the same as in this country. Owing to the large consumption of ice, especially during summer, in the United States, the driving of refrigerating machinery affords a very good opening for day load supply. The January number of the *American Electrician* contains an illustrated description of the electrical equipment of a refrigerating plant in New York. The building is large and capacious, and the lighting, ventilating and elevating power is entirely electrical, as also is a considerable amount of the pumping. The power plant, situated on the ground floor, includes three 150 H.P. tubular boilers, which drive two generating sets, each consisting of a simple horizontal engine direct-coupled to a General Electric multipolar compound-wound 250-volt generator. The dynamos are of 50 and 75 kilowatt capacity respectively, and the power is distributed from them to the motors which work the various plants. The refrigerating pumps are operated in pairs, each by a 20 H.P. belted multipolar General Electric motor.

Defects of Metric Screw Thread Systems.—From time to time the technical and commercial world is agitated by fresh demands for the adoption by the English-speaking peoples of the metric system, for the sake of uniformity with the practice of other nations. Gas engineers have their own reasons for desiring uniformity, as regards screw connections. It is rather a surprise to learn that, so far as the engineering industries are concerned, the adhesion of England to the metric system would not materially advance the cause of uniformity of screw connections, inasmuch as the European countries which have professed the metric system for many years have not yet been able to agree upon a standard metric screw-thread. Throughout Europe, says the *Journal of Gas Lighting*, there is no assurance that any metric nut will fit any bolt of the same diameter. This is not for any lack of attention to the subject; on the contrary, many such systems have been proposed, and the trouble appears to be that there are too many screw systems rather than too few. Hence, in many large Continental shops the Whitworth screw-thread is used, not only as regards pitch and form of thread, but also for the diameters of bolts; so that, while all the other dimensions of a machine may be in metric units, the bolts and nuts will be in English sizes, and conform to the Whitworth standard. The attempt to secure a standard metric screw-thread system, however, has not been abandoned; but special effort in this direction has been put forward by a

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congress for the unification of screw-threads which has just been held in Zurich. The real difficulty of all metric screw-thread systems is the unsuitability of the millimetre as a unit of progression. Once again, therefore, the paper convenience of the metric system for calculations is proved to be discounted by the awkwardness of the units and their lack of correspondence with practical needs. Consequently, in all metric screw-thread systems the symmetry and logical completeness of the metric notation, so greatly admired by our reformers, are thrown to the winds. There are 16 such systems, all with their adherents, and to these the Zurich congress has added one more. This is practically the Société d'Encouragement thread, with the modification of advancing by half and quarter millimetres in some stages. The pure decimal system is thus abandoned. It remains to be seen whether the new system will be generally adopted. As to this, it is shrewdly remarked that it is easier to get an international congress to adopt a new standard than to induce manufacturers to throw away an old one.

Municipal Trading.—The following letter from Prof. J. A. Fleming on this subject appeared in *The Times* of the 7th inst.:

I trust that the suggestions of Major Flood Page on the subject of municipal trading will not be allowed to pass without practical action of some kind being taken upon them. On the general question of the legitimate limits of municipal trading I will not venture to express an opinion, but having been for the last 18 years somewhat closely connected with electrical manufactuer and enterprise I should like to point out one or two facts connected with the industrial utilisation of electricity which have a bearing on the matter at issue. It appears that some 70 municipalities desire to engage in the manufacture of dynamos, electric lamps, and electric appliances, and to acquire or purchase patent rights over the same. It must not be forgotten that, in the continuous flow of electrical invention, each improvement as it arrives, is the subject of patent protection. At the present time some five or six thousand electrical patents are taken out per annum in Great Britain alone. Hence no municipality can advance very far in electrical manufacture without either infringing or acquiring particular patent rights. These, however, have a very problematical value until tested in the Courts; and every one of the great electrical inventions of the last 20 years has been the subject of long, costly and hazardous litigation between manufacturers. Corporations, therefore, which enter the arena as electrical manufacturers will certainly have to be prepared to speculate in or defend patents at the expense of the ratepayer. The next question which arises is as to the range of manufacture. Is it proposed that municipalities shall manufacture merely for self-consumption or supply other towns as well? Is one town, for instance, to establish a manufactory of electric lamps for its own citizens only or to supply outsiders in addition? It is a simple truism to state that the cost of production depends on the scale of manufacture, and that a municipality producing on a small scale has not a shadow of chance of doing it as cheaply as large and experienced manufacturers having a far greater output. Moreover, it must be remembered that in embarking on electro-technical manufacture a municipality would have to bear the loss of all failures and costly experiments. Under a system of purchase by contract and specification the ratepayers are protected from serious risks in the purchase of such expensive articles as dynamos and engines, but municipal trading would deprive them of safeguards for efficiency without any necessary corresponding advantages. Also it is obvious that highly technical manufacture cannot be conducted by any body of men merely in the light of nature. Hence a municipal committee placed in control over some specialised scientific branch of production would not improbably have to learn its business at the cost of expensive blunders, for which the ratepayers would have to pay. In fact, the ratepayers would become the involuntary shareholders in a practically unlimited liability company, the constantly-changing Directors over the same depending very much for guidance on their own officials. The strongest argument of all, however, against municipal trading is that it would destroy the stimulus to continual invention and improvement which springs from the incessant rivalry due to free and open competition. The private manufacturing firm which does not advance with the times dies. The manufacturing municipality would probably find its greatest safety in going slow. The point which should be emphasised at the present moment is that the risks and speculations of manufacturing enterprise constitute an absolutely different class of undertaking from the urban supply of gas, water and electric current, or even telephone and tramway facilities. These may, perhaps, all be most advantageously managed by the representatives of ratepayers in the common interest, but corporations have less justification for undertaking the risks of electro-technical manufacture than they have for conducting the municipal supply of milk or meat.

Modified Bunsen Cells.—Emil Petersen, of Copenhagen, says *Engineering*, draws attention to some promising modifications of the Bunsen cell. Bunsen placed zinc in dilute sulphuric acid, and, within a porous cell, carbon in concentrated nitric acid. The sulphuric acid may be replaced by a solution of sodium chloride. Neither the electromotive force, nor the internal resistance are affected, as he has proved by experiments, and the zinc need not be amalgamated. A substitute for nitric acid is more difficult to be found. Some of the various oxidising agents tried as depolarisers—potassium permanganate, hydrogen peroxide, lead peroxide suspended in sulphuric acid, &c.—actually give a higher electromotive force than nitric acid; but such combinations are inferior, both in constancy and in current yield. Petersen ascribes this to two causes. Firstly, there is a generation of hydrogen; and, secondly, decomposition products remain in the liquid, an objection which applies also to chromic acid depolarisers. He endeavoured to find a depolariser which should contain no oxygen salt, and whose kation could assume a lower valency under development of positive electricity, or whose anion could assume a higher valency under absorption of negative electricity. Chloride of iron is a liquid of the first class. The combination Zn-NaCl-$FeCl_3$-C has, indeed, been proposed by Buff already; but Petersen was not, at first, aware of Buff's researches, and he has carried the investigation further. The cells have the good properties of Leclanché cells, are most constant, currents of 1 ampere may be drawn for hours, and the electromotive force is high, 1·72 volt; the internal resistance of an ordinary size cell is 0·3 or 0·4 ohm. The electromotive force sinks slowly with the advancing reduction of $FeCl_3$ to $FeCl_2$, and finally the porous cell becomes coated with a grey deposit of iron, which can be removed by means of hydrochloric acid. The combination Zn-NaCl-$FeCl_2$-Fe (hollow iron cylinder) yielded for 72 hours a constant current of 1·2 ampere at 0·537 volt. An emergency cell of high electromotive force, 1·6 volt, can easily be obtained by separating a zinc and a carbon plate by a slab of wood and immersing the plates in iron chloride. The iron chloride undergoes hydrolysis and ferric hydrate settles near the zinc. In order to avoid this, Petersen substituted red prussiate of potash for the iron chloride. This salt is slowly reduced to yellow prussiate, while the electromotive force sinks from 1·438 to 1·105 volt. The internal resistance is about 0·3 ohm, and discharges at 1 ampere may be continued for many hours, Petersen also experimented with Daniell cells. The internal resistance can be diminished by using magnesium chloride instead of sulphuric acid. Sodium chloride is still more efficacious, but the resulting sodium sulphate tends to crystallise and to destroy the porous cell. Inside the porous cell he places a cylinder of sheet lead, perforated above and below, and closed below by copper gauze. When the battery is not used, the clay cell should be taken out and the lead cylinder with its charge of copper sulphate crystals be put in a solution of copper sulphate.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, February 10th.

PHYSICAL SOCIETY.

5 p.m. Annual General Meeting in the Rooms of the Chemical Society, Burlington House, W. Address by the President. At the Ordinary Meeting which follows, a Paper on "An Ampere-Meter and a Volt-Meter with a Long Scale," by Benjamin Davies, will probably be read by Dr. Oliver Lodge.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. Annual General Meeting at the New Institution Building, Storey's Gate, St. James's Park. Among the Papers down for reading is one by H. G. V. Oldham, on "Evaporative Condensers."

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read, "The Electrical Driving of Engineering Workshops," by W. Middleton.

ROYAL INSTITUTION.

9 p.m. Evening Discourse, "The Motion of a Perfect Liquid," by Prof. H. S. Hele-Shaw.

SATURDAY, February 11th.

INSTITUTION OF ELECTRICAL ENGINEERS.

2:30 p.m. Students' visit to the Shoreditch Central Station, Coronet-street, Shoreditch. Party limited to 20.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture on "The Mechanical Properties of Bodies," by the Right Hon. Lord Rayleigh, F.R.S.

WEDNESDAY, February 15th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "The Balloon as an Instrument of Scientific Research," by the Rev. J. M. Bacon.

THURSDAY, February 16th.

CIVIL AND MECHANICAL ENGINEERS SOCIETY.

7:30 p.m. Meeting at the Hotel Victoria, Northumberland-avenue, S.W. Paper to be read: "Electric Tramways," by M. Holroyd Smith.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Paper to be read: "Electric Traction by Surface Contacts," by Miles Walker.

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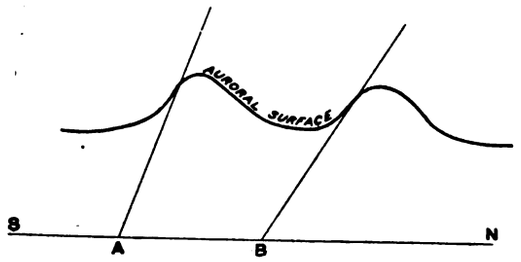
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Interference of Cathode Rays.—That there are still some valiant defenders of the wave-theory of cathode rays is proved by G. Jaumann's Paper on their "interference," which covers 100 closely printed pages and brings a large mass of material and argument in favour of what we are accustomed to consider the expiring theory. Like another Young or Fresnel, he bases his main argument on the action of one beam of cathode rays upon another beam. They not only produce, as the author showed some years ago, a bright surface where they coincide, but they produce a dark surface where their opposite phases encounter each other. This surface is displaced by changing the lengths of the connecting wires of the two cathodes, a circumstance which suggests that the waves producing them are longitudinal. Hence the expression, "longitudinal light," formerly heard a good deal in connection with the theory of Röntgen rays. The author even succeeds in making the black interference surface travel across the space between the two cathodes, by altering the length of one of the wires, and on still further altering it, another dark surface, corresponding to the next whole phase, travels across in the same manner. He calculates the velocity of the cathode rays as something between $\frac{1}{300}$th and $\frac{1}{3000}$th of the velocity of light, or about 100 to 1,000 times less than the greatest accepted value. The author appears to have a very poor opinion of the advocates of the prevailing theory.

[Jaumann, *Sitzungsberichte*, Vienna, October, 1898.]

Altitude of the Aurora.—Cleveland Abbe has completed a valuable and exhaustive investigation of all the methods hitherto used for determining the height of the auroral



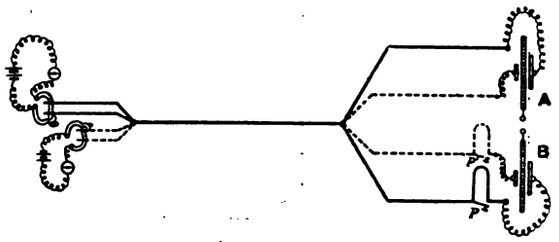
display above the earth's surface. The most remarkable fact brought out is that the best observations give impossible results, in the shape of negative parallaxes. Thus, an observer stationed a few miles south of another, and fixing his theodolite upon the same arch, sees that arch a little higher above the horizon than the northern observer, though sometimes he sees it lower, or at the same altitude. The author is forced to the conclusion that the aurora, like the rainbow, contains something of an optical illusion, and he frames an ingenious theory based upon atmospheric phenomena analogous to lightning discharges. He supposes that the discharges occur comparatively low down in the atmosphere, at the surfaces separating moist from dry air currents. These surfaces are folded or crinkled, as proved by balloon observations, and when the observer looks along a tangent to one of the surfaces he sees a bright line, perspectively curved into an arch. Another observer at a distant station may see the same appearances, but may be observing an entirely different arch, as shown in the diagram. This explanation would also account for the connection between clouds and auroras. It could be verified without much difficulty.

[Abbe, *Terr. Mag.*, December, 1898.]

Röntgen Rays and Spark Discharges.—Whatever may be the differences in the ultimate nature of Röntgen rays and ultra-violet light, they have certain characteristic properties in common. They are both capable of ionising gaseous molecules, and of reducing the discharge potential of a spark. The precise effect produced upon spark discharges by Röntgen rays has been lately made clear by H. Starke. He studied what is called the static discharge potential, *i.e.*, the small difference of potential which, when applied to the spark-gap, produces discharge within 4min. For one gap the discharges occurred with various retardations at 8,800, 4,000 and 4,500 volts. When either one or the other terminal was struck by a beam of Röntgen rays, discharge occurred at once, and at a uniform potential of 3,800 volts. It is curious to note that ultra-violet rays must illuminate the cathode to produce any effect, whereas Röntgen rays are indifferent as to sign. This indicates an important difference. Probably the Röntgen rays in themselves are not effective at all, but develop some other kind of radiation where they impinge, and that radiation strikes the cathode. The author does not find that any effect remains after the impact of the radiation has ceased, either in the case of X-rays or of ultra-violet light.

[H. Starke, *Wied. Ann.*, No. 13, 1898.]

Hertzian Wire Telegraphy.—A. Turpain has solved the following problem: Given several stations A, B, C, . . L, N, distributed along a single wire AN, to find an arrangement permitting simultaneous telegraphic or telephonic transmission between any two stations on the single line. This is solved by means of Hertzian waves "concentrated" by two wires, or even by a single wire. The general plan is shown in the diagram, designed for two different receiving stations. A and B are two equal oscillators, which compensate each other under ordinary circumstances, when the bridges p and p' are closed. But when one or both the bridges are broken, one or both of the distant resonators respond. Practice shows that separate wires are not necessary, as long as the circuits are separated for a short length at each end, and the lengths at the receiver end are equal to half the wavelength of the corresponding oscillator. Experiments with the "multi-communication" so designed were carried out at Bordeaux-les-Chartrons with complete success.



Some messages were received by means of resonator sparks, others by telephone and Morse recorder, using gapped resonators. The length of the time was 170 metres, and none of the ordinary careful insulation was found to be necessary.

[Turpain, *Comptes Rendus*, No. 26, 1898.]

Coherers.—That coherers are not suitable for simple Hertzian wave experiments is attributed by O. Behrendsen to the fact of their extreme sensibility. By avoiding all single-wire lengths, using only parallel outward and return wires close together, as in telephone circuits, and reducing the sensibility of the coherer, the author has succeeded in making the coherer available for all the fundamental Hertzian experiments. Thus for the classical experiment showing the reflection of electromagnetic waves by a metallic wall, he uses a coherer made of powdered and sifted arc carbons, which always has a finite resistance, and moreover alters its resistance step by step, according to the strength of the impinging wave. The coherer used is of 2mm. internal diameter, and the carbon is loosely packed between silver terminals. A very pretty experiment is also described by the author as illustrating the diffraction of electric waves. A small nickel coherer is mounted at a distance of 15cm. behind a sheet of tinfoil containing two horizontal slits 8cm. long and 3mm. wide, 1cm. apart. On working a small Rubens exciter with a Holtz machine, four metres on the other side of the tinfoil, the coherer reacts when in a horizontal position. On raising or lowering it by 1cm. the coherer ceases to react, thus indicating a "dark" interference line. A further displacement reveals a bright space followed by another dark line.

[Behrendsen, *Wied. Ann.*, No. 13, 1898.]

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INDUCTION MOTOR DIAGRAMS.

BY C. C. HAWKINS, M.A.

(Continued from page 468.)

If the primary windings were of very low ohmic resistance, so that the C.R. drop and the copper losses in the field were negligible, then, on our assumption of no magnetic leakage, the back E.M.F. induced in one primary circuit and the impressed E.M.F. per primary circuit would at all loads be in phase and equal and opposite to each other. Further, if there were no hysteresis or eddy currents in the field and no losses in the armature—*i.e.*, in an ideal induction motor—the only current at no load would be the magnetising current, and this would lag 90deg. behind the impressed E.M.F., so that it would be entirely wattless (Fig. 7). The operation of magnetising iron is, however, always accompanied by a certain loss of energy from magnetic hysteresis, and hence the actual magnetising current required to give a simple sine wave of magnetism or induced E.M.F. is not itself a simple sine wave having the same phase as the magnetism and in quadrature with the induced E.M.F. It is, in fact, a distorted wave, unsymmetrical on the two sides of each half-period, and though it reaches its maximum when the magnetism is a maximum, it passes through zero several degrees ahead of the zero value of magnetism. Thus, on the whole, it has a component in phase with the E.M.F., and power is thereby absorbed. The effect of hysteresis may, therefore, be taken into account by resolving the actual wave of magnetising current into two components—viz., a sine wave of equal effective value and of equal power to the distorted wave, and a wattless wave of higher frequency, which is superposed on the former, and which, as it is wattless, may be neglected. So long as magnetic saturation is not approached, and especially if there be an air-gap in the magnetic circuit, the maximum value of the equivalent sine wave is nearly the same as the maximum value of the actual distorted wave of magnetising current. From the data of the magnetic circuit the maximum value of the actual magnetising current can be calculated for any given number of lines; hence from this value we easily derive the effective value of the equivalent sine wave, which we will now call the magnetising current C_μ. This sine wave is in advance of the magnetism by a certain angle, β', and so lags behind the back E.M.F. by an angle, $90° - \beta'$; thus, it has a component, $C_\mu \cos(90° - \beta') = C_\mu \sin \beta'$, in phase with the back E.M.F. e, and power is absorbed by it to the amount $eC_\mu \sin \beta'$.

In Fig. 8 let the phases of magnetism and of back E.M.F. in quadrature with it be represented by the two lines OM and Oe for a given effective value of E_i or e, say 100 volts per primary circuit; let the effective value of the magnetising current required from each of the primary circuits to produce the necessary strength of field be, as in Fig. 7, $C_\mu = 26{\cdot}3$ amperes. Let $\frac{w_h}{m}$ = the loss by hysteresis in the field per primary circuit, its value being calculated from the volume of iron in the magnet, frequency and induction, and m being the number of circuits or phases. Then $e \cdot C_\mu \sin \beta' = \frac{w_h}{m}$ = say 888 watts, whence we find $\beta' = 8{\cdot}5$deg. The only difference, therefore, between Figs. 7 and 8 is that the magnetising current has been brought more into phase with E_i, the angle of lag being 81·5deg. instead of 90deg. If C_μ be resolved into two components, $C_\mu \sin \beta' = g_h e$ and $C_\mu \cos \beta' = be$, we obtain two coefficients, g_h and b, which, when multiplied by the E.M.F., give respectively the power component and wattless component of the magnetising current. The former coefficient is called by Steinmetz the effective hysteretic conductance, and the latter the effective susceptance, the square root of the sum of their squares being the admittance $y = \sqrt{g_h^2 + b^2} = \frac{C_\mu}{e}$. Hence from C_μ and e, and our estimate of the hysteresis loss $\frac{w_h}{m} = g_h e^2$, we can at once find $\sin \beta' = \frac{g_h}{y}$, where β' is the hysteretic advance of phase.

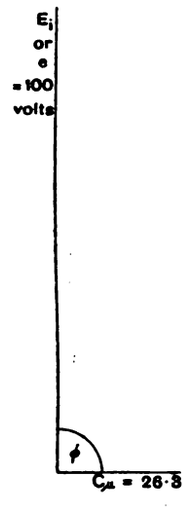

Fig. 7.—Ideal Motor with no losses at no load. $\phi = 90°$

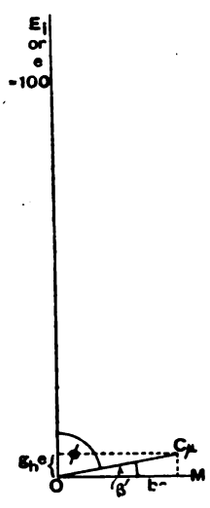

Fig. 8. — Motor with hysteresis loss only. $\phi = 81{\cdot}5°$. $\beta' = 8{\cdot}5°$

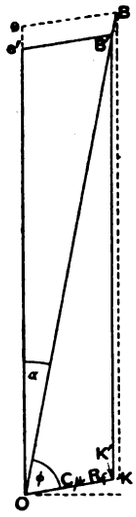

Fig. 9.—Motor with hysteresis and copper losses. $\phi = 70{\cdot}8°$. $\alpha = 10{\cdot}7°$. $\beta' = 8{\cdot}5°$

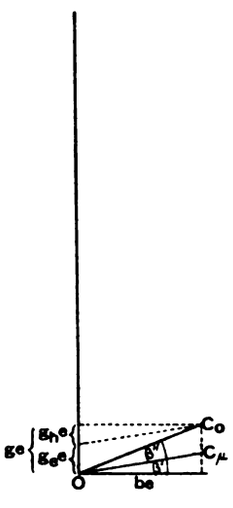

Fig. 10.—Motor with hysteresis, copper and eddy losses. $\beta = \beta' + \beta'' = 8{\cdot}5° + 11{\cdot}5° = 20°$

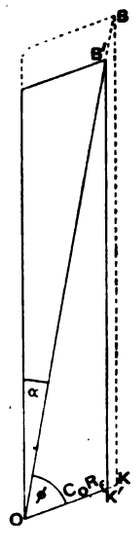

Fig. 11.—No-load diagram with no armature losses. 1,000 revs. $\phi = 59{\cdot}7°$. $\alpha = 10{\cdot}3°$. $\beta = 20°$

We next have to consider the effect of ohmic resistance in the primary, or R_f = say 0·75 ohms. Taking the same values or the back E.M.F. and magnetising current—viz., 100 volts, and 26·3 amperes—the drop of volts by the passage of the magnetising current over the resistance of the primary is $C_\mu R_f = 26{\cdot}3 \times 0{\cdot}75 = 19{\cdot}7$ volts. Now the impressed E M.F. must be the resultant of $C_\mu R_f$ and e, these being inclined to each other at an angle $90° - \beta'$ (Fig. 9). Hence plot $C_\mu R_f$ along the line of magnetising current, and from its extremity erect the perpendicular $KB = e$. Join OB; then OB must give the value and phase of the impressed E.M.F. when $C_\mu = 26{\cdot}3$ and in our case = 104·9 volts. But the impressed E.M.F., which is actually to be applied is 100 volts; hence the diagram requires correction. The relation between field and magnetising current may be assumed to be one of proportionality, since the iron in induction motors is worked at a low density. If, therefore, we mark off on OB a length $OB' = E_i = 100$ volts and draw the similar parallelogram OK'B'e', we find the corresponding actual values of C_μ R_f and e, viz., 18·8 and 95·5. The effect of ohmic resistance is therefore to bring the impressed E.M.F. more into phase with the current, since it now falls behind the back E.M.F. by an angle $\alpha = 10.7$deg. Since $\beta' = 8{\cdot}5$deg., the angle of lag between E_i and C_μ is reduced to $\phi = 70{\cdot}8$deg. The projection of C_μ on the line of impressed E.M.F. gives the active component $C_\mu \cos \phi$ which supplies the loss by ohmic resistance and hysteresis. It will be observed that the corrected diagram further assumes that the

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hysteretic conductance g_h is constant; so that the loss by hysteresis is now $g_h e^2 = \cdot0388 \times 95\cdot5^2 = 354$ watts, and this assumption, though not absolutely true, is so nearly correct within a wide range of variation that it is justifiable. In a magnetic circuit broken by an air-gap $\frac{1}{100}$ of its total length, the admittance, y, is practically constant, if the iron is not approaching saturation. Hence $\sin \beta' = \frac{g_h}{y}$ may be taken as constant. The angle α is such that $E_i \sin \alpha = C_\mu R_f \cos \beta'$, and the values of both back E.M.F. and magnetising current bear to their values in the resistance-less motor the ratio of $\frac{E_i \cos \alpha - C_\mu R_f \cos (\phi + \alpha)}{E_i}$.

Lastly, we have to take into account the eddy-currents set up in the magnet by the rotating field. For a given value of field and frequency, an estimate is made of the loss of power in eddy-currents, and let the value of this per primary circuit be $\frac{w_e}{m}$ = say, 562 watts when $e = 100$. These eddy-currents demagnetise the field, and must therefore be balanced by a corresponding component of the primary current $= \frac{w_e}{e} = 5\cdot62$ amperes. Their phase is the same as that of the back E.M.F., which is also due to the same field, and hence this component must be plotted upwards from O along Oe. In Fig. 10 let $g_e e$ = the eddy-current component = 5·62; compound this with the magnetising current $C_\mu = 26\cdot3$, and we get as their resultant $C_0 = 27\cdot7$, which is the total no-load primary current (when $e = 100$ volts) if the armature has no losses, and so runs at the speed of synchronism. Its angle of advance ahead of the magnetism is $\beta' + \beta'' = 20$deg. In order, therefore, to complete the diagram, draw the line of no-load primary current 20deg. ahead of the magnetism (Fig. 11), and on it mark off a length $= C_0 R_f = 20\cdot8$ volts, and at its extremity erect the perpendicular KB $= e = 100$. Join OB; then OB must give the value and phase of the impressed E.M.F. when $C_0 = 27\cdot7$ and $e = 100$, and in our case = 109 volts. As before, the diagram must now be reduced in the proportion of 100 : 109, whence $e = 91\cdot7$ volts, and $C_0 = 25\cdot4$. Not only is ϕ reduced to 59·7deg., but the angle by which e is in advance of E_i is found to be now reduced to 10·3deg. It will be seen later that any load or losses in the armature will have the effect of still further gradually reducing the angle α from its initial value of 10·3deg, and the determination of this—its initial value—is necessary to draw the complete diagram for any load; in fact, the initial value of α may be regarded as a constant of the machine.

The diagrams of Figs. 10 and 11 now show how the value of C_0, which we will call the "exciting current" as contrasted with the magnetising current, and the angles α and β may be simply determined in one operation, instead of piecemeal. The no-load current C_0 may be resolved into two components $(g_h e + g_e e)$ and be, in which $e(g_h e + g_e e) = e^2 (g_h + g_e) = \frac{w_h + w_e}{m}$. Hence, if we add together the estimated hysteresis and eddy losses per phase for a given value, e, and divide by e^2, we obtain $g = g_h + g_e$, or a conductance which is the sum of the hysteretic and eddy-current conductances. It has already been stated that g_h is practically constant, while g_e is strictly a constant, so that it is possible to correct the diagram by simple proportion. From our knowledge of C_μ and the hysteresis, we find $b = \frac{C_\mu \cos \beta'}{e}$. Thence, $y = \sqrt{g^2 + b^2}$ and $C_0 = ye$. The phase of C_0 or the angle $\beta = \beta' + \beta''$ is then given by the relation $\sin \beta = \frac{g}{y}$. It will be seen that the angle β is the sum of the two angles β' and β'' due respectively to hysteresis and eddy-currents, and is a constant of the machine, just as the angle α is. Further, since the angle β' is very small, and will not exceed 9deg. in an induction motor with its appreciable air-gap, the equivalent magnetising current C_μ is very little different from $be = C_\mu \cos \beta'$. Hence, when the requisite maximum magnetising current has been calculated from the data of the magnetic circuit, its effective value may at once be identified with be. Thus, if R = the reluctance of the magnetic circuit per pole, or half the total reluctance of a circuit, and Z = the total number of lines per pole, the magnetomotive force required per pole = RZ = F. If m = the number of primary circuits or phases, the resultant effect of the various coils, which must be equal to F, is $1\cdot256 \frac{m}{\sqrt{2}} . t . C_\mu$, where C_μ is the effective value of the magnetising current per circuit, and t = the number of turns per circuit. Hence

$$be = C_\mu = \frac{F}{1\cdot256 \frac{m}{\sqrt{2}} . t}$$

and

$$ge = \frac{w_h + w_e}{me};$$

whence the constants g, b and $y = \sqrt{g^2 + b^2}$, and $\sin \beta = \frac{g}{y}$ can be immediately derived.

(To be continued.)

A NEW AIR-SPACE TELEPHONE CABLE.

The paper or "dry core" cables, now used almost to the exclusion of all others for underground telephone lines, owe their low capacity and high insulation resistance to the partial use of air as the dielectric. Dry paper has certainly a very low specific inductive capacity, and a high resistivity, but it cannot compare with air in this respect. It is, therefore, customary to apply the paper to the wires, and to strand the wires together, as loosely as practical considerations in the manufacture will permit, and the attention of cable makers has been directed to devising means of increasing the distance between the wires without increasing the amount of paper between them, or, what amounts to the same thing, diminishing the paper without diminishing the distance between the wires. Thus a patent, owned, we believe, by the Western Electric Co., describes the use of an embossed instead of a plain paper ribbon, and, as another alternative, a perforated or both perforated and embossed ribbon.

What appears to be a great advance in this direction, if the results of the tests that have been taken are borne out in practice, is the introduction by Mr. G. J. Hall of a new material to replace the paper. This material bears the trade name of "leno," and is an open-work gauze cloth, held together by starch glaze. It is cut in narrow strips, and applied to the wire longitudinally, with a spiral of thread to keep it together, just as the paper is applied in paper-insulated cables. In spite of the thinness of the gauze, it is stated that there has been no trouble from short circuits between the wires, but the danger of this should be borne in mind, as a cable receives much rougher treatment and sharper bending during laying than in the factory.

For the particulars of the "leno" cable, and the tests given below, we are indebted to Mr. Mervyn O'Gorman. The tests compare the capacities and insulation resistances of paper and "leno" insulated cables. Each cable contained 52 copper wires of No. 19 S.W.G., laid up in pairs. The outside diameter of the "leno" cable was 1·37in. (over the lead covering), and the internal diameter of the lead covering was 1·10in. in both cases. Three lengths of the "leno" cable, two of 200 yards and one of 100 yards, have been made up to the present.

	Capacity (all other wires to lead). Microfarads per mile.			Insulation (megs. per mile).
	Maximum.	Minimum.	Mean.	
"Leno" cable	0·0715	0·0633	0·0668	2,000
Paper cables	0·0798	0·0743	0·0773	5,000
	0·0794	0·0723	0·0777	"
	0·0737	0·0683	0·0721	"

A Tax on American Telephone Poles.—The New York authorities have in consideration the taxing of telephone poles at the rate of £2 per pole per year. As this represents about £160 per mile of way, the telephone companies are raising a vigorous protest.

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EFFECTS OF PROLONGED HEATING ON THE MAGNETIC PROPERTIES OF IRON.*

(SECOND PAPER.)

BY S. R. ROGET, B.A.

In a Paper by the author, read before the Royal Society on May 12, 1898,† the results of some experiments were given showing the change in the value of the hysteresis of soft iron transformer plate when subjected to continued baking at temperatures not exceeding 200°C. The experiments there described have since been extended to higher temperatures, and the results for heating at temperatures up to 700°C. are given below.

The same specimens were used as in the former experiments, consisting of soft Swedish iron transformer plate which had been reannealed. The baking at these high temperatures was carried on in a specially constructed electric oven heated by coils of platinum wire wound on a mica frame, inside a metal vessel completely surrounded by a lagging of silicate cotton except for a mica tube through which the specimens and thermometer were introduced. By this means, any desired temperature could be maintained up to a bright red heat, so that the apparatus could be also used as an annealing furnace. As the specimen and thermometer were situated within the heating coil they could be very rapidly brought up to the desired temperature, which was read direct on a Callendar-Griffiths platinum pyrometer. Regulation was effected by alterations in the grouping of the coils as well as by outside resistances. The measurements of hysteresis were made as before with Prof. Ewing's hysteresis tester, the specimens being removed periodically from the oven and tested at atmospheric temperature.

A number of short runs at various high temperatures were taken. The results given in Fig. 1 represent the means of several independent observations at each temperature. The general features of the action are similar to those noticed before at more moderate temperatures. They should be compared with Fig. 2 of the former Paper. The initial rise of hysteresis is more rapid the higher the temperature, but the subsequent fall takes place sooner, and the final state is one of lower hysteresis the higher the temperature, until at about 700° C., a temperature just short of that required for complete annealing, the hysteresis falls again to quite its original value after a very short time. At temperatures above this, no trace of any rise has been observed.

The question at once suggested itself whether iron which had been heated at a constant temperature with the effect of causing its hysteresis to pass a maximum and to become reduced, would have its hysteresis again increased by exposure to more moderate temperatures, or would show some degree of immunity to temperature effects. It was found that the susceptibility to change at moderate temperatures was not by any means entirely removed by prolonged heating at high temperatures. The subsequent action of low temperatures was, however, slower than in freshly annealed iron, especially after the high temperature had been applied for a considerable time, also it appeared that temperatures at 500° or 600°C produced less effect on the susceptibility to subsequent change at lower temperatures than was produced by more moderate degrees of preliminary heating. A complete series of experiments on this point, however, has not yet been made, only a few samples having been re-heated in this way, but the results obtained with these were consistent, and pointed to the above conclusions. The latter part of the action at the higher temperatures resembles an incomplete annealing, as there appears to be little difference between the state after the iron has been heated for a few hours at a temperature just short of the "critical" temperature at which ferromagnetic quality disappears, and that of the same material which has been heated above this temperature so as to become completely annealed.

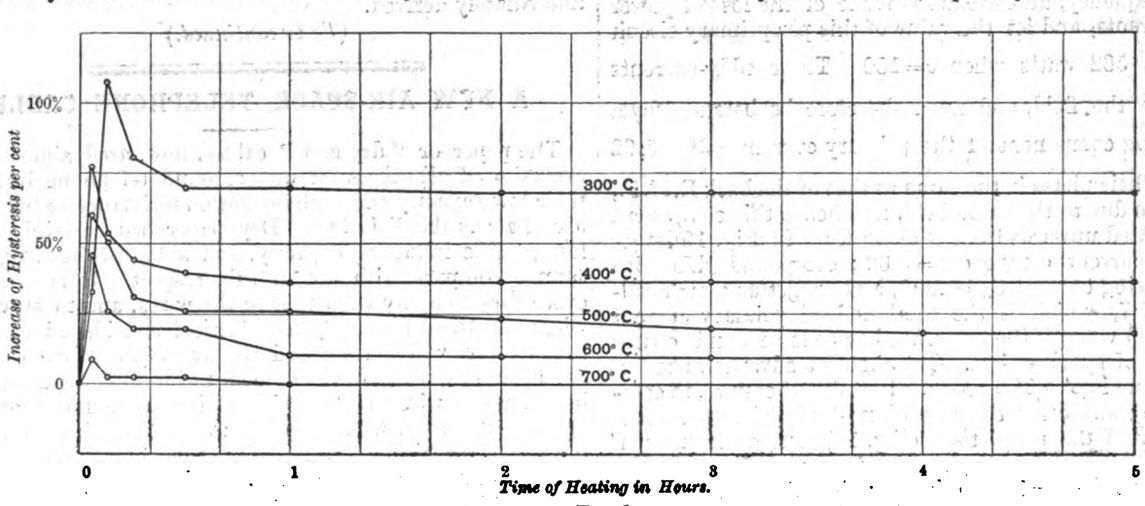

FIG. 1.

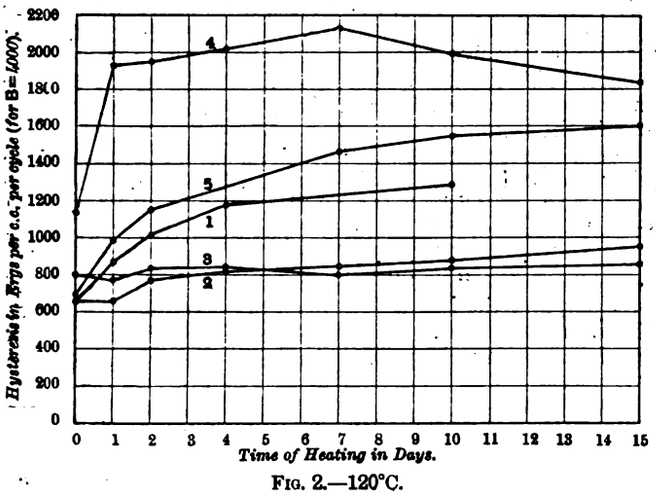

FIG. 2.—120°C.

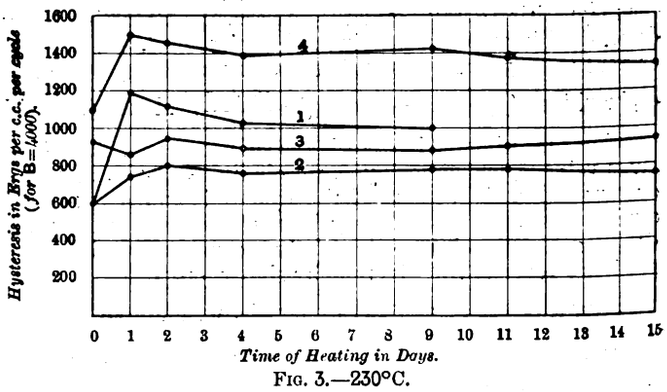

FIG. 3.—230°C.

The above experiments, and those in my previous Paper, refer to one particular brand of iron, all the specimens having come from the same sheet. A few examples, showing how widely different is the behaviour of different brands of steel and iron, are given in Figs. 2 and 3. They relate to various samples of commercial iron and steel, some of which were supplied by makers in this country and some from America. Fig. 2 shows the effects of heating at 120°C., and Fig. 3 shows the effects of heating specimens of the same iron at 230°C. The curves, numbered alike in both figures, refer to the same material. All these samples were initially in the annealed state. No. 1 is a piece of the iron used in the previous experiments, and is given here for the sake of comparison. No. 2

* Abstract of a Paper read before the Royal Society, December 8, 1898.

† Roy. Soc. *Proc.*, Vol. LXIII., pp. 258—267. [See also *The Electrician*, Vol. XLI., p 182.—ED. *E.*]

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is a sample of special transformer steel of equally low initial hysteresis. The action of heat on it is similar in general characteristics to the action of No. 1, but much less in degree. No. 3 is practically "non-ageing," even in the annealed state, and although not of such low initial hysteresis as some of the other specimens, would be the most suitable for transformers on account of its immunity from change by prolonged heating. No. 4 is a sample of sheet iron not specially made for transformers; it is of poor magnetic quality, but is interesting as showing, at 120°C., effects which require a higher temperature in the other brands of iron; the initial rise is very rapid, and the subsequent fall of hysteresis is clearly shown, even at this temperature. No. 5 shows greater rise than No. 1 at 120°C. in the annealed state, although this identical sample appeared to be practically unaffected by heating for a fortnight in the state in which it was supplied, but was then of somewhat higher initial hysteresis. It is interesting to notice that this iron if annealed before use in a transformer would ultimately, through low temperature heating, show much more hysteresis than if left in the state in which it was submitted by the manufacturer. The author has no information as to the treatment by which this remarkable degree of "non-ageing" quality had been produced. The general characteristics of the action at 230°C. on the different samples (*see* Fig. 3) is much the same, differing only in degree. No. 3 is, again, little changed by prolonged heating.

It seems from these and other tests, that brands of transformer steel, which are practically "non-ageing," are obtainable commercially, but they are not (at least, in these examples) of such low initial hysteresis as the "Swedish iron," which was formerly considered the best material for transformers. The effects of annealing vary much in different samples. All the samples tested after annealing have been found to be more liable to change in that state than in the state in which they were supplied by the makers. The method of annealing and rate of cooling may have much to do with the "non-ageing" quality of the material. Incidentally the experiments have given some evidence that samples of iron may undergo a slight change in hysteresis, even if kept at atmospheric temperature for three or four years.

It may be convenient to briefly summarise the chief effects of prolonged heating on the magnetic properties of iron which have been observed in these and the previous experiments:—

1. Material in the annealed state is more liable to change than in a harder state.
2. All the changes produced by prolonged heating are completely removed by re-annealing.
3. The heating need not be continuous; the same cumulative effect is produced by a number of short periods at a given temperature as by a continuous heating at the same temperature.
4. The effect may be regarded as being due to two actions superposed, one tending to increase the hysteresis, this action being the more prominent at lower temperatures; the other analogous to an incomplete annealing, tending to decrease the hysteresis, this action predominating at higher temperatures.
5. The liability of the material to increase in hysteresis at moderate temperatures is not removed by prolonged heating at high temperatures.
6. The change is confined to the lower part of the B.H. curve, the saturation value of the magnetisation being substantially unaltered.
7. The effect is produced equally, whether the iron is or is not exposed to the air during heating.

In conclusion, the author wishes to express his thanks to Prof. Ewing for placing at his disposal the facilities which have enabled these experiments to be carried out, and for much other kind help.

RULES FOR THE REGULATION OF THE WIRING OF PREMISES FOR CONNECTION TO PUBLIC SUPPLY MAINS.*

BY J. PIGG.

The importance of ensuring the performance of good work in the wiring of premises for connection to public supply mains for lighting or power purposes can scarcely be over-estimated, from whatever standpoint it may be considered. That the importance of this subject is recognised is shown by the attention recently given to it. Hitherto, however, attention has been mainly concentrated upon the merits of different systems of wiring, or, more correctly, upon systems of protecting wiring, to the exclusion of other matters of hardly less importance. The writer has recently had occasion to examine the rules issued by various authorities for the regulation of the wiring of premises for connection to public supply mains, with results such as would seem to justify calling attention to them. Such rules partake of the nature of a specification for the proper performance of certain work; but, whilst it is recognised that such rules have, necessarily, to be drawn somewhat broadly to cover a variety of cases, the divergencies in practice, and requirements observable on examination, are so great for what is practically the same class of work, and the attainment of the same objects, as to excite surprise.

A cursory examination of the subject shows that there are three classes directly interested in the execution of reliable work. These are—(1) the consumer, (2) the guarantor, (3) the undertaker. Besides these, there are others hardly less directly interested, such as the Board of Trade and the representative bodies of the profession.

Of the three classes enumerated, the first is seldom in a position to specify how the work to be executed on his behalf shall be done, or to recognise good work from bad. In many cases, and perhaps in the majority, the magnitude of the work is not sufficient to justify the employment of a consultant, and the consumer is compelled to place himself under the protection of one, or both, the other classes enumerated.

The second class referred to are the various fire insurance companies, who, from the nature of the risks they undertake, have necessarily to estimate the possibilities of each case submitted to them in all its aspects. Such corporations in their capacity of guarantors issue rules which are, more or less, applicable to the generality of cases, and which are subject to modification to suit special circumstances. The guarantor, where the risk is undertaken, occupies the position of greatest responsibility in respect of the premises, and represents the consumer in so far as any damage sustained by the latter can be satisfied by a pecuniary recompense.

The third class interested are the private companies or municipal authorities which undertake to supply the consumer with electrical energy. Whilst the consumer, or the guarantor on his behalf, is principally interested in the execution of work which shall not endanger his premises or their contents, the undertakers are more concerned with the safety of their generating and distributing plant, and the maintenance of a continuous supply to their customers. Hence we find that undertakers invariably disclaim any responsibility for whatever may happen to the consumer, or his premises, or their contents, through defects in the work. The repudiation of responsibility is, of course, natural, but it should not be forgotten that the consumer obtains an indirect guarantee by the issue of such rules, and from the inspection and testing—and gets it for nothing.

The Board of Trade is interested in the execution of good work in its capacity of guardian of the safety of the public. The representative bodies of the electrical profession are interested in the reputation of the profession, and are looked to by individual members for guidance and advice. Of these representative bodies only one has, as yet, issued such rules. As these bodies, however great their moral authority may be, have no direct control over those entrusted with the execution of such work as is under consideration, it is difficult to see how any rules issued by them can, however admirable they may be, ever become more than the recommendations they are stated to be.

An examination of the rules issued by various authorities for the control of such work shows very considerable differences in practice, and the magnitude of the results to be attained in the completed work; and the differences exist, not only between the different classes interested, but also between members of the same class. The Board of Trade regulations for securing the safety of the public refer in very meagre terms to internal wiring and, practically, only fix a maximum leakage as a limit of connection to the supply mains. The general rules recommended by the Institution of Electrical Engineers are not capable of being enforced by that body; and it would, therefore, seem as if the specifications under which wiring *must* be done are narrowed down to those issued by the consumer, or on his behalf by the guarantor, and those issued by the undertakers.

One of the most important points of any installation of wiring which is intended to be connected to public supply mains is the insulation resistance required. Very considerable differences of opinion exist in the requirements of different authorities in this respect, not only in the magnitude of the results required, but even in the manner of specifying the results to be obtained, and in the bases upon which the specifications are drawn. In many cases "insulation," or "insulation resistance," is specified without any indication being afforded of the points between which the difference of potential is to be established for the purpose of the test. The manner in which the insulation resistance required for any installation is specified varies greatly with different authorities. The Board of Trade regulation, No. 41, indicates the minimum insulation resistance by specifying the maximum leakage allowable as a proportion of the maximum current used for the purposes of the installation. The regulation does not directly specify the method of making the tests to determine the value of the leakage current, or the testing pressure to be used, but the only reasonable interpretation

* Abstract of a Paper read before the Institution of Electrical Engineers, January 26, 1899.

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would lead to tests "to earth" and "between mains," with a pressure equal to that ordinarily used in the installation. Under such conditions of test, the testing current would have the same value as the leakage current from the wiring during ordinary use. Such a method of specifying the results to be obtained may be put in the general form :—

$$\text{Leakage current} = \frac{A}{p};$$

whence

$$R = \frac{pE}{A}.$$

Where p is a constant, depending for its value upon the opinion of the framer of the rule, A is the maximum strength of the working current, in amperes ; E is the testing pressure, in volts ; and R is the insulation resistance required, in ohms.

The specification of the Liverpool and London and Globe Insurance Company is similar to the Board of Trade regulation already referred to, but differs, however, in that the maximum strength of the leakage current is only half that allowed by the Board of Trade regulation, with double the working pressure for testing.

The rule of the Institution of Electrical Engineers relating to the insulation resistances to be exacted gives the values as the ratios of a constant resistance to the maximum strengths of the working currents of the respective installations, or, in a general form,

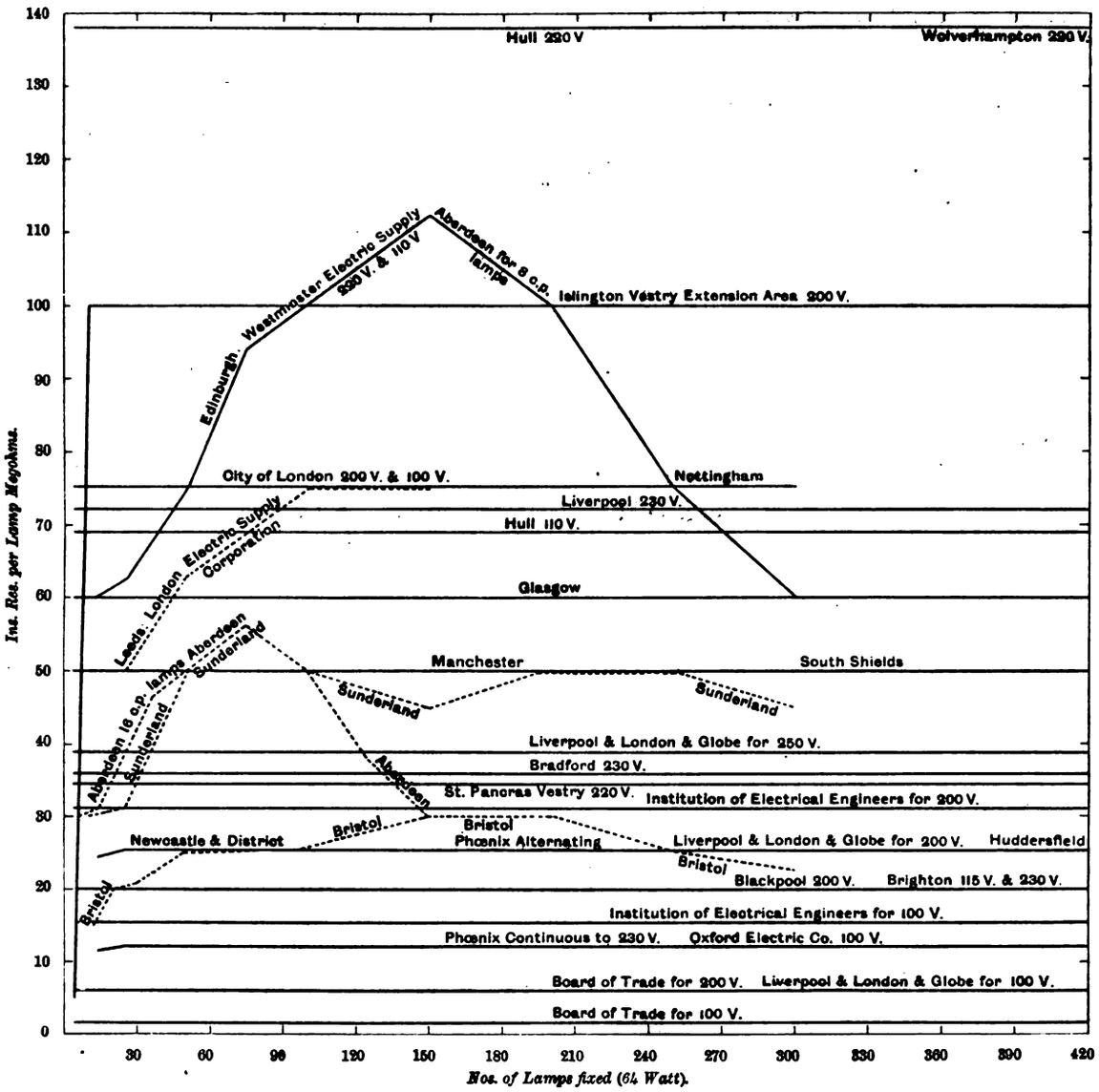
$$R = \frac{R_1}{A},$$

where R is expressed in megohms, and A is the maximum current, in amperes, used on the installation. Under this rule also the testing pressure is to be twice that used in ordinary working; and, with the exception of a set of rules issued quite recently, the rule has the distinction of being the only one that has come under the author's notice in which the duration of electrification is specified. The rule of the Institution of Electrical Engineers is followed, more or less closely, by a number of other authorities; the principal difference being in the values assigned to R_1.

Another form of specification, very closely allied to that of the Institution of Electrical Engineers, is that in which the insulation resistance is *indicated* by the number obtained by dividing another number by the number expressing the maximum strength of the working current in amperes. In this form of specification the differences exist in the values assigned to the number which is to be divided. The method adopted by the Phœnix Fire Office differs from those already referred to in that the actual resistances required for installations of different numbers of lamps are directly specified in ohms, and are not to be derived from a general equation. The range throughout which the insulation resistances are specified is between 12 and 1,000 lights, irrespective, as far as the specification shows, of the currents required by individual lamps, and, within the limits to which the rules are applicable, of the pressure used on the installations. The Phœnix Fire Office rules have the distinction of being the only set of rules, with which the author is acquainted, in which the insulation resistances required for installations using alternating currents are double those required for, otherwise, exactly similar installations where continuous currents are used. A number of authorities specify the insulation resistances required in the same way; but the actual values required vary considerably. In one case, however, which has come under notice, the figures are specified as for 33 Watt lamps or their equivalent.

An examination of the figures given by different authorities shows that the requirements differ not only between the authorities concerned, but that differences exist in the requirements for installations of different numbers of lamps to be supplied by the same authority. Thus the Phœnix Fire Office specifies as under :—

12 lights ..... 1,000,000 ohms.
25 „ ..... 500,000 „



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These figures are equivalent to 12 megohms, and 12·5 megohms, per light, respectively, and the latter figure is maintained throughout the whole subsequent range of the specification. If the figures specified by other authorities who use this method are examined, in the same way, it will be found that they are by no means so consistent in this respect. In one case, for example, the requirements commence with 60 megohms per lamp, rise to a maximum of 112 megohms, and fall again to 60 megohms, all in a range of 300 lamps. Thus, consumers having installations of 10, 150, and 300 lamps would have to obtain insulation resistances at the rates of 60, 112, and 60 megohms respectively, for connection to the same supply mains.

Another method of specifying the insulation resistance required is that where the values are expressed as the ratio of a constant resistance to the total number of lamps fixed on the respective installations. Such requirements may be expressed, generally, by—

$$R=\frac{R_1}{N},$$

where R is the insulation resistance required; R_1 is a constant resistance for any one set of rules; and N is the number of lamps fixed. Since R_1 is the insulation resistance per lamp, and for any one set of rules is constant, we see that the differences between such specifications and that of the Phœnix Fire Office is in the wording of the rules, and the values assigned to R_1 only.

Another variation of this manner of specifying the requirements is that in which the insulation resistance is specified as to be not less than 100 lamp-megohms for installations of above a certain size. Yet another method of specifying the requirements in this respect is that in which the insulation resistance is to be not less than

$$R=\frac{R_1}{n},$$

where R_1 is a constant resistance, and n is "the number of points."

Besides the differences already noted, considerable differences exist in specifying the insulation resistance between mains, in those instances where it is recognised. In this respect the two insurance companies, whose rules have been referred to, specify the insulation resistances required between mains in the same way, *i.e.*, it must not be less than that specified to earth. The rule of the Institution of Electrical Engineers does not provide for a test of the insulation resistance between mains, and many other authorities ignore such tests, so far as can be ascertained from their rules. Some authorities specify that the insulation resistance between mains shall not, in any case, be less than 75,000 ohms, a value, in many instances, considerably lower than that exacted to earth. In one case examined the insulation between mains is to be not less than one-third of that specified to earth. In another case, however, the insulation between mains is required to be double that specified to earth.

Another point of some importance, brought out by an examination of the specifications, is the variation in the limit of insulation, as fixed by various authorities, at which the right is reserved to discontinue supply to an installation already connected to the mains, in consequence of a decrease of the insulation resistance from its original value. As already stated, the Board of Trade limit for connection is $\frac{A}{10,000}$ and many authorities quote this as the limiting value of the leakage current allowable. In other cases, however, specific figures are given for the minimum insulation resistance after connection, and these range from 10,000 to 500 ohms.

The strength of the leakage current from any installation depends, not only upon the value of the insulation resistance, but also upon the pressure acting across that resistance. Hence, it would seem desirable that the insulation resistances specified should bear some relation to the pressure employed as well as to the size of the installation. Given a maximum leakage current, it is obvious that the insulation resistance, which is just sufficient to confine the leakage from a 100 volt circuit within the limit imposed, will not be sufficient to do so for 200 volt or 250 volt circuits. Under such a condition the insulation resistances of otherwise exactly similar installations would require to be proportional to the pressures employed. The other factor determining the strength of the leakage current, the value of the insulation resistance, depends, in some proportion, upon the size of the installation. Other things being equal, the installation containing the largest number of lamps will have the lowest insulation resistance. It by no means follows, however, that the proportion existing between the insulation resistances of different installations will be so regular as would seem to be implied by the proportions given in some of the rules which have been considered, such as, for example,

$$R=\frac{pE}{A}, \qquad R=\frac{R_1}{A}, \qquad R=\frac{R^1}{N}.$$

The insulation resistance obtained on any installation will depend greatly upon its design as a whole, the grouping of the means of utilising the power required, the number and character of auxiliary fittings, the design of the fittings employed, and the care with which they are fixed and connected, and the character of the workmanship in other directions. The equations given above all assume that the means of utilisation of power increase in a regular order, and that leakage will increase in the same degree. In respect of the rate at which the insulation resistance will vary with the size of the installation, the equation

$$R=\frac{R_1}{n}$$

is nearer to the exact conditions obtaining.

Consider the equation expressing the Board of Trade regulation already referred to

$$R=\frac{pE}{A},$$

where E = testing pressure, A = max. current used, and R = the insulation resistance to earth or between mains, according to the points between which the testing pressure is established. If E also equals the working pressure we obtain the insulation resistance as the ratio of the product of the working pressure by a constant, to the maximum current used on the installation. Or, since $\frac{E}{A}$ equals the minimum conductor resistance, the minimum insulation resistance must be equal to the product of the minimum conductor resistance and the constant, or,

$$R=rp.$$

It may also be noted that the results obtained are true resistances, and that no exception can be taken to the character of the equations obtained under the regulation. If we further consider the equation $R=\frac{pE}{A}$ we find that the insulation resistances exacted by the regulation for installations taking the same maximum currents, but at different pressures, are directly proportional to the pressures; but for installations taking the same powers at different pressures, the insulation resistances are in proportion to the squares of the pressures. This equation, as already noticed, assumes that the insulation resistances will vary inversely as the maximum currents employed. This, of course, is not quite correct for all cases. Given two installations with lamps of different candle-power, but of the same efficiency, and in other respects exactly alike, there is no reason to anticipate any difference in the insulation resistances to be obtained. The Board of Trade regulation, however, would require a higher insulation resistance for the installation containing the lamps of lower candle-power. In exactly the same way, it will be noted, that in two installations, otherwise exactly alike, that in which lamps of the highest efficiency are used will require the highest insulation resistance to comply with the regulation. The grouping of a number of lamps on one fitting will also tend to increase the insulation resistance obtainable, as compared with that obtainable with single lamps, owing to the number of points for leakage being diminished.

If the equations expressing the Board of Trade regulation are further examined we find that they furnish two methods of specifying insulation resistance in addition to that obtained indirectly by specifying the maximum leakage. From $R=\frac{pE}{A}$ we may obtain —The minimum insulation resistance to earth, or between mains, must be such that, if tested with a pressure equal to the product of the constant and the working pressure, the resulting current shall not exceed that specified as the maximum current required for the installation. From $R=rp$ we may obtain—The minimum insulation resistance must not be less than the product of the constant and the minimum effective conductor resistance when all appliances are in use.

Consider next the case of a specification, the wording of which gives the insulation resistance of an installation as

$$R=\frac{R_1}{A}.$$

If E_1 = Testing Pressure, and C = Testing Current we have—

$$\frac{E_1}{C}=\frac{R_1}{A} \text{ and } E_1 A=C R_1.$$

If we consider the first equation, we find that since the denominators of both members of the equation are of the same nature, a pressure must be the equivalent of a resistance; and from the second equation we are led to the conclusion that a power is the equivalent of a pressure. Further, we see that unless the testing pressure is equal to the working pressure, neither member of the second equation has an actual existence. If we consider the equation $R=\frac{R_1}{A}$ in the equivalent form $R=\frac{rR_1}{E}$ where r represents the minimum conductor resistance, and E the working pressure, we see that the insulation resistances required for installations using different pressures, are inversely proportional to the pressures employed.

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In two installations taking the same maximum currents, but employing different pressures, the insulation resistances exacted under any one set of rules will be—

$$\frac{R_2}{R}=\frac{r_2 E}{r E_2}, \text{ and since } \frac{r_2}{r}=\frac{E_2}{E},\ R_2=R.$$

If the two installations take the same maximum powers at different pressures—

$$\frac{R_2}{R}=\frac{r_2 E}{r E_2}, \text{ but since } \frac{r_2}{r}=\left(\frac{E_2}{E}\right)^2,\ \frac{R_2}{R}=\frac{E_2}{E}.$$

If the maximum currents required in the two installations are such as make $r_2=r$, then $\frac{R_2}{R}=\frac{E}{E_2}$.

Under the Board of Trade regulation the insulation resistances required in the three cases considered would be as under :—

With the same maximum currents $\frac{R_2}{R}=\frac{E_2}{E}$.

With the same maximum powers $\frac{R_2}{R}=\left(\frac{E_2}{E}\right)^2$.

With currents in the same proportion as the pressures $\frac{R_2}{R}=1$.

The strengths of the leakage currents in the three cases considered under this rule, and under the Board of Trade regulation, are set out below.

Under $R=\frac{R_1}{A}$		Under $R=\frac{pE}{A}$
Leakage Currents.		*Leakage Currents*
$\frac{C_2}{C}=\frac{E_2}{E}$	Same maximum currents	$\frac{C_2}{C}=1$
$\frac{C_2}{C}=1$	Same maximum powers	$\frac{C_2}{C}=\frac{E}{E_2}$
$\frac{C_2}{C}=\left(\frac{E_2}{E}\right)^2$	Currents in proportion to pressures	$\frac{C_2}{C}=\frac{E_2}{E}$

A very similar method of specifying insulation resistances is that adopted in some cases, in which the wording of the rule is such as indicates that the authors recognise that a *resistance* is not legitimately obtained by dividing another resistance by a current. Hence we find specifications which read :—"The insulation resistance . . . should not be less than the number of ohms which shall be indicated by the number resulting from the division of 40,000,000 by the number expressing the maximum current in amperes . . . ," which, if somewhat involved, has the advantage of being precise.

Some reference has already been made to the method of specifying adopted by the Phœnix Fire Office, and followed, more or less closely, by others. As already remarked, the specification named is based upon a practically constant resistance per lamp, although specific figures are given for installations containing given numbers. Hence the specifiation named is capable of being expressed in the general form $R=\frac{R_1}{N}$, which, of course, is the general form for specifications where the insulation resistance required is defined as the ratio of a constant resistance to the number of lamps fixed. The fact that R_1 is not constant for all specifications and, in some cases, not constant throughout the same specification has already been referred to, and no further comment is needed here. Such a method of specifying the requirements to be met takes account of only one of the factors involved in the determination of the strengths of leakage currents, viz., the size of the installation, and that not in an exact way, as has already been referred to. The specifications ignore altogether the effect of the pressure employed, although in some instances where this form of specification is in use, different pressures are in use, or allowed.

One of the specifications, which is drawn in a similar manner to that of the Phœnix Fire Office, specifies the figures for numbers of 33 watt lamps, or their equivalent. The specification is not drawn on a regular basis throughout its whole range. Had it been so, the general form would have resolved itself into $R=\frac{R_1}{EA}$, which differs from any other form considered. As the value of R_1 varies at one point to a figure very nearly double that at either end of the range, the specification appears to be somewhat arbitrary.

Of the form of specification $R=\frac{R_1}{n}$ where n is the number of *points* it is unnecessary to refer further to it than has been already done, except to point out that it also ignores the effect of variation in the pressure employed, and that, for the average installation, the insulation resistance exacted will be greater than where the form $R=\frac{R_1}{N}$ is in use, the value of R_1 being assumed to be equal in the two cases.

Probably the greatest differences in the various specifications are those that exist in the magnitudes of the insulation resistances exacted. In order to show these differences fully it is necessary to reduce them to a common basis. In the accompanying diagram the insulation resistances per lamp required under various specifications are shown, for 64 watt lamps in every case ; and where the insulation resistance required depends in any way upon the working pressure, the pressure for which the value of the resistance per lamp is suitable is marked. As will be seen, the values of the insulation resistance required per lamp vary, with the higher pressures, between 138 megohms to 6¼ megohms, which is the Board of Trade limit for 200 volt supply. In the case of representative bodies, the diagram shows the insulation resistances required for the same maximum powers at different pressures. Thus, under the Board of Trade regulation, and the rule of the Liverpool and London and Globe Insurance Co., the insulation resistances are proportional to the squares of the pressures employed. Under the rule of the Institution of Electrical Engineers, and similar specifications, they are proportional to the pressures only. Under the Phœnix Fire Office rule they do not vary in any way with the pressure used. The diagram also shows in a very conspicuous manner the irregular character of the basis of some of the specifications examined.

If we further examine the various specifications, we find that those in which the insulation resistance of the complete installation is inversely proportional to the maximum current employed cover all classes of apparatus that may be used, whilst other forms of specifications have necessarily, or should, to be complete, to specify directly for other appliances than incandescent lamps. Some diversity is also exhibited in the requirements for such special cases. In some specifications the insulation resistance required for motors and arc lamps is to be equal, respectively, to that required for the number of incandescent lamps taking the same *energy*. In other cases the insulation resistance is to be equal to that exacted for a certain number of incandescent lamps, irrespective of the power taken by the special apparatus specified for, or of the power required by the incandescent lamps which form the basis of the requirements for the special apparatus. In other cases, again, the insulation resistance is to be "to the engineer's approval," and in still other cases the requirements are not specified or referred to in any way. In one case it will be noted that, although the insulation resistance required for motors follows from the insulation test for a complete installation, a minimum insulation resistance of 1 megohm is specified. In this case, on the basis of the insulation resistance required for the complete installation, the minimum is reached for a motor taking a little more than 3 E H P. Under the Board of Trade regulation the insulation resistance would require to be only 230,000 ohms for such a motor. In another case in which the insulation resistance required for such a motor follows from the insulation resistance exacted for the complete installation, and would be, under the rule, 2 megohms, a minimum of 50,000 ohms is fixed. Under other rules, of similar construction, the insulation resistance required varies between 1 and 2¾ megohms approximately. In other cases where the insulation resistance is specified in terms of a number of incandescent lamps irrespective of the power required, the minimum for any size of motor is 2 megohms.

In the case of the use of arc lamps the conditions differ somewhat, owing to the differences between the pressure required for one lamp of ordinary construction and the usual pressures of supply. Where the insulation follows from the prescribed insulation test, the result is not the insulation per lamp, but that per circuit of such lamps. Hence the insulation resistance per lamp will vary with the pressure and the current. Thus, under the Institution of Electrical Engineers' rule the resistance exacted for a circuit of arc lamps, taking 10 amperes, would be 1 megohm, and, under other specifications of a similar character, 4 megohms. If these lamps are arranged two in series on 100 volt circuits, the insulation resistance per lamp, would be 2 and 8 megohms respectively. If arranged four in series on 200 volt circuits, the insulation resistance per lamp, would be 14 and 16 megohms respectively. Under the Board of Trade regulation the insulation resistances for 100 volt and 200 volt circuits would be 100,000 and 200,000 ohms respectively, and the insulation resistances, per lamp, 200,000 and 800,000 ohms respectively. Under other specifications of various construction, the insulation resistances per arc lamp, irrespective of the power required, varies between 2 and 5 megohms. In another case, where the insulation resistance of arc lamps is directly specified, the figures given are those which are expected *per circuit* irrespective of the number of lamps on such circuit, and therefore independent of the pressure employed.

Another point in which some diversity of practice is apparent is the mounting of motors. In the great majority of cases motors are to be efficiently insulated from earth, together with all their accessories. This is varied somewhat in certain specifications by requiring the frames of motors to be earthed for pressures above a certain specified limit. In one case the limit is 250 volts. In another case

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it is 460 volts. In another case, however, the framework of motors is to be connected to earth by a copper conductor of a sectional area equal to that of the leads up to a maximum of 10 square millimetres.

Another point which may have attention called to it is the inference which might be drawn by any one sufficiently depraved from the wording of a number of the specifications with reference to the testing pressure to be employed. In many cases we find that "*current* will not be supplied, *if, when testing with a pressure of — volts*, the insulating resistance is below. . . ." The italics are the writer's, of course. Leaving on one side the fact that what is supplied is "power," and what is charged for is "work," the remainder might cause an inquiry as to whether resistance was dependent upon the pressnre used in measuring it. Although it may be desirable, *before measuring*, to break down an incipient fault by the use of a higher pressure, the use of that pressure *for the purpose of the measurement* has no effect on the value obtained. At the same time it may be worthy of consideration whether the use of a pressure higher than that used in working, of such values as are ordinarily available, is of much use in breaking down an incipient fault under the ordinary conditions of wiring. It is not desired to advocate a return to the method of testing which has been described as being done with "a forty-guinea bridge, a leaky cell, and a detector which stuck on the slightest provocation," but it would seem to be a particularly bad case upon which the usual testing pressures would have the desired effect, the more especially as the testing battery or generator seldom has much power. The real object of testing insulation resistance is the ascertainment of the leakage to be expected under working conditions, although this seems to be sometimes partly lost sight of, and it would seem, seeing that no greater pressure is to be applied in working, that the working pressure would be most suitable for testing. There are, of course, cases where higher testing pressures may be of advantage, but these are in the case of installations which have become defective.

Another point may be shortly referred to. We find the following, "The whole of the lamps or appliances for utilising the energy having been connected to the conductors, and all fuses being in place, an E.M.F, equal to twice the *E.M.F. which will be ordinarily used*. . . ." It need hardly be pointed out that installations taking power from public supply mains have a difference of potential established at the terminals, but not an *E.M.F. in ordinary use*.

It will be observed that in several of the specifications the insulation resistance required for motors is to be "equivalent to the number of lamps as represented by the *energy* required for the motor." If *energy* is measured by its power to do work the element will require taking into account, and it would be possible to so proportion the relative times of the use of the lamps and the motors respectively as to make the insulation resistance which the latter should have, under the rules, of any desired value. Obviously the specifications should have reference to the "power" required for the motor.

Besides the differences already touched upon, a study of the specifications reveals numerous other differences of greater or less importance. To deal with these in detail would be tedious in the extreme. The insulation resistances exacted for conductors range from 2,500 megohms to 300 megohms. In many specifications different values of insulation resistance for conductors are assigned for use in different positions. In some cases tests are specified for ensuring the quality of the cable, and in some cases the maker's certificate *may* be required. In some cases different tests are specified for lead-covered cables; in one specification "lead-covered wires should not be used under any circumstances." Some slight differences exist with reference to joints, but the surprising point in this respect is the number of specifications which ignore joints altogether. Differences also exist in the maximum current density allowed; in the maximum "drop" to the farthest consuming device; and in the percentage conductivity, with or without a standard. Other differences with respect to conductors exist in the specification for the smallest wire to be used, and in the smallest unstranded wire. Again, "bunching" of "positive conductors together, or of negative conductors together" may only be done, in some cases, by "permission." But wires, which under certain conditions are practically at the same potential, may, under other conditions of ordinary use, have the full difference of potential between them. It does not follow that a wire has a potential of the same sign whether the consuming device is in operation or not.

Differences also exist with reference to cut-outs, ceiling roses, and lamp switches. In some cases double-pole cut-outs are specified; in other cases there must be two single pole cut-outs. Ceiling roses in some cases must not be provided with fuses; in other cases they must have them. In one case the only possible interpretation of the rule requires two single-pole cut-outs to be provided for every ceiling rose. On the other hand, the writer heard of, but did not see, a specification which called for ceiling roses with two fuses in the fitting. Differences exist in the specifications for lamp switches chiefly in the length of "break" required. In one specification the use of double-pole switches, or two single-pole switches, is preferred throughout the whole installation. In some cases the specifications require "the metal part (of switches and cut-outs, &c.) preferably arranged so that the screw heads, and so forth do not come through to the bottom of the base; should they do so, the holes must be filled up with plaster of Paris, well shellaced, or some equivalent material." The writer has seen such fittings so protected, with large breaks, insulated covers, and everything handsome about them, which, when fixed, provided a distance of about $\frac{1}{16}$in. between the live parts of the switch and the head of the screw fixing the switch on the block. In the case of some so-called high insulation ceiling roses, the wires are required to pass through holes separated by a wall of about $\frac{1}{16}$in. thick, and in many cases the size of the holes has been found insufficient to allow the wires to pass through without stripping off the insulation.

Differences also exist in the requirements for main switchboards. In most cases, where all three cables on a three-wire system are taken for connection to an installation, the use of three poles, single or coupled together, is specified; in other cases, the use of a treble-pole main switch is not recommended; and in still other cases each side is to be treated as a separate two-wire system, and complete disconnection provided for.

Other instances of differences of practice might be readily adduced; but probably sufficient has been already given to show the desirability of more concerted action in drawing up rules for the regulation of such work as has been considered. It is true that, in some cases, specifications do bear a certain resemblance to each other, but the resemblances are not necessarily the result of concerted action, but are more probably due to different specifications being drawn up under the direction of one person. Of the necessity for the taking of counsel together for the drawing up of rules which may, at least, form a basis for securing greater uniformity in such specifications there can be very little doubt. Differences of opinion are, no doubt, indicative of originality of thought, but such differences may be eliminated in consultation. Rules drawn up as the result of a conference between those responsible for the issue of specifications, for the guidance of those to whom the work is entrusted, could scarcely fail to secure a greater degree of uniformity than exists at present.

There are two appendices to the Paper. Appendix I. contains extracts from the Board of Trade Regulations, and from the wiring rules issued by the Institution of Electrical Engineers, the London and Liverpool and Globe and the Phœnix fire offices, and by 22 supply undertakings. Appendix II. is a table of the various insulation resistances specified.

The Electrical Properties of Carbon Arc Vapours.—In experiments upon the discharge of negative electricity by light, the electric arc is usually employed as the source of ultra-violet rays, and a question arises as to how far such experiments are affected by the electrical state of the vapours of the arc. The *Physical Review*, Vol. VII., pp. 129-148, 1898, contains an article on this subject by Messrs. Merritt and Stewart. It was pointed out by Hallwachs, in 1890, that the protection offered by a quartz window and wire gauze is in some cases insufficient to screen the direct electrical action of the arc vapours from the actino-electric apparatus. The electrical properties of the arc vapours are similar to those of gases that have been acted upon by X-rays, or to gases from a flame. It is supposed in these cases that a condition is developed in the gas somewhat similar to that in an electrolyte, *i.e.*, ions are formed, some carrying positive charges and others negative charges. This condition is only temporary; in the case of X-rays the gas loses this ionised state in about one-tenth of a second. A charged body placed in the ionised gas would attract one set of ions and repel the other. Upon coming into contact with the charged body the ions are supposed to give up their charges and to cease to exist as ions. The experiments of Messrs. Merritt and Stewart show that, except at low potentials, the rate of discharge is not proportional to the potential, but approaches a limiting value as the potential is raised. The discharging power is retained even after the arc vapours have been passed through long tubes of glass or of metal, and lasts for at least 10 seconds. There is some evidence that the negative ions diffuse more rapidly than the positive ones. If air or oxygen saturated with water-vapour is introduced into the enclosure containing the arc, the conducting power of the arc vapours is greatly increased. But this effect can no longer be observed when the body to be discharged is at considerable distance from the arc.

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ELECTROLYTIC ALKALI AND BLEACH.

We give elsewhere an account of the latest developments of the Le Sueur process for manufacturing electrolytically alkali and chlorine. When the process was described in this country some years ago, it did not present any features from which success could reasonably have been predicted. Its cumbrous and short-lived diaphragm was especially against it, and no one was much surprised when rumours of its progress or even existence grew fewer, and eventually ceased. It is pleasant news that something better than oblivion has now been achieved. The article which we cite shows that the Le Sueur process is working with fair success on a tolerably large scale, and that there is no reason why it should not be largely used where power is cheap. That the process is rather wasteful of energy cannot be denied, but on the credit side of its account must be set the simplicity of the plant and the large size of the units of plant. All this is set down fairly and without malice or extenuation in the Paper in question, which is distinguished by containing a vastly smaller dose of special pleading than one usually gets from an official source.

The concluding paragraph of the above-mentioned article alludes to a condition of the soda and bleach markets that calls for further comment. It is stated that in the last six years the price of bleaching powder in Boston, U.S.A., has fallen from £9. 9s. to £6. 6s. 0d. per ton, while caustic soda has experienced an even greater fall from £15. 10s. to £7. 11s. Statistics of the alkali industry of the United Kingdom reveal an equally bad, if not worse, condition of affairs here. In 1891 our export of caustic soda was 311,370 tons, and the revenue therefrom £2,335,281; in 1895 the export was 312,996 tons, but, although the bulk was greater, the revenue fell to £1,560,140; and last year the caustic soda export had fallen to 163,509 tons, while the price declined from £7. 10s. to £7 per ton in the twelve months. A similar decay is noticeable in the British exports in bleach. In 1897 the export of this product was 75,685 tons, realising £522,415; in 1895 the

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export was 70,672 tons, realising £500,717; but last year the export was only 51,038 tons, and the price declined during the year from £5. 10s. to £4. 12s. 6d. per ton. Two of the causes alleged to account for this marked and steady decadence in an important chemical industry are, firstly, the obsolete plant in British chemical works; and, secondly, the keen competition from successful electrolytic processes now in use at many of the American and Continental works. It is the old story of excessive conservatism and apathy. The British chemical manufacturer, trained only in the routine of his father's and his own works, is blind to the advantages, and unconscious of the steady advance, of modern processes of manufacture. His lack of scientific education necessarily leads to complete inability to perceive the merits of any new discovery, until it has forced its advantages upon his belated attention by undermining his business. This, indeed, is what the electrolytic processes are steadily doing at the present time, in regard to British industry in alkali and bleach; and the only remedy we can discover is for our manufacturers to adopt electro-chemical methods immediately. Without doubt, to do this will necessitate two principal conditions; the scrapping of a large amount of existing obsolete plant, and the supply of cheap electrical power in large quantities. The first requires, perhaps, a considerable amount of courage, especially in a country where manufacturers are generally averse from making radical changes in their works; but it is a course which, both in America and on the Continent, has been found eminently successful. The second requirement—cheap electric power—should lead manufacturers, who have the prosperity of their business at heart, to do all in their power to hasten on the supply of electricity "in bulk" over large manufacturing areas.

REVIEWS.

The Life Story of the Late Sir Charles Tillston Bright. By his brother, Edward B. Bright, and his son, Charles Bright. Two vols. (London: Constable. 1898.)

The ten years that have elapsed since the death of the subject of this memoir are no doubt partly responsible for the dimensions of these two handsome, but somewhat unwieldy, volumes. Had the authors gone to press earlier we should have learnt more, probably, of the chief character, and less of the events more or less remotely connected with his career. In fairness to the authors, however, it should be mentioned that they themselves modestly admit their literary shortcomings as biographers, and claim indulgence for their book more in the character of historians. One of them, indeed, has written to a contemporary complaining that its reviewer omitted the full title, which covers the stories of the Atlantic cables and the telegraphs to India and the Colonies; from which it may be gathered that the work has been deliberately designed not alone, or even chiefly, as a memorial of Sir Charles Bright and his achievements, but as a book of reference for the electrical profession interested in the rise and progress of telegraphy in this country, and of submarine cable-laying at home and abroad. Regarded in that light, it can be confidently recommended as the best and most complete work of the kind yet published. More than this, it is highly interesting, and in places the narrative attains to the dignity of being exciting. The plan of the book lends itself to this result by telling the whole of each story from beginning to end irrespective of whether the subject of the memoir remained in or dropped out of the action; and with similar intentness upon the great telegraphic developments during Bright's lifetime, a vast amount of information is collected together which will be invaluable to future historians, though it may not help them much to a knowledge of one of the principal actors. Sufficient is said, however, to interest us greatly in his character, and to let us perceive that he was a man who in almost any circumstances would have been worthy of a biography all to himself. It cannot but be regretted, therefore, that his kinsmen, in their zeal for historical material, have, so to speak, almost buried him in a basketful of cuttings. By patient searchings, however, we can make out much of his personality which far transcends his accidental surroundings.

Bright's was essentially a precocious genius. He began his career young, obtained his highest honours when little more than a youth, and ended his days in the prime of life. The ending was something after the fashion of the beginning, pecuniary difficulties of the father resulting in the son being obliged to earn his own living at the age of 16 instead of going to college, as had been intended; and the same sort of troubles, perhaps inherited from the father, overtaking the son in his later career, contributed not a little to his untimely decease. It surprises one that the same man, who, as servant of the Magnetic Telegraph Company, showed such business capacity in saving his employers from the entire loss of their underground wires, should himself in later life have embarked in mining and other adventures which inevitably led to disaster. Yet so it was; and from this, and a remark as to his spending his substance on "the immediate pleasure of himself and his friends," we are forced to the belief that Bright was one of those men who, though wonderfully good public servants, are somewhat lacking in qualities which make a man master of himself. As a public servant Bright's estimable character and unflinching fidelity shone out supreme.

At the early age of nineteen he was in charge of the laying of underground wires for the Magnetic Telegraph Co.'s system; and, always looking older than his years—which he purposely concealed—he became engineer-in-chief of that company when he was only 20. He married in the following year, and before the end of it he had laid the first successful cable across the Irish Channel. By this time he was the inventor of many novel and valuable appliances and devices both for overland and submarine telegraphy, the most notable of which have continued in uninterrupted use to this day. In 1854—that is to say when Bright was 22—the first Atlantic cable was projected and, mainly through his instrumentality, it took practical form, found favour with the British financial public, and, in less than three years, was fairly launched on the ocean, Bright himself being chosen as engineer-in-chief for the company. Bright was then only 25, but it would have been well if he had been appointed still earlier, for the cable was of a pattern he did not approve, and its failure was in no way to his discredit. On the contrary, his management of this gigantic pioneer expedition proved beyond doubt that the venture was a practicable one. Bright's own words to his wife on leaving for the second trial describe the situation exactly, and reveal the character of the man: "I don't say we shall do it even this time, but we shall do it *some* time." The some time was near at hand, for in less than a month Bright was able to send word to his wife the cheerful intelligence from Valentia: "Atlantic cable laid. Signals received both ways." Commenting on this memorable event *The Times* of August 6, 1858, wrote as follows:—"Mr. Bright, having landed the end of the Atlantic cable at Valentia, has brought to a successful termination his anxious and difficult task of linking the Old World with the New, thereby annihilating space. Since the discovery of Columbus, nothing has been done in any degree comparable to the vast enlargement which has thus been given to the sphere of human activity."

By Her Majesty's command, Bright received the honour of knighthood at the hands of the Lord Lieutenant of Ireland; and his biographers note with natural pride that he was the youngest man who had received such a distinction for generations past—and we know of no similar instance occurring since. It was the first title conferred on the telegraphic profession, and remained the only one for many years. The line survived only for a few weeks

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as a serviceable signalling medium; but what did survive was the demonstration that more than 2,000 miles of continuous cable could be safely stretched across the ocean bed at depths of from two to three miles; and that telegraphic signalling through an insulated conductor over that vast distance was simple, swift and reliable. For the engineering of this great feat Bright must have the entire credit; its greatness can be best realised by reference to those pages, which describe the indomitable perseverance, the untiring vigilance, the inexhaustible resource and wonderful foresight of the man in command. These great qualities Bright exhibited in a very marked way, not only with the several Atlantic cable expeditions with which he was intimately associated, but perhaps even more conspicuously in the Far East when combating the difficulties of landing the Persian Gulf cables; and again in the West Indies, where for a prolonged period he had to face climatic and physical obstacles which often reduced his staff to the condition of helpless invalids and himself nearly to death's door. He succeeded, however, in carrying out all that he was bidden to do by sheer strength of will, and by that sympathetic mastery over the men about him which won their devotion and commanded their willing service at all times of stress and danger.

Bright was brought up in a rather rough school—the Merchant Taylors'—and in his early boating days was capsized on the Thames some seven or eight times, narrowly escaping drowning on each occasion. These and other athletic exercises fitted him admirably for his future career; and, blessed with a fine physique, a commanding presence far ahead of his actual years, he took his place naturally among the leaders of men at an age when most of us have barely attained the full dignity of boyhood. Here is a characteristic passage from one of his letters to his sweetheart, describing the work he was superintending in Liverpool:—"Last night I spent entirely out of doors. . . . It is the third bedless night I have had lately, and I expect two more next week. . . . They (the workmen) never do a third of the work unless I am with them. . . . Last night I did the quickest piece of telegraph work that has ever been done. We began at ten, and by eight in the morning we had laid piping containing eight wires under the streets nearly half a mile, and all repaved." And then, after explaining how the thing was done, he winds up with words that he knew would give pleasure, and which we cannot read without admiration even now: "I tell you about my night's doings because I was pleased at the speed which I had calculated before on doing it in. The plan was a new one of my own." He might have added that the whole business was new; and that he, a youth of 20 summers, not only had to create it but to plan, organise, equip and map out the undertaking down to the minutest detail. With the same energy and thoroughness, a few years later, he won a seat in Parliament for the borough of Greenwich, in spite of his inexperience of political affairs. Although preeminently a man of action rather than of speech, Sir Charles "could talk the leg off an iron pot" when the necessity for speech arose. Probably this reserve of oratorical power was exerted with great effect at the Greenwich election. The part he played in the extension of submarine telegraphy to India and Australia, and his services in connection with the Paris Exhibition, for which he received the Legion of Honour in 1881, are well known. His presidency of the Society of Telegraph Engineers and Electricians in 1887 fittingly marked the climax of a brilliant though short-lived career, his term of presidency having scarcely expired when he himself was overtaken suddenly by the hand of death.

Of Sir Charles Bright's numerous inventions and great services to his profession full accounts are given in these pages. Perhaps the one which bears his name, the first acoustic telegraph instrument, will keep his memory fresh the longest. Bright's Bell is the fastest manual telegraph instrument ever devised, and is still very largely employed in this country. Strange to say, the inventor's biographers attribute the superiority of this apparatus to its utilising "both negative and positive currents"; whereas its obvious advantage over the Morse key, its only formidable rival, is due to the signals being all dots, the different elements of the alphabet being made up of sounds of equal length, differing only in tone.

The two volumes under review are separately indexed, the illustrations profuse, the notes and appendices voluminous; and in these respects, as well as in the sumptuous make-up of the work, Sir Charles Bright's brother and son have laboured hard to give the world a fitting memorial of one of its earliest, most popoular and most eminent electrical pioneers. J. L.

Intruzioni Pratiche di Servizio Sulla Telefonia Intercomunale. By I. Brunelli. (Rome: Tip. Del'Unione Cooperativa Editrice. 1898.)

In Italy, as in this country, the inter-urban telephone lines are the property of the State, and the urban exchanges are operated by private companies. The former lines end in post or telegraph offices, and the *brochure* before us contains service instructions for trunk switching, and descriptions of the apparatus employed, and of the way it is connected. The arrangements are very simple, and do not include the elaborate methods to insure automatic signalling and quick operating essential to the British trunk service. A switchboard equipment consists merely of three-point jacks, two-way plugs with a pair of ringing keys, a hand-restoring ring-off indicator, and one speaking key to each cord, and, for each trunk line, a combined translator and relay, actuating the calling indicator through a second relay. The drawings of apparatus and diagrams of connections in the book are clear and well printed, and the instructions in the letterpress are as complete as could be desired. As an example of the attention to detail, we may mention that it is specified that every call office shall contain, among other things, "Un cartello con l'indicazione: *E probito di fumare e di sputare.*"

Annuaire Pour L'An 1899. Published by the Bureau des Longitudes. (Paris: Gauthier-Villars.)

In the 1899 issue of this useful annual the chapter on electricity has been entirely rewritten, and we note with satisfaction that the 106cm. ohm has at last been relinquished in favour of the international column of mercury 3mm. longer. There is still room for improvement in the electrical tables that have been retained, however. For instance, the resistances of certain metals and alloys are given to four significant figures, in fractions of an "ohm dit légal," but it is not stated definitely whether this refers to the old legal ohm of 1881, or to the international ohm defined as a legal unit on a previous page of the book. This is, perhaps, immaterial, as no indication is given as to the temperature at which these figures are correct. The same omission of temperature occurs in stating the E.M.F. of the Clark cell.

Lockwood's Builder's and Contractor's Price Book for 1899. Edited by Francis T. W. Miller. (London: Crosby, Lockwood and Son, 1899.)

The portions devoted to electric lighting, bell and telephone fitting and lightning conductors, have undergone very little alteration since last year. The following passage from the preface is worth quoting:—

During the year now closing, the prices of all kinds of materials and labour have remained at the positions to which they had previously advanced at the commencement of the year. This is somewhat remarkable when it is remembered that such prices had reached an unexampled height, and must be largely attributed to the extraordinary activity displayed throughout almost the whole of the country in all departments of the building trade. But it must also be remembered that the cost of labour has risen very greatly owing to the policy adopted by the various trade unions in restricting the amount of labour given in return for wages, with the result that the master builders, in the consequent uncertainty as to what particular jobs of work will really cost them, have been led to raise their prices higher than they otherwise would have done.

Electricity Made Easy, by Simple Language and Copious Illustration. By E. J. Houston, Ph.D., and A. E. Kennelly, Sc.D. (London: Swan, Sonnenschein and Co. 1898.)

This is a very elementary treatise, intended, it would seem, rather to give the "General Reader" a very superficial knowledge of the applications of electricity than to afford any practical help to the student who wishes to qualify for the electrical profession. The book is printed from American stereotypes, and contains numerous illustrations, good, bad and indifferent. A certain amount of letterpress and a

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number of illustrations are devoted to self-lighting gas burners; but no mention is made of alternators, transformers, or static electricity. The paper and printing are good, however, and the binding neat and serviceable.

THE LE SUEUR PROCESS FOR THE ELECTROLYTIC PRODUCTION OF ALKALI AND CHLORINE.

This process, which was the subject of a considerable amount of comment, not unfavourable on the whole, in its early days, has rather dropped out of public notice during late years. But it is far from defunct, and has, indeed, been substantially improved since its introduction into England some six years ago. A description of the development of the process and its present status was given by Mr. Parsons, at the Boston meeting of the American Chemical Society, held in August last, and this we propose to transcribe with such commentary as may seem requisite.

The Le Sueur process, as worked in 1892, was intended for the electrolysis of an aqueous solution of common salt with the usual carbon anodes and iron cathodes, and was noteworthy chiefly for its employment of a diaphragm containing blood albumen, as a characteristic constituent, if our memory is to be trusted in this particular. These diaphragms were stated at the time to need renewal every 48 hours, and the practicability of a process needing such a condition to be fulfilled appears problematical. That considerable changes

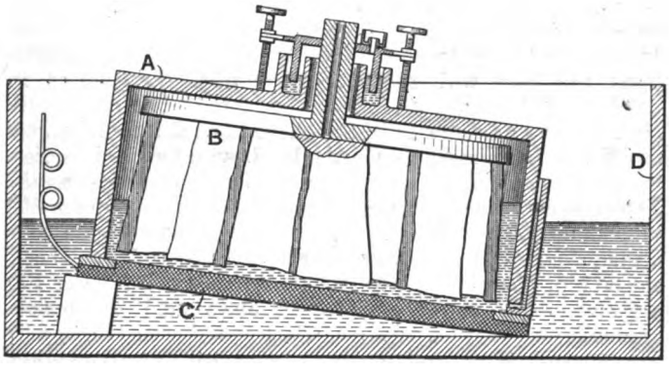

FIG. 1.

have been made in this respect will be seen from the following historical description :—Works were put up in 1892 at Rumford Falls, Me., to carry out the Le Sueur process. Caustic soda and bleaching powder began to be turned out in February, 1893, current being obtained from a 200-kilowatt Thomson-Houston machine. The success of the trial was such that three more dynamos of like output were installed at the end of 1894, and the concern expanded into the Electrochemical Co., whose technical directors were Le Sueur and Parsons, the author of the present Paper. The cell first put into practical use is shown in Fig. 1, and does not differ greatly from that originally tried. A is an inverted trough of stoneware in which is the anode B, composed of blocks of retort carbon cast into a lead cap. In these two particulars, the arrangement resembles that used by the Electrochemical Co., of St. Helens, though this is, we believe, a totally distinct firm. The trough is inclined as shown, and is closed at the bottom by a diaphragm C on which is stretched a sheet of wire gauze serving as the cathode. In order to give as large an anode surface as possible, the spaces between the carbon blocks are filled with small pieces of broken carbon. The trough contains salt solution, which is kept at a level slightly higher than that of the salt solution in the iron tank D, which contains the whole apparatus. By the arrangement shown, the distance between the electrodes may be made small, and the resistance of the cell thus kept within reasonable bounds. The diaphragm is made of asbestos and needs to be renewed every fortnight—an improvement on the previous need for replacement every two days. This diaphragm proved fairly effective in keeping the anode and cathode liquids apart and introduced so moderate a resistance that the cell required a pressure of 4 volts, whilst its current efficiency was 70 per cent., *i.e.*, it had an energy of 40 per cent. It was found, however, that the stoneware trough was not a very permanent piece of plant, because it was too liable to break, even spontaneously with variations of temperature. An improvement was made by substituting for the stoneware trough a vessel built of slabs of slate, held together by a pinewood frame, so arranged that the framing was wholly outside, and, therefore, in contact merely with the alkaline solution, which had but little action on it. In working this cell the chief difficulty arose from the diffusion of a part of the caustic soda produced at the cathode, into the anode compartment, where it formed hypochlorite, which was in turn electrolysed, giving oxygen, and eventually (by action on the carbon anode) CO_2. This is objectionable, not only because of the destruction of the anode thus caused, but also because of the presence of CO_2 in the chlorine hindering the manufacture of bleaching powder of full strength. Two remedies may be adopted: one, the maintenance of the liquid in the anode cell at a higher level than that in the cathode compartment, has already been indicated; the other is the addition of a regulated quantity of hydrochloric acid to the contents of the anode cell, so that it may be kept slightly acid. Any hypochlorite which may be momentarily formed by the incursion of caustic soda from the cathode side of the diaphragm is at once decomposed and caused to yield its full equivalent of chlorine instead of oxygen. This second method, though effective, is somewhat dear at Rumford Falls, where hydrochloric acid actually costs more than does its equivalent of chlorine. Of course, in a district where Leblanc works, as well as electrolytic factories exist, no such difficulty exists, the hydrochloric acid being considerably cheaper than chlorine made by any purely chemical process. The case is interesting, and, with the extension of electrolytic manufacture, is likely to recur; it can be met by producing a relatively small quantity of hydrochloric acid from the chlorine and the cathode hydrogen. Sundry schemes of the kind have already been devised by inventors apprehensive that with the gradual extinction of the Leblanc process, hydrochloric acid will become a rarity. Of these there is no immediate prospect.

At the present time the Le Sueur process is worked with cells that are of large size, viz., about 9 by 5 by 1½ft. made of ¼in. boiler plate. The anode cell is a built-up structure nearly as large as the outer cell. It is made of slate or tiles held in a wooden frame, and the joints are made good with Portland cement. Strips of hoop iron are used as the cathodes and as in the older models are placed close to the asbestos diaphragms. Carbon is no longer used as the material for the anodes; for it very thin sheets of platino-iridium are substituted. These cost about 3s. each, and there are 60 in each cell; this corresponds with a capital expenditure for anodes of £1,000 for a monthly output of 200 tons of bleaching powder. Experience shows that these platino-iridium plates are in the long run considerably cheaper than carbon anodes. The metal is not appreciably attacked, and the trouble caused by the production of CO_2, mentioned above, naturally disappears.

The cost of power at Rumford Falls is given at £1. 13s. per electrical horse power year. Accepting this statement, it may be conceded that a high current density, wasting a good deal of power may be profitable to adopt in working. Thus a single cell may take 1,000 amperes at a pressure of 6½ volts, the high voltage and consequent low energy efficiency being of small moment compared with a high output per unit of plant. Where power is less remarkably cheap the Le Sueur process would probably pay best if worked at a moderate current density and moderate pressure, the increased energy efficiency compensating for the smaller output per unit of plant. The present plant consists of three sets of 22 cells each. The chlorine is used for making bleaching powder and chlorate; the caustic soda liquors are boiled down in a vacuum apparatus, separated from sodium chloride in a centrifugal machine, and finally evaporated in ordinary caustic pots to 74 per cent.

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alkali. The separated salt is returned to the cathode compartment. Fresh salt solution, acidulated with a little hydrochloric acid, is supplied to the anode compartment, no recovered salt, which may contain a little caustic soda, being permitted to enter the anode cell. By adopting this precaution, 87 per cent. of the calculated yield of chlorine is obtained. The yield would be higher if it were practicable always to maintain the liquid in the anode compartment in a slightly acid state. The output of caustic soda, on the other hand, is not quite so high, because any which diffuses into the anode compartment where the liquor is intentionally somewhat acid, is neutralised and rendered unavailable.

It is useful to recall the changes which have occurred during the last few years in the conditions which have to be fulfilled by any electrolytic process which is to be more than an elegant experiment. Owing to the stress of competition the price of bleaching powder in Boston is now £6. 6s., as against £9. 9s. in 1892; in like manner, caustic soda fetches £7. 11s. instead of £15. 10s. The margin of profit is thus much curtailed, and extravagant processes, which had some prospect of success half-a-dozen years ago, are now hopelessly outclassed. An electrolytic process to succeed must now compete on level terms with chemical methods worked with the skill and experience accumulated in the course of 80 years of manufacturing, and now carried on with the smallest surplus consistent with solvency.

THE PARIS-AUBERVILLIERS ELECTRIC TRAMWAY.

The last number of the *Bulletin* of the Société Internationale des Electriciens contains a Paper by M. de Marchéna on the first trial of the "mixed" system of electric traction in Paris. The length of the lines are as follows:—

	Intra muros.	Extra muros.	Total.
Paris-Aubervilliers...	2·9 miles.	1·3 miles.	4·2 miles.
Paris-Pantin	2·8 „	1·0 „	3·8 „

Without the fortifications the tram runs on the trolley system, the accumulators on the cars being charged meanwhile from the trolley wire, and within the fortifications the cells furnish the energy to propel the car. For a distance of 1·5 miles within the town the two lines coincide. There are also three branch lines without the city, aggregating 3·4 miles in length, which are also run from the Aubervilliers power station, but on the ordinary trolley system. The maximum gradient is only 3·3 per cent., but it comes at a time when the cells are already nearly discharged.

Each car carries 224 chloride cells permanently connected in series. These are held in a box, 5ft. 8in. × 6ft. 10in. × 2ft., carried beneath the car body; they are not placed under the seats. There are seven plates to a cell, the three positives weighing 11lb., the four negatives 8·8lb., the complete cell with acid 28·7lb., and the whole battery with its box 75cwt. The cars are mounted on bogie trucks, the battery being placed between the two bogies. The latter are so designed that the larger wheels, which are the drivers, bear 75 per cent. of the whole weight. The car body is double-decked, the upper deck being covered, and its two ends are absolutely symmetrical, there being no space for turn-tables at the Paris terminus. Thus it is seen that the cars are unusually heavy, weighing, in fact, 10 tons, without passengers or cells. The 56 passengers, the driver and conductor may bring this weight to 14 tons, and with the battery, the aggregate weight is 17 or 18 tons. The equipment includes a series-parallel controller on each platform, as well as switches to connect the controller either to the cells or trolley line, and to make the connection for charging the cells from the trolley line, two 25 H.P. Thomson-Houston motors, made in France, electric brakes on each of the driving axles, hand shoe-brakes, and sand-strewing apparatus. In the official tests of the electromagnetic brake, the car, loaded with its batteries, and, in addition, 8cwt. of sand ballast, and running down a 2·4% gradient at 12½ miles an hour, was stopped in 46ft., without the help of the sand apparatus.

The power house has three Roser multitubular boilers at 150lb. pressure, and three condensing Corliss engines, running at 75 revolutions, and driving the 6-pole compound-wound 150 kilowatt French-made, Thomson-Houston dynamos at 400 revolutions, from the 10-ton fly-wheel. For charging car-cells at the power house, the dynamos can run as shunt machines at a pressure up to 600 volts. The cells are charged for 30 minutes at the Pantin and Aubervilliers termini after each double journey, but they have a capacity of 45 to 48 ampere-hours, sufficient to make a second double journey if necessary without this supplementary charge. An additional charge is given them at night, on their return to the power house. The line pressure is 500 volts, but the feeder to Pantin is supplied at 530 to 550 volts. A siding at the power house is kept free for the reception of invalided cars, and provided with a hydraulic lift and 6-ton traveller, enabling the battery to be taken out and a new one put in in three or four minutes. The French Chloride Co., who maintain the cells, have here an installation for repairing them, including the needful arrangements for charging and forming the plates and an oven for drying the positive plates after they have been filled with active material. The usual car repairing shop and the condensing water pumps are driven by electric motors.

The following results and tests are interesting: The consumption of an empty car during the double journey of 5·8 miles, with 14 stoppages, was 885 watt hours per car mile. When loaded the consumption rose from 965 to 1,005 watt hours per car-mile. These figures correspond to abont 65 watt hours per ton-mile. In practice, however, with the ordinary drivers and a greater number of stoppages, these figures are exceeded. At any rate, it is claimed, that they are not more than 15 or 20 per cent. greater than for cars fitted with the same motors and weighing 10 or 11 tons loaded, instead of 17 or 18. Outside the fortifications the cars will run smoothly, with the motors in parallel, at 15 miles an hour. An ammeter in the motor circuit shows no increase in the current on going round curves of 80ft. to 100ft. radius. On the level, with motors in series, the current is from 20 to 25 amperes, but on the hill up the Faubourg St. Denis it is necessary to put the motors in parallel to obtain sufficient speed. The mean pressure of the cells during their 25 or 26 ampere discharge is 420 volts. When the 30min. charge is made the current starts at 80 or 100 amperes, drops to 60 amperes in 5min. and diminishes gradually to about 20 amperes, when the charge is stopped. The capacity of the cells is found to vary with the condition of the positive (pasted) plates, often dropping to two thirds of its original value in a few months. Ebonite boxes have been used for the cells up to the present, but have been troublesome. Experiments are being made with other material, notably ambroin.

The consumption as registered by watt-meters at the power house has been:—In June, 1800 watt-hours per car-mile; in July, 2,140; and in August, 2,350. It must be remembered that a third of the car-mileage is on the simple trolley system. The increase in the consumption is attributed to deterioration in the cells, and it is concluded that the efficiency between dynamo and motor terminals can be 60 per cent. under good conditions, but that it may drop to below 50 per cent. when the state of the batteries is no longer so satisfactory.

ELECTRIC INTER-COMMUNICATION IN RAILWAY TRAINS*

BY W. E. LANGDON.

The first practical means of communication between the passengers, guards and the driver of a railway train was that established by Mr. W. H. Preece, C.B., F.R.S., past-President, on the London and South Western Railway in 1864. The agency employed was electricity. The need for some means of communication between the passengers and the officials in charge of railway trains had been long felt. The Railway Commissioners, as well as the Board of Trade, urged its desirability. On two occasions it formed the subject of inquiry by committees of the House of Commons; and prior to 1866 no less than three com-

* Abstract of a Paper read before the Institution of Electrical Engineers, Dec. 15, 1898.

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mittees composed of the general managers of the various railways had specially considered the subject. In 1865, the Board of Trade instructed Captain (now Sir Henry) Tyler, then one of the inspecting officers for the Railway Department of the Board of Trade, to examine and report upon the question. His report, which was issued the same year, was in favour of the establishment of "some" means of communication. In 1867 the Board again drew attention to the subject; and in 1868 an Act of Parliament made it incumbent on all railways to provide a means of communication between the passengers and the guards of every train travelling over 20 miles without stopping.

The railway companies themselves had not been indifferent to the need, for, as Mr. Preece, in a Paper* read by him before the Institution of Civil Engineers in 1866, relates, the London and North Western Railway had spent a considerable sum of money in an endeavour to establish an electrical means of communication; while experiments had also been conducted, with a like object, on the London and South Western Railway. It was not, however, until Mr. Preece produced his system in 1864 that a satisfactory basis for effecting the long-felt need was laid down. This was rapidly followed, on the South Eastern Railway, by Mr. C. V. Walker, one of our first Presidents, who produced that known under his name in 1866. Varley about the same time established an electrical form of communication on one or more London and North Western trains. The London and South Western fitted up several trains with Preece's system, and trial trains were also fitted with the same system on the Midland and London and North Western. An improved mechanical "cord" system was produced about the year 1868. This "cord" system is that with which every railway traveller is acquainted, and which, passing along the eaves of the vehicles, is available from the outside and from one side only of the train. Eventually, in 1868, the railway companies elected to employ the mechanical rather than the electrical mode of communication; and to this the Board of Trade extended conditional approval.

The South Eastern Company declined to fall in with this decision. Recognising the advantages which an electrical means possessed over that of the mechanical cord, they desired to retain it; and in this they were subsequently † followed by the London, Brighton and South Coast Railway. Each of these companies have now their entire passenger stock fitted with an electrical communication. The London and South Western—a company having more trains electrically fitted than any other company at the time when the "cord" system was adopted—presumably found the difficulty of keeping together a partially fitted stock too great, and in course of time abandoned the effort. In 1872 Captain Tyler reported the working of the "cord" system as unsatisfactory, and in the course of his remarks observed, "An electrical apparatus appears, on the whole, to offer the best chance of success." The "cord" communication has, however, been retained in use on the majority of railways; the only exceptions being the two lines previously referred to. The Hull and Barnsley (the stock of which was electrically fitted at the opening of the line in 1885), together with a portion of the stock of the Chatham and Dover Company; the Furness Great Central, and Cambrian lines, employ to a certain extent a partial application of the vacuum brake.

The whole question has now been brought to a climax by the report of the departmental committee appointed by the Board of Trade in 1897 to consider and report upon the subject. As is now well known, the result of the deliberations of this committee was the condemnation of the mechanical cord and the recommendation of an electrical system, accompanied by certain suggestions in relation thereto. The adoption of an electrical system involves some very important considerations. The question has now to be viewed from a vastly different standpoint to that from which it has been considered hitherto. It is to be applicable to the entire passenger stock. It is desirable it should appeal against outrage as well as meet other demands. The interchange of railway stock between the various railway systems is now a matter of everyday occurrence; consequently, the system to be adopted should have a common basis, and the mode of connecting the various vehicles should be absolutely uniform. How is this to be accomplished?

The railway companies have, practically, at this moment an open field before them. The total number of passenger traffic vehicles belonging to the entire railway service of Great Britain and Ireland amounts, exclusive of 18,099 locomotives, to 55,868—in all, 73,967. The total stock of the three companies which have their coaches already electrically fitted comprises 5,430 vehicles and 977 locomotives; so that, if an entirely new system had to be adopted, the number of vehicles which would require modification would, in comparison to the whole, not prove very considerable; and this especially so, should the modification of the stock already fitted prove of a very simple character.

I propose to consider the question under the following heads:—(1) The electrical system; (2) Mode of connecting vehicles; (3) The means for claiming the attention of the officials in charge of the train.

1. The Electrical System.

Fig. 1 illustrates diagrammatically the system introduced by Preece in 1864. I reproduce this because it forms the basis on which this form of communication has, in almost all cases, been framed; and it, moreover, constitutes the only basis upon which a practical form of passenger and guard communication can be established.

A is an insulated wire proceeding through the train; B represents the rails upon which the train is travelling; c is the engine; d, d', guards' vans; and e, e', e'', coaches. Each of the guards' vans is provided with a bell, battery, and a bell key. The passenger vehicles are provided, in each compartment, with a switch, or

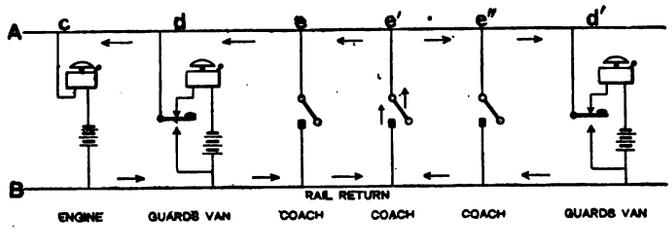

Fig. 1.

means of joining the two conductors, A and B. The batteries are, as will be observed, arranged in parallel. The condition is practically one of balanced currents. All is in tension, but until the balance is disturbed no action sufficient to operate the bells can take place. If the switch at e' is closed, we at once form this outlet, and each battery finds its circuit, as shown by the arrows. Every bell in the train is thereon set ringing, and continues to do so so long as the connection at e', or, of course, any other like connection, remains good. The same occurs when either of the guards desires to signal to the other, or to the driver. By pressing the bell key the two conductors, A, B, are joined in precisely the same manner as when connected at e', but the guard who makes the signal, in doing so removes his own bell from the circuit.

Fig. 2 illustrates the arrangement inaugurated by Walker. Considerable modifications have been introduced by Mr. Leonard, Mr. C. V. Walker's successor, but some complication still attaches

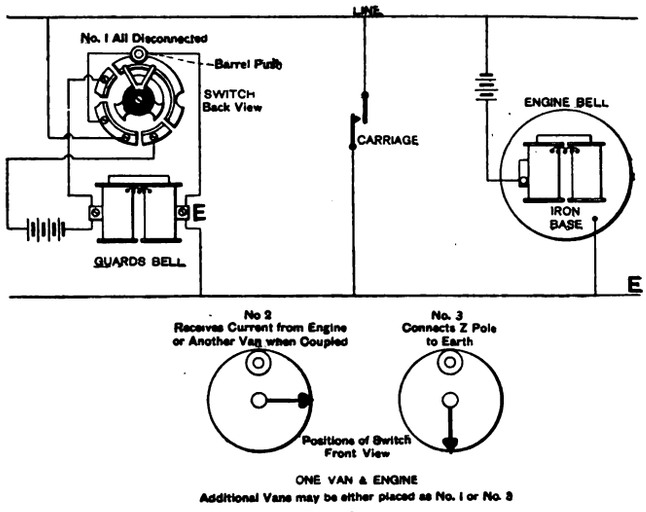

Fig. 2.

to it. One insulated wire is employed; the rails as a rule, forming the "return," although, latterly, Mr. Leonard is supplementing the rail return by an open wire joined to the rail connections. The batteries of the two end vehicles only are in use. They are in parallel; but a three-way switch has to be provided in each van, and the guard has to arrange the switch of his van according to the position the van occupies in the train. When intermediate between the engine and another guard's van, it is so placed that his bell may ring but that his battery may be out of circuit.

The Brighton Company's system is essentially Preece's. Mr. Houghton, the Company's electrical engineer, informs me that he also is now forming, by means of an open wire carried under the frame of the vehicle, a metallic return—not independent, but

* Preece, "On the best Means of Communicating beween the Passengers, Guards, and Drivers of Trains in Motion," Institution Civil Engineers, 1866-67.

† The electrical passenger and guard communication on the Brighton line was introduced in 1874, and from that date gradually superseded the mechanical cord.

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supplementary to the earth or rail connections. It is found that the rail "return" is not reliable, especially in very dry weather—a result which might be anticipated.

The London, Chatham and Dover have somewhat recently applied an electrical form of communication to certain of their trains. The system is termed Varley's, but it has, at the suggestion of the Company's electrical engineer, Mr. Burnham, undergone some modification. The principle now being pursued is shown in Fig. 3. It is, in practice, very similar to that in use on the South Eastern. The batteries of the two end vans are in circuit. The batteries of intermediate vans are cut out. The system is a two-wire system, both wires being insulated. It will be observed

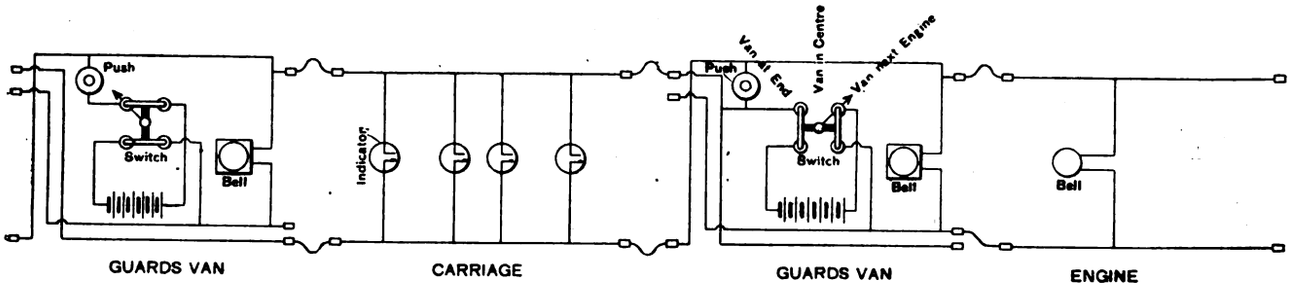

FIG. 3.

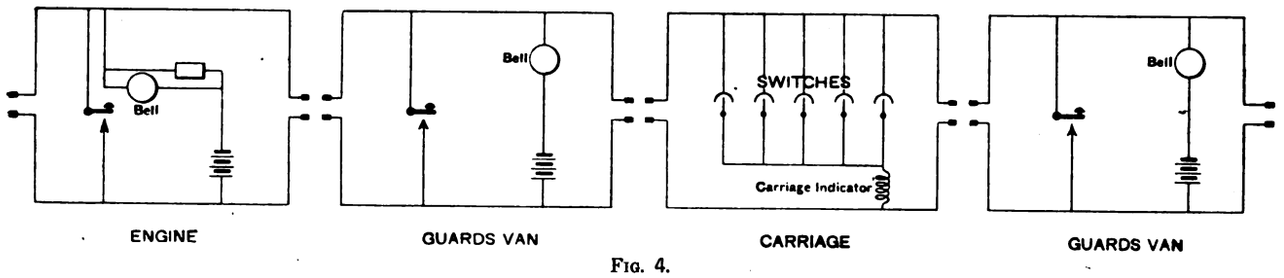

FIG. 4.

by the diagram that the guards' vans are provided with three connections, two of which are applicable to the connection between the van and the locomotive, and that the bell in the van adjoining the engine is in parallel with that on the locomotive. This dispenses with a battery on the engine, but in order to ensure equal action on the part of the two bells it is necessary that the *resistance* of the conductors and instruments should be fairly equal.

The system employed on the Hull and Barnsley is also a two-wire system, and the circuit arrangements call for the provision of adjusting switches in the guards' vans, in like manner to those employed on the South Eastern and Chatham and Dover.

Considerable attention has been called to a train fitted up by the Great Eastern. The rails are not in this system made use of. One insulated wire passes through the train. The iron tube serving the brake is taken advantage of to form a portion of the return circuit, which is, consequently, uninsulated. The electrical arrangement is shown in Fig. 4. The batteries are in parallel.

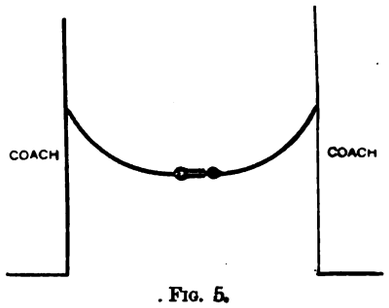

FIG. 5.

The system is that of Preece, with the exception that an open "return," independent of the earth or rails, is provided.

A train has also been fitted by the Midland. The electrical system is that represented in Fig. 1, with the exception that two insulated wires are employed—neither rails nor brake pipe are touched. All portions of the electrical system are protected from moisture, so that there may be no leakage.

We have now before us the various electrical "systems" calling for criticism, and the first question which will present itself for consideration is whether a one or a two insulated wire system is to be preferred. We have seen, from the experience of the London, Brighton and South Coast Railway, that an earth or rail return is not satisfactory. It will also be clear that with an open—*i.e.*, an uninsulated—return any leakage which may arise in the insulated wire, or its connections, will result in short-circuiting the batteries to a less or greater extent according to the amount of leakage; and it will be equally obvious that with two insulated wires any defect in one would not produce such a result. The cost of the second wire is so small that it is questionable if it would amount to that incurred in making the connections to the wheels or other portions of the vehicle in order to ensure a satisfactory earth return, where this course is pursued. Indeed, it is difficult to imagine why a one-wire system should ever have been preferred, unless it is to be accounted for—as is probably the case—by the fact that a two-wire connection may have presented some difficulty in the matter of coupling up the vehicles. With this branch of the subject, however, we will deal later on.

In October of last year, the author, with a view to obtain data on the action of battery cells joined in groups, in parallel, caused three sets of bichromate cells, composed of two-quart jars, and

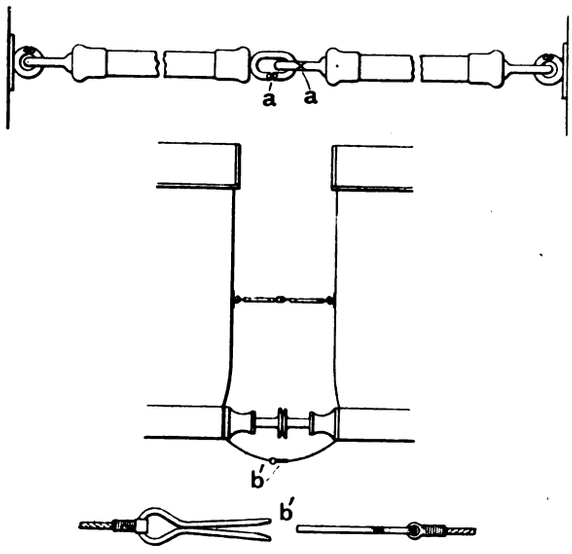

FIG. 6.

three sets of ordinary Leclanché, of No. 1 size, to be connected with bells as shown in Fig. 1, the connecting wires being insulated. The working capacity of the cells was taken each day from October 18th to November 20th. There was apparently no depreciation. The positive element was free from crystals, and the electrolyte did not show depreciation. Consumption, of course, there was, but it was exceedingly small. This tallies with the experience of Mr. Houghton, who tells me that the consumption of battery power on the Brighton Company's trains—which, it will be observed, are worked under this system—is very little. The adoption of the parallel battery arrangement, uncostly in battery consumption, possesses also the great merit that it enables the vehicles to be turned about and connected up indiscriminately, independent

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of the position they may occupy in the train. Switches are not needed, and, manifestly, if this is so, it is a convenience as well as an economy to dispense with them. Their object except, perhaps, with a view to economising battery power, is not apparent.

2. Mode of Connecting Vehicles.

It has been suggested that possibly the question of coupling up the vehicles has proved influential in the adoption of the single insulated wire and earth return. With an earth return it is necessary to make provision for joining one wire only through from carriage to carriage, the opposite pole being connected to the wheels and frame of the carriage so as to afford metallic connection with the rails. This branch of the question appears to have proved a somewhat serious stumbling-block. In the Board of Trade report we find it laid down as one of the conditions to be achieved, that the electrical coupling should be combined with one of the couplings already in use—the brake, heating service, the screw coupling or the side chains. All, except the first named, we may at once dismiss as unsuitable, or too difficult in application to merit consideration.

Fig. 7.

Fig. 5 is an illustration of the coupling employed by the South Eastern. It consists merely of a piece of wire arranged as a spiral, with a loop at either end, which passes over a hook on the end of the vehicle, and which forms the termination of the line wire. Fig. 6 represents the coupling employed by the Brighton Company. It is formed of a spiral of wire enclosed in an indiarubber tube. The wire terminates at each end in a galvanised iron loop, which at the end which is attached to the vehicle passes over a hook forming the termination of the line wire; but the loop at the end which has to be coupled up is divided at *a*, so as to admit the loop of the corresponding part, applicable to the adjoining carriage, passing through it. Each of these companies is, as previously indicated, gradually introducing an uninsulated return wire, the rails in dry weather not proving satisfactory. This return wire is coupled through by a bare stranded copper wire terminated with a split spring connection, *b'*, as shown in the illustration.

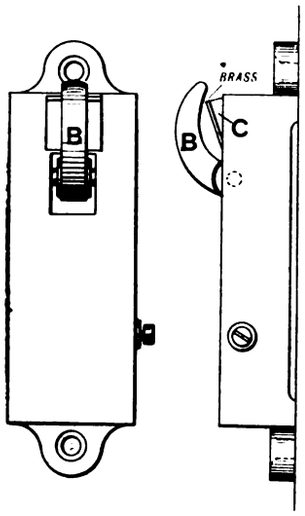

Fig. 8.

Fig. 7 is the coupling used by the Chatham and Dover Company, and 8 is the coupling box. The loop, A, in coupling up, is passed over the hook, B, which, under the influence of a strong spring, holds it in good contact with the projection, C.

(To be concluded.)

BOOKS RECEIVED.

"The Official Gazette of the United States Patent Office," No. 4, Vol. LXXXVI. Published by authority of Congress. (Washington: Government Printing Office.)

"Science Abstracts." No. 1, Vol. II. Edited by J. Swinburne. Also Index to Vol. I. (London: E. and F. N. Spon.) Price 3s. Index: Price 3s.

"*Transactions* of the North-East Coast Institution of Engineers and Shipbuilders." Parts 1 and 2, Vol. XV. (London: Andrew Reid and Co.)

NEW WORKS OF MESSRS. WILLIAMSON AND JOSEPH, AT CANONBURY.

Immediately after the acquisition by the London County Council of their old works premises at Horsleydown, S.E., Messrs. Williamson and Joseph (Limited), an old established firm of manufacturing electrical engineers and electricians, decided to concentrate their offices and works into one establishment, and for this purpose acquired the freehold of an extensive three-storey building in Northampton-grove, Canonbury, London, N., which had previously been occupied by a firm of mechanical engineers. The favourable situation alongside the North London Railway, and the extent of the building, together with the opportunity of purchasing some adjoining ground suitable for the erection of offices, store-rooms, and foundry, rendered the position very suitable for the purpose in view. A well-equipped, efficiently warmed and ventilated range of offices and warehouses has been built and occupies the front portion of the set of buildings. In the rear a foundry has been erected and is shown in the first of our illustrations. To the rear of this foundry is the building which has been converted into excellent workshops for hand and machine operations. In Fig. 2 a view is presented of the machine shop, in which are erected metal workers' benches and light lathes, and a number of automatic

Fig. 1.—Foundry.

machines for milling, stamping, shaping, cutting, &c. At the end of this shop is a large central space, which is shortly to be filled with automatic machinery for the manufacture of screws, terminals, &c. Fig. 8 shows the fittings' shop on the first floor, and at the end of this shop a circular staircase (shown in the illustration) leads up to the cabinet making and carpentry department, in which instrument bases and frames, fuse boards, cabinet work, and similar goods are manufactured. On this floor the lacquering and finishing rooms are also conveniently situated.

Messrs. Williamson and Joseph are equipping their works with special machinery for the manufacture of high voltage fittings and appliances, for which there is a very great and increasing demand. In addition to this class of goods, the firm continue to manufacture fittings for ordinary electrical work both for private installations and for those connected with public electric supply. The excellent character of their manufactures and the systematic methods adopted throughout the new factory render it possible for this firm to compete on very favourable terms with the Continental makers of small electrical fittings and apparatus especially, and on the occasion of a recent visit we were shown a number of well-made fittings and other electrical appliances, which are supplied to the trade at prices that make it difficult for the Continental makers to compete with them, either in quality or price. Switches and switchboards are also a special branch of the manufactures of this firm, and in this department an

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extensive business is being done exclusively for trade and professional orders. We may mention here that only trade and professional work is undertaken at Northampton Works.

Messrs. Williamson and Joseph, we understand, intend to specialise their manufactures, operations being mainly confined to switches, switchboards, fuses, cut-outs, screws and terminals, case and cabinet work and small electrical details and fittings, and it is further intended to stock nothing that is not actually manufactured at the works. The firm are the owners of the "Prentice" patents for cut-outs, &c.

Upon the three large floors of which the workshops consist a staff of over 100 hands is engaged, many of whom have been with the firm since its establishment in 1887, and of the remainder many have served for several years, and are consequently well acquainted with the development in electrical manufactures which the past decade has shown. The close proximity of the works to the centre of distribution, and the possession of new up-to-date plant and machinery, much of which is automatic, will ensure for Messrs. Williamson and Joseph a good share of the business in the particular class of manufactures (electrical and otherwise) in which they are engaged, and for which the new works, when fully complete and equipped, will be in a position to handle extensive orders.

In Fig. 4 we illustrate a new type of charge and discharge switch-concentric type, which is now being placed upon the market to meet a demand which has arisen for a switch occupying the minimum of space giving maximum ease of manipulation. The position of the two handles, one above the other, is a handy and simple arrangement.

Fig 5 shows a new type of high-voltage lamp holder, which is now in demand in large quantities. Messrs. William son and Joseph claim for this lamp-holder the highest possible insulation, the insulation being strongest where in all previous lamp-holders it has been the weakest, viz, where the flexible lead is attached to the plunger. If has been impossible before this to prevent possible leakage from the set screw to the lamp-holder case. This switch entirely overcomes this difficulty. The porcelain is non-hygroscopic, and has been

FIG. 2.—MACHINE SHOP.

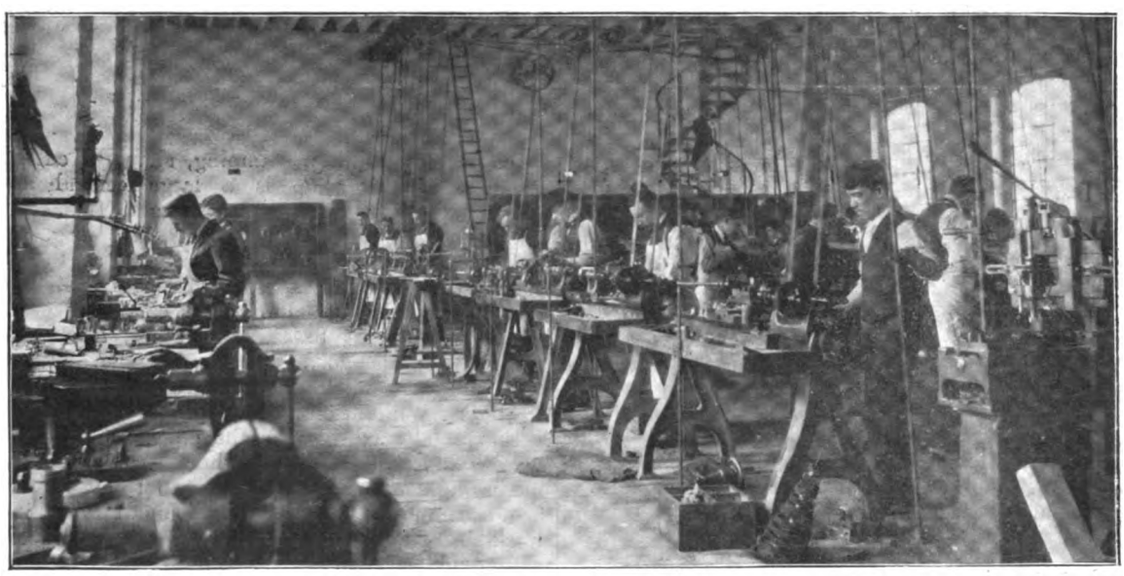

FIG. 3.—LATHE AND FITTINGS SHOP.

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subjected to the most severe tests. It is simple and easy to wire, and it is practically impossible for "shorts" to be

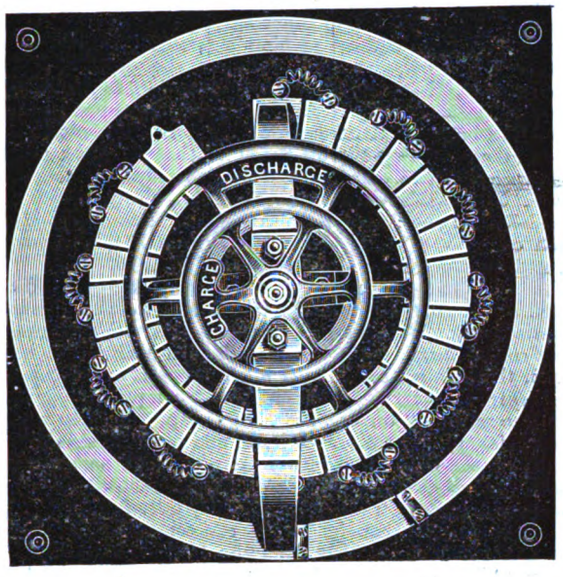

FIG. 4.—CHARGE AND DISCHARGE SWITCH-CONCENTRIC TYPE.

occasioned by the carelessness of the average wireman in leaving the flexible loose, and so short-circuiting the same with the

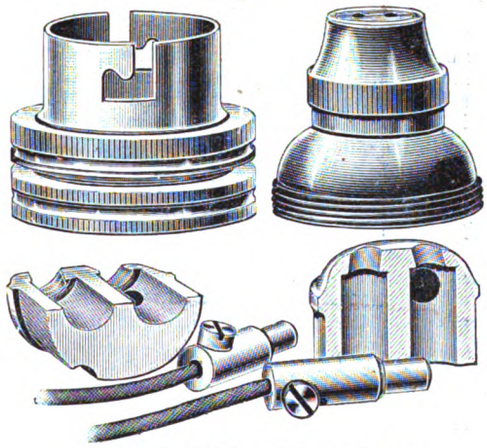

FIG. 5.—HIGH VOLTAGE LAMP HOLDER.

case. A testimonial from the representative of one of the principal fire offices is very eulogistic of this new form of holder.

NERNST'S ELECTRIC LIGHT.*

BY JAMES SWINBURNE.

Before describing Nernst's invention, it may be profitable to spend a few minutes reviewing the position of electric lighting. The whole industry is at present controlled by the incandescent lamp. We are so accustomed to this, and it is taken for granted in such an unconscious way, that we do not realise how much everything depends on the maker of the carbon incandescent lamp. In very early days, that is to say, in the early eighties, there were a few Edison lamps at 100 volts, with an efficiency too horrible to mention, but the Swan lamp came along made for 50 volts. I say made for 50 volts advisedly; I mean that the makers tried to make 50 volt lamps, and produced lamps taking from 40 to 60 volts. If the lamps were not bright enough you ran the engine faster, or put a smaller pulley on the dynamo. (The belt then generally slipped, but that is not to the point.) For about four years, which is a long period in the development of such a rapidly growing industry as electrical engineering, the makers of incandescent lamps, or, in fact, the makers of the Swan lamp, decreed that the electromotive force used should be from 40 to 60 volts. There was no appeal. There was no development of central station supply at that time, but still, even then in large buildings there was the longing for higher pressures on account of the cost of the mains.

About 1885, the Swan 100-volt lamp came into use. It was a clumsy affair, with little loops of platinum at the sides. At first the lamps were pretty bad, but they gradually improved, and 100 volts, or in some cases 110 volts, became the recognised pressure for electrical supply. As town lighting from central stations came into being, the limit of 100 volts became a serious trouble, and the evil was partly mitigated by the use of three or even five-wire systems. I must point out that the incandescent lamp exercises its tyranny in two ways. It not only insists on a low pressure, such as, say, 100: and thus demands large leads to feed it, but it is so sensitive to variations of pressure that the system of distribution has to be arranged to give a practically uniform pressure at the terminal of the lamp. The necessity for uniform pressure probably gives more trouble, and costs more than the mere low pressure; and it would be cheaper to supply at 100 volts with a good margin of permissible variation of pressure than supply at 200, with a very small percentage of variation.

Quite lately the incandescent lamp makers have produced things called 200-volt lamps, and some make them for 250 volts. So there is a general tendency on the part of supply companies to jump to a 200-volt supply. The innocent consumer is, therefore, pressed by the company to change over to 200 volts. The company likes the change very much, and the lamp maker also enjoys it, as he makes more lamps and charges more for them.

Considering the enormous importance of the incandescent lamp, its improvement has received extraordinarily little attention. It limits us as regards pressure, it used to hamper us by its cost, it limits us as to variation of pressure, and it limits us very seriously by its inefficiency. Yet, in spite of these, the carbon incandescent lamp has made practically no advance in 15 years. Of course, mere detail improvement in manufacture has taken place, and this has led to better quality and greater uniformity, hence cheapness; but there has been no radical improvement. The jump to 200 volts from 100, or from 50 to 100, did not depend on any sort of radical improvement in the incandescent lamp; it was merely the result of detail improvements, making it possible to produce long, thin filaments. Other things being equal, it is easy to see that the long, thin filaments must be weaker. If the carbon has the same specific resistance, the relation between pressure and length is $E=L^{\frac{1}{2}}$ and $E=D^{-\frac{1}{2}}$. If the filaments are flashed, the proportions will be still more extreme. The question of high-pressure incandescent lamps is thus: How far can we make the filaments longer and thinner and flimsier without exasperating our consumers? Unfortunately, the consumer is rapidly getting saddened as it is. The 100-volt 8 c.p. lamp does not please him much, and the 200-volt 8 c.p. lamp has in no way delighted him; if the lamp is made with two 100-volt filaments in series, it combines the disadvantages of both, without the advantages of the small candle-power of either. But it adds some further disadvantages peculiar to the higher pressure which I have not so far touched upon, and that is that the higher the pressure the more troubles there are through the silent discharge, or whatever it is called. I need only refer to the well-known experiment, in which a third terminal is sealed into the lamp. A galvanometer then shows a current going across country inside the lamp. This is no doubt intimately connected with the life or rather with the death of the lamp.

I have dealt with the question of high-pressure incandescent lamps at some length because the subject is really of vital importance, and is too much neglected. Our technical colleges, and our technical press, and our technical societies pay the greatest attention to questions of a per cent. or two in the efficiencies of dynamos and transformers, and give a good deal of attention to engines and boilers. That is because there is plenty of room for calculations in connection with these subjects; but the incandescent lamp, which at present holds the whole career of the lighting industry in the little curl of flimsy red-hot carbon that can hardly support its own weight, receives no attention at all. How much does the average electrical engineer know about incandescent lamps? The only subject that is treated in the same way is the cable. About half the money in town lighting goes in the cable, a mere fraction in the dynamos and transformers themselves; so the average electrical engineer knows nothing about cables. So far I have only discussed the incandescent lamp; the arc lamp has also to be considered. I will not say much about the arc lamp just now, but will add a little more when the Nernst lamp is compared with it. The ordinary arc is limited in pressure to about 50 volts, including the series resistances necessary for regulating. The enclosed arc is a new development which is more satisfactory as regards pressure and as regards consumption of carbon.

The lamp I describe to-night is the invention of Professor Walther Nernst, of the University of Göttingen. Though he is a young man, Professor Nernst's name is already known to all modern chemists as a leading authority, and original thinker in

* Paper read before the Society of Arts, Feb. 8, 1899.

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the field of physical chemistry. It is unusual for a man who has climbed to the top of one tree to jump to the top of another. Nernst's, like most great inventions, is exceedingly simple as soon as it is understood. The efficiency of an incandescent body, as far as radiation goes, depends simply on the temperature. The efficiency of an incandescent lamp, for instance, depends on the temperature of the filament only, providing there is no loss by convection. The carbon will not stand a sufficiently high temperature, especially as, in addition to its low specific resistance, the filament has to be long and slender, and thus weak. Nernst, therefore, chose a material that would stand higher temperatures than carbon, and his material has the incidental advantage that its specific resistance is so high that strong rods can be used for high pressures instead of thin filaments. The most refractory materials so far used in lighting are zirconia, which has been used to replace lime in the limelight, and the oxides or so-called rare earths, in the Welsbach mantles. I am aware, of course, that many people suppose that the Welsbach mantle is not very hot, treating it as if it were at a temperature, for instance, below the melting-point of platinum. The light emitted is supposed to be due to some special power of selective emission due to the oxides employed. I have had a good deal to do with incandescent gas mantles, and I find no reason to suppose there is any magic effect of this sort going on. The part of the flame where the mantles hang fuses platinum wire easily, and very few materials can stand the temperature without fusing or volatilising. Lime and many other oxides volatilise slowly from the mantles. I do not mean that the mantles are above the boiling-point of lime ; I have some idea of its melting point, as I have made a few pounds of melted lime, and run it out on the floor to look at it. The Welsbach mantles, which are now chiefly thoria, are at a temperature near their softening point, and in the making are raised to a temperature at which they begin to soften.

Nernst takes highly refractory oxides as his material. It does not seem promising, because such oxides are notoriously good insulators. But such insulators are electrolytes when hot ; Nernst, therefore, heats the rods to make them conduct, and then heats them electrically, preserving a temperature which is within the limits that the material can bear without softening. This means that he can take the most refractory bodies supplied by the whole range of chemical research, and can heat them to a temperature short of their softening point, and can thus get an efficiency unknown to workers on the incandescent lamp. Such efficiency also means whiteness of light, so long as the efficiency is not too high. Thus the crater of the arc being at a temperature of boiling carbon, gives a light that is unpleasantly blue. The material is worked up into little white rods. Each rod is mounted on two platinum wires, a little paste made of refractory oxides being applied to the joints. The little rod, with its two wires, is then mounted in a holder which fits ordinary electric light fittings. As the rods fall in resistance as the temperature increases, after the manner of electrolytes, an increase of current produces a decrease of resistance. This tends to give some instability in running in parallel on supply circuits. This instability is corrected, as in an arc lamp which has analogous properties, due to a different cause, by a series resistance. The Nernst rod has therefore a resistance in series. This is made up of exceedingly fine wire, and for ordinary circuits amounts to 10 or 12 per cent. of the whole resistance of the lamp. The consumption, including the resistance, is 1·5 watts per candle for large lamps, and 1·6 for small lights or low pressures. In small or low-pressure lamps the loss of heat at the ends is larger in proportion.

Such a lamp as I have described will not light up of itself, for the rod is an insulator when cold. The simplest way to start it is to warm it up with a match, or better with a small spirit lamp. Such a lamp as this is not only very cheap as regards first cost, but very economical in running. The life of rods, running at an efficiency of $\frac{3}{4}$ of a candle per watt, including the resistance, is already more than 500 hours in good specimens. If the Nernst lamp advances as much in the first few years of its existence as the carbon lamp did between 1880 and 1882, it will soon be made so well that the rods last a life-time. When the rod is worn out a new rod with its wire mounts is all that is replaced. The whole lamp is not thrown away at all. The method of lighting I have described, though it may be used in many cases, such as large public rooms, is really a savage mode of ignition, fit only for dealing with uncivilised commodities, such as gas and tobacco. The small lamps and the lamps of medium size are in practice started by a heating resistance. This is arranged close to the rod, and in shunt to it. As soon as the rod is hot enough to conduct, its current works a tiny cut-out in the resistance circuit. In large lamps the heating system is a little more elaborate, as the resistance arrangement is arranged as a sort of hood which covers the rod. As soon as the rod conducts, not only is the resistance circuit broken, but the electromagnet lifts the little hood clear off the rod. In all these forms, the rod and its mounting are replaceable without interfering with the rest of the lamp.

We now have to consider the part the Nernst lamp is probably going to play in the near future. Compared with the small incandescent lamps, as you deal with a material of much higher specific resistance, it is easy to give both small lights and high pressures. The question of lighting is exceedingly important, though it appears trifling at first sight. People are so accustomed to lamps being turned on from the door without any further trouble, that they will generally object to having to light them with matches or spirit lamps, but there are many cases in which it will be quite satisfactory to have one lamp with an automatic lighter to show you the way into the room, the rest being lighted with matches or a spirit lamp as needed. There will be, however, a considerable opening for the cheap, small power, high efficiency lamp ; and the disadvantage as to lighting is small in such cases as cafés, restaurants, churches, hotels, railway stations, and, in short, in most public rooms, is small.

Coming now to the next size, that is to say, lamps of 20 c.p. to 200 c.p., and even small lamps in which it is worth while to have automatic ignition, the first cost of such lamps will be higher than the first cost of incandescents, but as the rod itself has alone to be replaced, that is a matter of very slight importance. This size of Nernst lamp has further every chance of completely ousting the carbon incandescent on the score of cheapness, as to renewals, higher efficiency, better coloured light, and perhaps more especially high pressures. Once the Nernst lamp becomes so general that systems of distribution are laid out to suit it, instead of to suit the carbon lamp, the carbon lamp is practically out of the running. It must be remembered that the Nernst can compete with the carbon filament at any pressure that suits the filament, but the Nernst lamp can easily go right out of the depth of the filament, and have the higher pressures to itself. It must be remembered that at present the cost of cables in a system of distribution is an exceedingly large item.

Turning now to the large lamps, they compete with the arc lamp in efficiency. Of course, the efficiency of the arc lamp is not a very definite quantity. The candle-power is generally determined by multiplying the current by two and adding zeros at discretion. All I can say is, that however many zeros the good nature of the maker may supply, a Nernst lamp taking the same power gives a better light. When carefully arranged on the photometer, the arc may be better in given directions, but a lot of light given in directions that you do not want is not the same as the same light distributed with a uniform spherical emission. The arc lamps shown here will give the audience a good idea of the relative values. The Nernst gives a pleasanter, and, of course, a perfectly steady light. Coming to costs, the Nernst will be very much cheaper in first cost, but enormously cheaper in maintenance. It also goes quite away from the arc as to pressures. There is no trouble, for instance, in making large lamps to work in parallel at 500 volts, and by using double rods at 1,000 volts. This puts an entirely new development of electric lighting in the hands of the engineer.

There is one point I have said little about yet. The incandescent lamp, which is still with us, gives trouble, not only because of the low pressure it needs, but also because it demands that the pressure shall be kept uniform. It seems quite possible that the Nernst lamp may be made to stand a much greater variation of pressure than the filament. If this proves true it means an enormous difference in the designing of distribution mains. I do not like to say much about this yet as the invention is too young, and too little time has been available to make much certain progress in that direction. Results are promising, but it is best not to be sanguine. It is difficult to discuss an invention like this without being carried away by enthusiasm. I feel, however, that I have but feebly shown forth the probable future of what seems to me the greatest invention in electric lighting that we have seen for many years. Still I am sure I have not been too sanguine.

An Armature Baking Oven.—The power-house of the Atchison Railway Light and Power Co., in Kansas, has in its car-repairing shop a very simple but effective oven for baking motor armatures. The oven, says the *Street Railway Review*, consists of a box in which one of the car motors was shipped, lined with tin and about 1in. thickness of asbestos between the wood and tin. The box is 17in. wide, 17in. deep and 3ft. 3in. long inside. The armature rests on two end bearings. On each of the wooden blocks is a five-lamp circuit, and these furnish the heat for drying. After the armature is in place the oven is closed, so that it is practically air-tight, and all the incandescent lamps are turned on. When the interior of the box is thoroughly heated one circuit is cut out, the other being sufficient to dry the armature. The oven does its work quickly and at small expense.

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CORRESPONDENCE.

BLACK'S REVERSALS METHOD.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. R. R. Black is to be congratulated on having made a useful addition to the methods by which conductor resistances may be measured (page 416). His test is, of course, based upon the supposition that, since one of the sides of the bridge is a fixed resistance, the strength of the testing current will be the same whether the direction of its flow be positive or negative, and the ohmic equivalent of the E.C.; consequently, constant in amount, but subtractive or additive according to the relative direction of the testing current. I say "supposition" advisedly, because it is, unfortunately, not always safe to assume that the polarisations, and, consequently, the effective EM.F.s of the battery and earths, will be the same when the flow of the testing current is in one direction as when in the other, even if the time intervals between the reversals be made practically equal; nor that they will even be so for currents of similar sign after a reversal.

The errors resulting in this way may not, as a rule, be large, but they appear to be present even in the examples given in the article. They may, however, be avoided by inserting a milammeter in the battery circuit, and accepting balances, not at equal intervals of time, but only when the testing currents are observed to settle down to some given constant value.

Reversal methods should be used sparingly and with caution. They are only reliable when the battery, line and earths are practically perfect, and they should be employed, as a rule, only as a check method on perfect cables.

A further and most important objection to the too exclusive use of reversals is that observers are prevented from obtaining the training and practice necessary for the successful application of E.C. zero tests. These are so frequently required for the purposes of localisation, and are so instructive to learners, that they cannot be too frequently rehearsed on good cables, since it is only in that way confidence and expertness, in recognising the correct moment at which the E.C. zero should be taken, can be acquired. It is useful to note that the voltage of the E.C. existing during tests by Mr. Black's method may be obtained, when the ratio is even, by the formula

$$e = \tfrac{1}{4}(R - R_1)c,$$

where c is the current in the battery circuit expressed in amperes. This, however, assumes the difference $R - R_1$ to be totally due to the E.C., which, as I have pointed out, may not always be the case.—Yours, &c.,

London, Jan. 31, 1899. WALTER J. MURPHY.

LEGAL INTELLIGENCE.

Electric Construction Co. (Limited) v. Dick, Kerr and Co.

This case came before Mr. Justice Romer, in the Chancery Division, on Friday last, on a motion by plaintiff of an interim injunction to restrain the defendants from alleged infringement of the plaintiffs' patent in connection with electric motors.

Mr. FLETCHER MOULTON, Q.C. (for plaintiffs), said defendants had put in affidavits which showed that there was a question to be tried, and he, therefore, suggested that the motion should stand till the trial upon the defendant's undertaking to keep an account. His clients found they could not yet deliver pleadings because the Master in Chambers had ordered an adjournment of a summons for directions until after the hearing of the present motion. In a patent action it seemed to be quite ridiculous not to be allowed to deliver particulars of breaches, and he, therefore, asked his lordship's leave to deliver particulars.

His LORDSHIP said he could not go into that now. The matter would go before the Master, and if he objected then it would come before him in Chambers.

Mr. MOULTON then asked that the action might be allowed to be set down at once.

Mr. RALPH NEVILLE, Q.C., for defendants, objected to this, because this was one of several actions brought in respect of the same patents, and, so far as could judged, what the plaintiffs were endeavouring to do was to try one of the subsidiary actions for reasons of their own before the principal action.

Mr. MOULTON said that the plaintiffs' object was to get the case on as quickly as possible.

Mr. NEVILLE: If you got the right action on as quickly as possible, I should not object.

His LORDSHIP said that if the application to expedite the hearing was not consented to, he could not allow it. The case must, therefore, come on for trial in the usual way.

Reed v. Dunn and Watson and Belshaw.

An amusing case came before Judge Lumley Smith at the Westminster (London) County Court on Wednesday, in which damages for trespass and conversion of electrical fittings were claimed under circumstances somewhat peculiar. Plaintiff had chambers at 35, Lincoln's Inn-fields, on the third floor. He went there six or seven years ago, and Messrs. Andrews wired the place for the electric light. About two years ago he cut the light off. Messrs. Dunn and Watson, architects, took the second floor of the building in September, 1898, and in October plaintiff happened to move a switch on his floor and found the light was on. He knew Mr. Belshaw, an electrician, had been doing electrical work for Messrs. Dunn and Watson, and came to the conclusion that contact had taken place between the wires. He informed Dunn and Watson, and on Oct. 12 he heard someone in one of his rooms. He found there was a workman there disconnecting his fittings, who said he was doing so for Mr. Belshaw. He called upon Dunn and Watson, who asked him not to deprive them of their light by refusing them the use of his leads, as the ground floor tenants would not allow any others to be brought through their premises. They threw the blame of the workman's intrusion upon his employers, who, in turn, threw it upon Dunn and Watson, but eventually purchase and compensation were spoken about, but terms were not arrived at and the present action was brought. He had paid £15 for his fittings. He found the installation on the second floor was from his leads by having a representative of Messrs. Siemens Bros and Co. in to make an examination. His tenancy expired last Christmas, but he had an indefinite renewal, and was not keeping on the tenancy for the purposes of this action. He thought the value of his installation was about £20, but now claimed £50. The workman was let in by the housekeeper and left the premises when requested. He was there about ten minutes. The trespass by the workman was therefore only nominal.

Messrs. Dunn and Watson submitted that the leads became part of the freehold property, and plantiff could not have removed them without permission.

It was contended that Mr. Belshaw should not have been joined to the action as he acted under the instructions of Messrs. Dunn and Watson.

ROBERT WATSON said the connection with plaintiff's main was in error, and he had always been prepared to pay him a reasonable sum for the error. The leads were used without permission for a week.

The JUDGE said the action ought not to have been brought. The damage was only technical. He gave judgment for the plaintiff for 10s. against all defendants. Plaintiff would have what costs there were on such a small judgment against Mr. Belshaw, and Messrs Dunn and Watson would have costs against plaintiff.

Howell v. Howell Simplex Anti-Inductive Telephone Syndicate.

In the City of London Court on Monday, before Mr. Registrar Wild, T. J. Howell, electrical engineer, sued the defendant company to recover five weeks' salary as consulting engineer at £4 a week and £2 5s., money paid out of pocket. The plaintiff said he was the inventor of a patent telephone, which he had disposed of to defendants, but they had never carried out the terms of the agreement. At one of the board meetings he was in attendance and sent in a note to the chairman saying he had an appointment, and did not wish to be kept hanging about. The chairman told him that if he left the office he would be discharged. The defendants were to supply workshops and tools, and he was to let them have telephone sets at wholesale prices. They had applied to him for the telephone sets at wholesale prices, and he had told them it was impossible for him to turn out the sets, as he had no machinery, and they would have to be made by hand. For the defence it was said that the reason the plaintiff had been dismissed was that he was intemperate. They were defending the action as they did not feel justified in spending the shareholders' money. The plaintiff emphatically denied having been guilty of any misconduct. Mr. Registrar Wild said he thought the defendants were justified in their action, and gave judgment for defendants with costs.

Alleged Perjury.

At the Central Criminal Court on Monday, before the Recorder, John Limbrey Higgs appeared to a charge of having given false evidence upon oath authorized under the Companies Acts, 1862 and 1890, in connection with the I.E.S. Accumulator Company, Mr. G. A. Scott, for the prosecution, said the case had been twice adjourned on the ground of the illness of a material witness. Since the last adjournment the witness had died. The witness's depositions were not taken formally at the police-court, because the witness fell ill before he signed them. On these facts the prosecution did not propose to proceed with the charge, they being of opinion that the proper course for them to take was to withdraw with the leave of the Court. He therefore asked that the recognizances of the witnesses should be discharged and that the bill should not go before the grand jury. Mr. Bartley Dennis, for the defence, said that the person who was dead was a most material witness, not only for the prosecution, but also for the defence. It was unfortunate for Mr. Higgs that the witness had died, because the true facts of the case could never be disclosed owing to his death. He said that if the case had been thoroughly investigated there was no doubt that there would have been a complete answer to the charge. The Recorder said he thought the application was a reasonable one, and he granted it.

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Everard v. Higgs

This case came before the Court of Appeal yesterday on the application of the defendant for judgment or new trial, on appeal from a verdict and judgment, dated Oct. 26, 1898, of Mr. Justice Wright. The action was brought by Mr. F. E. Everard, electrical engineer and expert, against Mr. Limbrey Higgs, solicitor, to recover £60 in respect of certain shares. It appeared that the plaintiff purchased a patent for an electrical accumulator, and formed the I. E. S. Accumulator Co. to work it. The plaintiff had 100 shares in the company, and in March, 1896, the defendant informed him that he had arranged to sell 10,000 of the 20,000 shares, and as he had not that number he asked plaintiff to transfer his 100 shares, and as it was alleged, promised to pay him the amount realised by their sale when he received it. The plaintiff transferred his shares, and subsequently heard that there had been a pooling arrangement. On plaintiff asking defendant for the money which the shares had realised defendant said that as the plaintiff was a member of the pool he would have to take his share of the pooling arrangement, which would entitle him to 60 vendor's shares, 17 out of 5,000 new shares purchased out of the proceeds of the pool, and £1. 13s. 4d. in cash. The plaintiff eventually agreed to accept this, but on defendant failing to take any steps to transfer the shares until after proceedings for the winding-up of the company had been instituted, he contended that he was entitled to stand by his original arrangement to receive the price realised by the sale of the shares, or 12s. each. The defendant's case was that he had offered, and the plaintiff had agreed to accept, the vendor's shares and the new shares in satisfaction of his claim. These had been tendered, but had not been accepted. In the result the jury found for the plaintiff for £50, and judgment was entered accordingly. Hence the present appeal, on the ground that the verdict was against the weight of evidence.

Their Lordships, without calling upon counsel for respondent, dismissed the appeal, with costs.

Harten v. The Dublin Electric Tramway Company.

An action was heard at Dublin before Mr. Justice Johnson in which the plaintiff, a grocer, carrying on business in Georges-street, Kingstown, Dublin, sought to recover damages laid at £700 in respect of injuries alleged to have been caused to his premises by reason of the lowering of the level of the street-way in front of his house, consequent on the construction of the defendant's tramway line. Plaintiff is lessee of the premises referred to, and sues for damages and also for an injunction to restrain defendants from further committing the acts complained of.

Plaintiff said that in 1895 and 1896 defendants wrongfully lowered the level of the roadway in front of and abutting upon his premises, so as to obstruct and interfere with access thereto. He also said the works, if lawfully done, were negligently executed.

Mr. Justice JOHNSON said he found no evidence of negligence in the execution of the works, and that the cause of action must fail. The defendants to the other cause of action relied on a justification in the exercise of statutory powers conferred on them under their Tramway Order of 1893; on a justification under the authority of the Kingstown Township Commissioners, and on leave and licence of the plaintiff. His lordship held that all the defences had failed, and that judgment must be given for plaintiff. The plaintiff was entitled to recover, first, in respect of injury to business and obstruction of access while the lowering of the road was going on; second in respect of injury to business by reason of the present condition of the approach and access to his house in consequence of the alteration of the footpath; third, in consequence of necessary alterations in his premises in order to restore them as near as might be to the position in relation to the altered footway that they were in relation to the footway before it was altered; fourth, for depreciation in the value of the premises. He would assess the damages under these heads, and would give his award later.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. The Author hopes that, besides Telegraph and Telephone Engineers, it may, perhaps, also prove of service to those in charge of cables for the transmission of light and power. The localisation of faults has been very fully investigated, including the different degrees in which the various methods are affected by the presence of a second fault or of general leakage.—*Extract from Preface.* Demy 8vo, fully illustrated. 10s. 6d., post free; abroad 11s.

"The Students' Guide to Submarine Cable Testing."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition now ready.*

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves."—By Dr. O. J. Lodge, with many original illustrations. *Enlarged Edition*, 2s. 6d. net, 2s. 9d. post free.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"Laboratory Notes and Forms."—With the above title we have ready the New Edition of a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"The Manufacture of Electric Light Carbons."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated; price 1s. 6d.; post free, 1s. 9d.

"The Bibliography of X-Ray Literature and Research, 1896-97.' A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. Prospectus on application.

"Electrical Engineering Formulæ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. A fine large paper edition with wide margins for notes can also be supplied. Price 12s. 6d.; post free, 13s.; abroad, 13s. 6d. *New Edition in the press.*

"The Alternate Current Transformer," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *New Edition.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"Electromagnetic Theory."—By Oliver Heaviside. Vol. I., price 12s. 6d.; post free, 13s.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"The Electrician" Primers.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"Armature Windings of Electric Machines."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"The Potentiometer and its Adjuncts": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free; abroad, 6s. 6d. Digest post free.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free; abroad 13s. 6d. Prospectus post free.

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The "Big Blue Book" for 1899 will be sent out to subscribers early next week in the order of subscription. The Directory Division has been corrected up to Feb. 6, 1899, and all the latest new names, changes of address, &c., will be found included. The Handbook Division has been much extended, many valuable tables having been added. The volume will contain, also, the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways, finally corrected to Feb. 8, 1899. The price of the Directory and Handbook remains the same—10s., post free 10s. 9d.; abroad, post free, 12s. (United States, 13s. 6d.)

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TENDERS INVITED.

As announced in our advertisement columns, the Corporation of *Harwich* invite offers for the transfer of their provisional order. Tenders must be sent in by May 17 next to the town clerk (Mr. A. J. H. Ward), Harwich.

The Electricity Supply committee of the city of *Gloucester* require tenders for the supply of jet condensers and air pumps, cast-iron condensing water pipes, and steam, exhaust and feed pipes, &c. Specifications, &c., can be obtained, after the 6th inst., from the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, London, S.W. Tenders to the town clerk (Mr. Geo. Sheffield Blakeway), Guildhall, Gloucester, by Tuesday, 28th inst. An advertisement contains additional particulars.

The Electric committee of the *Belfast* Corporation invite tenders for the supply and erection of water-tube boilers, two 12½ kilowatt dynamos and switchboard. Some particulars are given in an advertisement, and specifications, &c., can be obtained from the city electrical engineer (Mr. Victor A. H. McCowen). Tenders must be lodged at the office of the town clerk (Sir Samuel Black) by 10 a.m. of Thursday, 23rd inst.

The *Edinburgh* Town Council invite tenders for the supply of steam, exhaust, feed and drain pipes, feed pumps and tanks for their Macdonald-road electricity station. Further particulars appear in an advertisement. Specifications, &c., can be obtained from the resident engineer (Mr. F. A. Newington), Dewar-place, Edinburgh, and specifications and drawings may be seen at, but not obtained from, the office of Prof. Alex. B. W. Kennedy, 17, Victoria-street, London, S.W. Tenders must be delivered at the office of the town clerk (Mr. Thomas Hunter, W.S.), City Chambers, Edinburgh, by Monday, 27th inst.

The *Shoreditch* (London) Vestry announce in an advertisement elsewhere that they require tenders for various stores for one year from March 26th next, including electric cables and sundries, engineers' stores, ironmongery, tools, wiring and fitting materials, &c. Samples may be seen at the Electric Lighting Station, Coronet-street, Hoxton, N., and at the Town Hall, Old-street, E.C. Tenders must be sent to the clerk (Dr. H. Mansfield Robinson), Town Hall, Old-street, E.C., before 3 p.m. of Tuesday, 28th inst.

The Tramways committee of the *Manchester* Corporation invite tenders for the supply of sample electric tramcars. Specifications, &c., may be obtained from the secretary to the Tramways Department (Mr. J. M. McElroy), Town Hall, Manchester. Tenders by Monday, 20th inst. See advertisement.

The trustees of the Clyde Navigation (*Glasgow*) invite tenders for two sets of engines and direct coupled dynamos. Further particulars are set out in an advertisement, and tenders must be sent to the secretary (Mr. T. R. Mackenzie), 16, Robertson-street, Glasgow, by 10 a.m. of 17th inst.

The *Islington* (London) Vestry invite tenders for the supply of electrical and other stores. Tenders to clerk, Upper-street, N., by 24th inst.

The Guardians of St. Leonard's, *Shoreditch* (London), require tenders for wiring and fitting the workhouse, infirmary, casual wards, &c. Tenders must be delivered to the Guardians at their meeting, at 204, Hoxton-street, N., on Wednesday next at 4 p.m.

The Corporation of *West Hartlepool* invite tenders for feeders, mains, arc light leads and road work. Tenders to the town clerk (Mr. Higson Simpson), by the 13th Feb.

The Gas committee of the *Nelson* Corporation invite tenders for the supply and erection of the following plant :—(*a*) steam dynamo, ejector condensers, &c., (*b*) switchboard, (*c*) alterations to accumulators, (*d*) overhead crane. Tenders to the town clerk (Mr. R. M. Prescott), Town Hall, Nelson, by noon on Tuesday, Feb. 14.

The *Kingston-on-Thames* Guardians invite tenders for private telephone communication between the various workhouse buildings. Tenders to clerk, Union offices, Kingston-on-Thames, by Feb. 14.

The *Southampton* Corporation require tenders for the electric lighting of the new Isolation Hospital. Tenders to the town clerk by 17th inst.

The *Oldham* Corporation invite tenders for two boilers. Tenders to the Gas and Water Office, Oldham, by 28th inst.

The *Hammersmith* (London) Vestry invite tenders for general stores for the electricity works for twelve months. Tenders by 15th inst.

The *Edinburgh* Town Council invite tenders for an overhead travelling crane and storage batteries. Tenders to the town clerk (Mr. Thomas Hunter), City-chambers, Edinburgh, by Feb. 20.

The *Oystermouth* District Council invite tenders for the electric lighting of the district. Tenders to engineer and surveyor by Feb. 27.

The Municipal Council of *Piedrahita* (Avila), Spain, invite tenders for the concession for the electric lighting of the town. Tenders by March 9.

TENDERS RECEIVED AND ACCEPTED.

The Town Council of *Middlesbrough*, having considered the reports of the Electric Lighting committee and the consulting engineer (Mr. Robert Hammond), have accepted the following tenders :—

A. Boiler House Plant: Three Lancashire boilers, three sets mechanical stokers, steam feed pump, electric feed pump, injector, electric motor and switchgear, weighing machine, barrows, &c.			
Holdsworth and Sons	£3,058	5	0
B. Engine House Plant: One 300 kilowatt slow-speed steam dynamo, one 100 kilowatt high-speed ditto, 200 sq. ft. floor plates, motor transformer, tools and instruments, oil filtering apparatus, painting and spare parts.			
Davy Bros. (Jackson dynamos)	6,900	0	0
D. Overhead travelling 15-ton crane, handrailing, ladder, and 100ft. of steel rail.			
Southgate Engineering Co.	325	0	0
E. Switchboard and instruments.			
Nalder Bros. and Thompson	1,200	0	0
F. Accumulators, stands and instruments.			
Hart Accumulator Co.	1,880	16	0
G. Underground work: Brick surface boxes, trenching, troughing, cables, joint boxes, &c.			
British Insulated Wire Co.	8,711	1	1
H. Meters (100 Direct current).			
Chamberlain and Hookham	500	0	0

The *Sheffield* Town Council on Wednesday accepted the tenders of Messrs. Cole, Marchent and Morley for the supply of two additional engines at the Kelham power station at £6,796; Messrs. J. Brown and Co., for the supply of four boilers at £6,250; and of the British Thomson-Houston Co., for two 500-kilowatt tramway generators at £5,280. 12s. 6d. The contract for the extension of the buildings has been given to Mr. J. Eshelby. The Council has also accepted the tender of the Brush Company for a motor generator at £1,002.

The tender of Mr. S. J. Scott has been accepted for the erection of stores and workshops in Church-road, Leyton, for the London Electric Wire Co., at £9,868.

The *Hereford* Town Council have accepted the tender of the India Rubber, Gutta Percha and Telegraph Works Co., for the supply of electric lighting plant at £11,231.

The Westinghouse Electric Co. have obtained the contract from the *Glasgow* Corporation for the supply of motors for the Govan Hill electric cars, at £6,600. Messrs. Doulton and Co. are to supply earthenware conduits.

The *Cardiff* Corporation have accepted the tender of Messrs. Chubb and Co. for the extension of the electricity station building, at £4,084.

The *Ealing* District Council have accepted the tender of the Reason Manufacturing Company for the supply of 50 street lamp fittings at 18s. each.

The tender of Mr. Frank Shalders has been accepted for the electric lighting of the *Southampton* County Lunatic Asylum, Fareham, at £4,052. Thirteen tenders, varying in amount from £4,052 to £9,500, were received.

The *Brighton* Town Council last week accepted the tender of Messrs. Willans and Robinson for the supply of two combined steam dynamos at £15,191, one of the sets to be completed by Nov. 1, 1899, and the other by March 1, 1900.

APPOINTMENTS VACANT AND FILLED.

The Leyton Urban District Council are prepared to receive applications for the appointment of electrical engineer, to take supreme charge of the station, including the management of the office. Some further particulars will be found in an announcement elsewhere. The commencing salary is £250 per annum, rising to £400. Applications have to be sent in by 20th inst.

The Southport Corporation invite applications for the position of electrician-in-charge for their electricity works. Salary, 40s. per week. Applications must be sent in to Dr. J. Davies Williams, town clerk, Southport, not later than 15th inst. See advertisement.

There is a vacancy at the Hull electricity works for an improver. Applications to the city electrical engineer (Mr. A. S. Barnard), Dagger-lane, Hull. See advertisement.

There is a vacancy for an assistant to the mains superintendent at Brighton. Applications to Electricity Works, North-road. See advertisement.

An assistant lecturer in engineering is required for the Huddersfield Technical School. Applications to Principal by 17th inst.

Mr. G. H. Carter, of St. Helens, and Mr. E. E. Eccles, of Manchester, have been appointed engineers at the new power station at St. Helens.

Mr. J. Shaw has been appointed general manager of the Douglas, Laxey and Ramsey, the Snaefell Electric, and the Upper Douglas

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cable sections of the Isle of Man Tramways Co., of which he has been chief electrical engineer since its formation.

In connection with the structural improvements and interior reorganisation of the Covent Garden opera house it has been decided to adopt the continental practice of appointing a technical adviser, and the choice has fallen upon Mr. Edwin O. Sachs, architect, author of "Modern Opera Houses and Theatres," recently reviewed in these columns, whose duties will include the general supervision of the installation and working of the stage mechanism. A description of the electrical equipment at Drury Lane Theatre was also recently given in *The Electrician*, and doubtless Mr. Sachs will, at Covent Garden, promptly substitute electrical working for manual labour as far as possible. The opera house has already a lighting scheme, the contractors for which are Messrs. Townsend, Tamplin and Makovski.

BUSINESS NOTICES.

The partnership business of electrical engineers hitherto carried on by Messrs. A. W. Staveley, J. H. Parsons, Thos. Hurley, and the executors of the late J. T. Gent, at 44, Belvoir-street, Leicester, has been dissolved. Debts by Mr. Hurley, who will continue the business under the old style, in partnership with his son, Mr. T. S. Hurley.

Messrs. N. H. Edmondson and F. Barrett, electrical engineers, Edward-street, Morecambe, have dissolved partnership. Debts by Mr. Edmondson.

Messrs. E. W. Roe and E. Brown, trading as the Nottingham Electric Lighting and Engineering Co., City-buildings, Carrington-street, Nottingham, have dissolved partnership. Debts by Mr. E. Brown, who continues.

BANKRUPTCIES, LIQUIDATIONS, &c.

The creditors of John Evelyn Liardet met last week. The accounts show liabilities £11,157, and assets valued at sufficient to yield a margin of £13,352. Debtor attributes his position to his inability to realise to advantage various patents relating to water motors, hydraulic apparatus and electrical accumulators. A scheme of arrangement has been lodged, but requires some amendment. The meeting was adjourned to March 10.

At a meeting of the Single-Wire Multiple Telephone Signal Co. (Limited), on Jan. 23, it was resolved to wind up the company voluntarily. Mr. G. R. Neilson, Winchester House, London, E.C., is liquidator.

Claims against the Electrical Coal Cutting Contract Corporation (Limited) (in voluntary liquidation) must be sent by March 24 to the liquidator (Mr. W. T. Goolden), 2, St. Nicholas-buildings, Newcastle-on-Tyne.

Sale of Modern Plant and Tools.—Particulars will be found in an advertisement on another page of the sale by auction, on Tuesday and Wednesday, Feb. 21 and 22, at eleven o'clock each day, of a collection of nearly new engineers' tools, which will be disposed of by Messrs. Fuller, Horsey, Sons and Cassell (of 11, Billiter-square, London, E.C.) on the premises, Bravington-road, Paddington, London, W. Included in this sale also is a small collection of modern engineers' tools, consisting of surfacing and cutting lathe, treddle lathes, drilling machine, horizontal planing machine, gas engine, &c. Copies of the catalogue can be obtained from the auctioneers, and from Mr. S. H. M. Killik, 3, Gracechurch-street, London, E.C.

Pocket and Portable Accumulators.—A new illustrated list of portable and pocket accumulators, fittings, lamps, electric jewellery, &c., is sent out by Messrs. Peto and Radford (Limited), and copies can be obtained on application.

Pumps for all Purposes.—Messrs. W. H. Willcox and Co., of 23, Southwark-street, London, S.E., have just issued their 1899 list of pumps and pump accessories. A large variety of useful apparatus for pumping work are here shown, and an especially serviceable article is the quadruple semi-rotary Wing pump shown on page 2 of the list. The body of this pump is divided into four chambers, fitted with two suction valves at the bottom and two retention valves at the top. The claims for this particular pump are that it has an extraordinarily high capacity, that there is very little wear and tear, and that it is very powerful. The water question in electric light and power work is an important one, and Messrs. Willcox's list contains a large amount of information regarding pumps and pumping machinery generally.

New High-Pressure Switch and Fuse.—Messrs. Veritys inform us that they are placing on the market new patterns of high-pressure switches and fuses, the design of Mr. L. J. Steele, and they furnish the following particulars:—No current-carrying parts are exposed, and the blades are shielded by an insulating guard, so that no "live" part can be touched whether the switch be off or on. A marble slab forms the base, and the actual contacts are behind this. The switch is quick make-and-break. In those designed for over 1,000 volts an incombustible shutter is provided, which is interposed between the blades and the contact clips as soon as the former are withdrawn. A curved arm working through a slot in the marble is connected by a link to the shutter, and on the switch handle being lowered the shutter is pushed up along the central guide at the back of the switch. In the Verity and Steele high pressure fuse a china frame, somewhat resembling an anchor with a handle added to it, is provided with two flat metal hooks. The frame is hung by these hooks on to two metal pins, which project through the switchboard. These hooks and pins form the connections to the fuse. The fuse passes through a glass U-tube containing oil, and is connected to the contact hooks under a terminal on each side. When one side of the fuse melts, the tube falls, and the broken end of the wire is drawn into the oil with twice the speed of the dropping tube, and this extinguishes the arc.

Measuring and Testing Instruments.—We have received from the Electrical Company, 122 and 124, Charing Cross-road, London, W.C., their latest list of measuring and testing instruments and electricity meters. The list is fully illustrated, and contains particulars and prices of a large variety of ammeters and voltmeters, electricity meters, &c. Copies of the list (No. 6) can be obtained on request.

Indestructible Paints.—The demand for the manufactures of the Indestructible Paint Co., of 31, Cannon-street, London, E.C., has necessitated the removal of the Company's works to more commodious waterside premises known as Norway Wharf, Limehouse. Opportunity has been taken of the removal to discard the older types of machinery used in the manufacture of the various specialities of the Company, and these have now been replaced by the most modern plant obtainable. The facilities now owned for receiving raw material by water carriage, and the additional room at the disposal of the Company, enable them to promptly meet a largely increased demand.

"Directory of Titled Persons."—We have received from Messrs. J. Whitaker and Sons, 12, Warwick-lane, London, E.C., a copy of this Directory for 1899. The work is designed as a companion to the famous "Whitaker's Almanac." The object of the publication is to furnish an accurate work of reference for the use of business houses who wish to get all necessary particulars respecting correspondents of position, with their town and country addresses, &c. The names in the list are accompanied by all the necessary particulars required by commercial firms, and it is not pretended that the work is one giving the genealogy of the county families of England, but rather a condensed handbook for urgent reference. There is as much need for such a publication in the office of the average electrical firm as in that of any commercial undertaking, and the book, which is published at 2s. 6d., may be safely commended for its accuracy and completeness.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Feb. 1 to Feb. 7, with the ports of destination:—

Argentina—Buenos Ayres, £1,838 (including £200 telegraph material). *Australasia*—Adelaide, £139; Auckland, £91; Launceston, £33; Napier, £30; Melbourne, £261 (including £182 telegraph material); Sydney, £1,411; Wellington, £2,013. *Belgium*—Antwerp, £120; Ghent, £90. *British Guiana*—Demerara, £21. *Burma*—Rangoon, £50. *China*—Shanghai, £2,039 (including £1,880 telegraph cable). *Denmark*—Copenhagen, £158. *Eyypt*—Alexandria, £12; Port Said, £20. *France*—Boulogne, £99. *Germany*—Hamburg, £300 (telegraph material). *Greece*—Syra, £17 (telegraph material). *Holland*—Amsterdam, £205; Rotterdam, £84 (telegraph cable). *India*—Bombay, £74; Calcutta, £2,990; Madras, £473. *Portugal*—Lisbon, £50. *Russia*—Reval, £359 (telegraph paper). *South Africa*—Cape Town, £849; Delagoa Bay, £185; Durban, £138 (including £73 telegraph material); East London, £23; Port Elizabeth, £656. *Straits Settlements*—Singapore, £10,515 (including £10,500 telegraph cable). *Sweden*—Stockholm, £89 (telegraph material). Total £25,432, against £9,758 in the corresponding week last year (Feb. 2 to Feb. 8).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Accrington.—Lord Kelvin has sent in a report, in which he approves of the electric lighting and refuse destructor scheme, prepared for the District Council by Mr. Shoolbred. His Lordship strongly recommends the low-tension continuous-current system, and is satisfied that with the 500 volt pressure now permitted by the Board of Trade, the Corporation will be able to cover a much larger area than that proposed at present for electric lighting, and will be able readily to extend the work of the generating station to the electrical working of the tramways. Mr. Shoolbred proposed to commence working on the two-wire system, and when the demand for electricity increased, to change over to the three-wire system. This, says Lord Kelvin, can easily be done, and will lead to a perfectly satisfactory result. He thinks, however, that when the time comes for supplying the more distant outlying districts it will be found that the best and most economi-

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cal plan will be to erect a new generating station to the south, and to connect it by feeder mains with the network supplied by the first station, thus causing the two stations to work together for the supply of the whole area. The use of the Horsfall destructor will, he believes, prove a valuable economy in saving coal, even when the amount of refuse to be treated only suffices to keep three or four of the six cells in active use. In a supplementary report Lord Kelvin expresses approval of the drawings.

Albury (Guildford).—As the Guildford Electricity Supply Co. have agreed to include the whole of Albury in their provisional order, the District Council have withdrawn their opposition to the company's application.

Aldershot.—The District Council have decided not to part with their provisional order (1898), and steps are being taken to acquire a suitable site for electricity supply works.

Asylum Lighting.—Messrs. Hampton and Co. have secured the contract for the electric lighting of the Hendon Asylum of the Central London Sick Asylums' Board. The installation will consist of a duplicate set of plant, accumulators, &c. The consulting engineers are Messrs. Owen Lucas and Pyke.

Bangor.—The sanction of the Local Government Board for the borrowing of £14,150 for electric lighting purposes has been received by the Town Council.

Barrow-in-Furness.—Although the regular supply of electric current from the electricity works at Barrow-in-Furness has not yet commenced, up to Dec. 31 the electricity department had received 54 applications for connections, representing 3,863 8 c.p. lamps, not including the street arc lighting, representing 396 8 c.p. lamps.

Battersea (London).—The plans for the electricity supply station building are being prepared by Mr. Stanley Peach, and as soon as these have been sanctioned by the London County Council the Vestry proposes to proceed with its electric lighting scheme prepared by Prof. Kennedy.

Blackpool.—A recommendation by the Electric Lighting committee that the borough electrical engineer (Mr. Robert C. Quin) be allowed to undertake consulting work on condition that he undertook to stay with the Corporation for three years has been referred to the General Purposes committee for consideration and report.

Brighton.—The Town Council have adopted the recommendations of the Electric Lighting committee to lay feeder mains in the Kemp Town district, at an estimated cost of £7,189. 9s., and also to appoint an assistant manager of the electricity works.

Burslem.—A sub-committee has been appointed to collect information as to the advisability of establishing electricity works, with power to employ a consulting engineer.

Burton-on-Trent.—The Gas and Electric Lighting committee on Wednesday brought up a report recommending the acceptance of the tender of Messrs. Edward Danks and Co., for the supply of three boilers, at £1,595. Councillor Austin, however, moved that the recommendation be referred back, on the ground that the tenderers were not paying the "standard rate of wages," and after discussion this amendment was carried. Steps have been taken to construct electric tramways in the town. The surveyor has already inspected the Halifax tramways, and is at present engaged in preparing a scheme for submission to the Highways committee.

Chester.—The Electric Light committee propose to reduce the price of electric current from March 25th from 5d. to 4½d. per unit. The price of current for motive power has been reduced from 3d. to 2½d. per unit for the first 1,000 units per annum, 2d. for the next, 1½d. for the third, and 1¼d. for the fourth.

Consular Reports.—In *The Electrician* for Aug. 28, 1896, we dealt with a communication received from the Foreign Office, in reply to a proposal of our own which had been placed before the authorities suggesting the appointment of a qualified abstractor of the reports which reach the Foreign Office out of the usual consular course. This reply was that the preparation of such information for use by the technical press could not be undertaken at Downing-street, and this was followed by the peculiar intimation that "all information on such subjects might be obtained from the daily press." A further reference was made to this subject in *The Electrician* for Oct. 9, 1896, and we are now glad to learn that Mr. H. H. Marks, M.P. (of the *Financial News*) is putting a question in Parliament asking that the plan outlined in our columns should be adopted by the Foreign Office in the interests of British trade. The subject is one of urgent present interest, and particularly in relation to the electrical and allied trades, as it may be said that in many of the old-world cities electric light, power and traction enterprise is unknown, and consequently affords excellent trading opportunities.

Darlington.—The Town Council have given their consent to the scheme for the construction of electric tramways in the Borough at an estimated cost of about £120,000.

Derby.—In moving the adoption of the Electric Lighting commitee's report at last week's meeting of the Town Council, Mr. Butterworth announced that 10 new lamps would be fixed in the streets in place of defective lamps. The cost of replacing these lamps would be about £130, which must come out of revenue, as it could not be charged to capital. The Council at the same meeting accepted the tender of Messrs. S. Z. de Ferranti for the supply of a new steam alternator at £7,090.

Devonport.—The Electric Lighting committee of the Town Council have decided to ask the Plymouth Corporation to state their terms for supplying electric current "in bulk."

Dublin.—The Corporation have received an offer for the transfer of their Provisional Order and for the purchase of their electric lighting undertaking from a London syndicate. The matter is to come before the Council at the next meeting.

Dundalk (Ireland).—The electric lighting scheme for this town has been revived. The syndicate, which was formed for the construction of an electric tramway between Dundalk and Blackrock, has re-opened negotiations with the Electric Lighting committee of the Town Commissioners.

Ealing.—At present there is an equivalent of 20,512 8 c.p. lamps connected to the electric light mains, and there are applications in hand for about 1,200 additional. Superheaters are to be supplied with the new boilers for the electric lighting station, and the four existing boilers are also to be fitted.

Eastbourne.—The Electric Lighting committee propose to increase their offer for the purchase of the undertaking of the Electric Light Company to £83,413. The committee offer £20 for every £10 share. There are debentures to the amount of £29,925; £3,401 would be required to repay amount over expended on capital account, £2,000 compensation to officers, and £4,152 for new machinery on order. A sum of £6,275 would be deducted for depreciation and reserve funds.

Electric Lighting in South London.—The Lambeth Vestry has resolved to lodge a petition against the County of London Co.'s Bill unless the company agree to pay a rental for the wayleave for carrying mains through the district to other areas, and in order to preserve the Vestry's right of veto as to the particular roads to be taken up for the purpose. By an agreement entered into some time ago the company pay the Vestry £100 per annum for wayleave of a line connecting the Battersea mains with those in Camberwell and a part of Streatham.

Electric Power Scheme.—A conference of the District Councils in Lancashire is to be held at Manchester on 14th inst., to consider the advisability of opposing the Lancashire Electric Power Bill.

Greenock.—At the special meeting of the Police Board, on Tuesday, the electric lighting scheme prepared by the electrical engineer (Mr. S. E. Fedden) was discussed and adopted. Particulars of the scheme were given in a recent issue of *The Electrician*.

Hampstead (London).—The Electric Lighting committee have recommended that the salary of the chief engineer (Mr. Geo. H. Cottam) be increased from £450 to £550 per annum, and the Vestry agreed; but a proposal to increase the salaries of the assistant engineers to £160 was, for some reason, strongly opposed. We are glad to know that one member (Mr. Stone) expressed his surprise that men with such high technical experience, acquired after years of costly education, should accept these responsible positions at such low salary. An increase to £150 was agreed to, the remaining two assistants to receive £140 each per annum.

High-Pressure Supply.—With reference to the proposal of the London Electric Supply Corporation for certain powers for the supply of high-pressure current, the Vestry of St. James, Westminster, has notified the Board of Trade that the Vestry object strongly to the proposed system of supply, by which transformers are to be installed in street boxes, and that if the proposal will enable the company to construct these boxes without first obtaining the sanction of the local authority, the Vestry would offer strenuous opposition.

Glasgow.—The committee rooms and adjoining apartments of the City Chambers are to be wired for the electric light.

Islington (London).—As from Jan. 1 the charge for electric current for street lighting has been reduced from 5d. to 3½d. per unit, and private supply will be reduced as from April 1 next, to 7d. per unit for first hour's consumption of the maximum supply, and 4d. for all current consumed after the first hour. Canonbury-road and New North-road (to the boundary of the parish) are to be lighted electrically. The cost of carrying out this work has been estimated by the engineer (Mr. Albert Gay) at £5,200.

From the Archway Tavern to St. Joseph's Retreat (*i.e.*, the entire length of Highgate Hill) is now lighted electrically by arc lights, current being supplied for the first time on the 3rd inst., from the Vestry's mains. A much needed improvement.

In the financial statement for the past twelve months which has just been issued by the electrical engineer (Mr. Albert Gay) it is

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stated that the gross profit for the past year amounted to £8,964, and, after payment of interest, sinking fund instalment, &c., there was a net profit of £2,206. Last year there was a loss of £318, and in 1896, £1,886.

Leeds.—The Adel reformatory is to be supplied with an electric light installation at a cost of £650.

An additional boiler is to be put down at the electricity works.

Leith.—In reply to a question at the Council meeting on Wednesday the convener of the Electric Lighting Committee (Bailie Manclark) stated that electric current would be available from that evening.

Light Railways.—The objections to the confirmation of the Hanwell-Uxbridge light railway were further considered at the Board of Trade last week by Sir Courtenay Boyle, assisted by Mr. Hopwood and Sir Thomas Blomfield. Mr. Earle, on behalf of the Middlesex County Council, said that as the Board of Trade had decided that the company might carry heavy goods, the County Council objected that the road would be damaged, and that there would be danger to some of the bridges. On behalf of some frontagers Mr. Moon raised an objection to the company being allowed to carry goods, minerals and animals to any extent. It was agreed that the promoters and objectors should agree on clauses to meet this difficulty, and submit them to the Board for confirmation.

Lincoln.—The Town Council have adopted the recommendation of the electrical engineer (Mr. Vesey Brown) to obtain tenders for additional machinery at the electricity works and to extend the electric light cables at an estimated cost of £19,000.

Liverpool—The Local Government Board have sanctioned a further loan of £44,000 for electric lighting purposes.

London County Council.—At Tuesday's meeting a loan for £30,000 was granted to the Vestry of St. Pancras for electric lighting purposes, and £2,560 to the Hampstead Vestry.

It was announced that the National Telephone Co. had been ordered to remove the telephone wires erected over Brockwell Park, and that the request of the company to erect poles in the park to carry telephone wires had been refused. Permission had, however, been given, on certain conditions, to run a covered wire along the edge of the fence on the outskirts of the park.

On the presentation of the report of the Highways committee, Mr. Benn said that it had at first been thought that Parliamentary permission would have been necessary before any electric traction experiments could be carried out on the Council's tramways on the south side of the Thames, but the committee now learned that, owing to a clause in an Act of 1888 empowering the London Tramways Co. to experiment with mechanical traction, the Council would be able to proceed with such experiments or with the installation of electric lines at once.

Naples Tramways.—The Governmental commercial departments of Germany and the United States must look to their laurels. The comments of *The Electrician* and other influential organs of public opinion are evidently having due weight with the British Foreign Office authorities, for we have a report from Naples by Mr. Consul Neville-Rolfe, which only reached the Foreign Office on Jan. 9, and was available in London early in February. Nor is this the most promising feature of the report. Mr. Neville-Rolfe has what few of the compilers of these documents possess—the gift of making his report both interesting and instructive. The case for electric in place of horse traction is particularly well presented. Altogether the report (which, by the way, is for the complete year 1898) may be taken as a model of what these reports should be. Mr. Neville-Rolfe states :—

"In a town so hot and so hilly as Naples, and withal so atrociously paved it is not wonderful that a population naturally indolent should make great use of the facilities provided by the tramway company, and that the company in return should earn very considerable dividends. One great difficulty has been the providing of horses of sufficient size, as the local horses are too small, and it will easily be understood that imported horses suffer from the summer sun in a way which local horses do not. The wear and tear of horseflesh is consequently an item to be closely looked into from the dividend-earning point of view, and the Naples Tramway Company has accordingly been devoting its attention to the best means of mechanical traction available. When it is remembered that there are in the aggregate several miles of hills in the course of their tracks upon which it is necessary to add one and sometimes two horses to the pair which are sufficient to drag the cars on the level, and that in every case these relief horses must have a man with them, it will be understood what a saving would be effected by mechanical traction. The company seem to have decided, and a majority of the municipal council appear to have agreed, that of all the mechanical means hitherto proposed electric traction was the most practical, and it seemed certain that this would be adopted. But the host had to be reckoned with, and the municipality seeing so good a chance of making a little money, proceded to propose an additional rent of 125,000fr. to the large sum already paid to them by the tramway company for their valuable monopoly. It seems strange that the company should have expressed itself as willing to pay this additional sum, but it appears that it is not much more than they are paying now in the shape of octroi or town tax levied upon the horse fodder at the city gates. After much fruitless negotiation the matter was allowed to drop, but it has since been revived, and an agreement arrived at whereby the tramway will be wholly electric, and the company will be granted besides the concession for the omnibus traffic of the town on condition of their paying up the debt of 100,000 lire due from the omnibus company to the town, and of employing all the servants of that company. The system to be adopted is the overhead trolley, and all materials and fittings to be of equal quality with those used at Rome. Some of the lines will be considerably extended, and the new concession will be in force until December 31, 1950. The payment to the town is to be 350,000 lire for the tramways, and 50,000 lire for the omnibuses, besides 12 per cent. on the earnings of the tramcars above 3,500,000 lire. These sums are to be raised in 1926 to 550,000 lire for the tramways. Three years are to be allowed for the transformation into electric lines, and the company is bound to keep on its old servants, and not to employ less than 75 per cent. of Neapolitans, or persons brought up in Neapolitan institutions or schools. The cars are to run every 10 minutes, and no servant is to be employed for more than 12 hours, including one hour for dinner, and their wages are not to be lower than those they now receive. They are also to have 24 days' holiday in the year. All fines levied upon the servants are to go to the benefit fund. Payments made for advertising in the cars are to go to the municipality, and the company is to furnish the Syndic with 80 free tickets for his nominees. It would appear that the municipality has done very well for itself. It has recovered what was practically a bad debt of 100,000 lire incurred by the omnibus company, and has added 230,000 lire to the quota paid by the tramway company, to say nothing of sundry other important profits. The tramway company is a private Belgian concern, and no authentic report of its dividends has ever been issued, but it is abundantly clear that the profits must have been very large to allow of their submitting to the present proposals. No sooner was the business settled than the company set to work with commendable alacrity, and an electric tram has been laid to the important suburb of Capodimonte, a locality situated on the top of a very steep hill, and much frequented by the gentry of Naples in the summer season. Preparations are also being made to change the present steam tram on the Corso Vitorio Emmanuele into an electric one, which will be a great boon to the residents of this important and beautiful promenade. A branch line is also to be made to the Vomero to compete with the present wire-rope railway. The new quarter of the Vomero is inhabited chiefly by middle-class people, to whom a cheap transport to and from business is of the first necessity. All the tramways are to be electric within three years.

Oswestry.—The Town Council have passed a resolution in favour of acquiring the undertaking of the Oswestry Electric Light Co.

Oxford Engineering Laboratory.—Prof. L. F. Vernon Harcourt pleads for funds for the Mallard Engineering Laboratory at Oxford, the resources of which, it is said, are extremely limited.

Newcastle-upon-Tyne.—The Tramways committee are to obtain a report from a consulting engineer as to the practicability of adopting the conduit system of traction on the local tramways.

National Telephone Company and the Public.—The National Telephone Co. are publishing in pamphlet form a reprint of certain articles from *The Times* of Jan. 20, 23, and 24, which, it is said, "accurately state the position of the company in its relation to the Government and the public." The following table, which amplifies a small table published in *The Electrician* of Jan. 27, p. 458, is added to the reprint : —

Table showing the progress of the National Telephone Company's undertaking since the amalgamation of the Companies in 1889.

Year ending	Paid-up capital.	Capital expenditure.†	Number of lines.	Gross income.	Working expenses.‡	Post Office Royalty.	Dividends and interest.	Reserve.
	£ s.	£ s. d.		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
April 30, 1890.....	2,511,583 0	2,589,120 8 10	26,086	380,075 3 3	157,590 1 3	30,493 13 11	143,643 6 3	53,500 0 0
April 30, 1891.....	2,953,246 10	3,050,453 6 4	38,560	431,112 11 11	199,483 15 8	36,581 12 4	160,678 4 5	93,500 0 0
April 30, 1892.....	3,267,322 0	3,371,445 5 0	47,878	463,741 5 4	236,252 0 5	40,239 5 8	178,249 1 8	104,627 3 6
April 30, 1893.....	4,003,412 10	4,023,021 5 0	59,031	583,590 2 11	311,644 10 2	54,220 9 10	190,013 15 4	134,627 3 6
Dec. 31, 1894* ...	4,419,155 0	4,565,027 0 3	73,353	1,179,333 19 8	615,307 16 8	108,899 11 11	364,400 18 10	260,000 0 0
Dec. 31, 1895	4,648,626 0	4,902,932 14 5	82,093	819,034 14 1	424,164 12 8	74,674 13 1	246,951 5 0	350,630 5 5
Dec. 31, 1896	4,648,626 0	4,926,468 3 8	94,407	870,745 18 0	469,972 13 1	79,266 18 3	252,416 13 10	439,255 19 0
Dec. 31, 1897	5,259,479 5	5,387,405 8 6	106,188	984,556 14 11	544,882 2 2	89,238 16 1	271,114 14 0	510,671 1 4
Dec. 31, 1898	5,404,094 14	6,270,253 12 4	120,144	1,112,666 5 0	615,563 11 2	104,029 18 7	294,819 2 9	628,788 15 7

* 20 months. † Exclusive of moneys expended in the purchase of lands, buildings, &c. ‡ Including maintenance, renewals, repairs, rents, taxes, &c.

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1900 Paris Exhibition and Industrial Designs.—Mr. T. Barclay, legal adviser to the British Chamber of Commerce in Paris, calls attention to the subject of the French law relating to industrial designs with special reference to the Paris Exhibition of 1900. A recent decision of the Paris Court of Appeal is to the effect that the protection of industrial designs in France is dependent, not only upon registration, but also upon the manufacture of the product to which it applies upon French territory. Hitherto registration has been presumed to be sufficient, and it was thought that protection was secured to British subjects by Art. 10 of the Anglo-French Trade and Navigation Convention of 1882 and Art. 2 of the Industrial Property Convention of 1883. These conventions, however, only grant the same protection to the subjects of contracting States as is possessed by native subjects. Any conditions imposed on native subjects must be complied with by the protected foreigner. Thus Sect. 54 of the British Patents Designs and Trade Marks Act, 1883, providing that "if a registered design is used in manufacture in any foreign country, and is not used in this country within six months of its registration in this country, the copyright in the design shall cease," applying to designs and persons without distinction, the French owner of a design registered in Great Britain would not be absolved from "using" it in Great Britain by the above-mentioned conventions. The recent decision in the French Court is practically in the same sense as this section of the British Act. According to this judgment, publication abroad would operate as a cesser of the copyright in France unless the design is used in the manufacture of goods in France, and even a French manufacturer would have to register his design in every district in which it was used. The Public Procurator appealed, and the French Government, since the decision, has vigorously taken up the reform and codification of the existing legislation on industrial designs, and a Bill on the subject has just been laid before the Chamber of Deputies, providing for the protection of foreigners. It should, however, not be overlooked that exhibitors are protected by the French law of May 23, 1868, which provides for the granting of certificates to native and foreign inventors for any article capable of being patented or registered under French patent law, and it is stated that this law is to be re-enacted in connection with the exhibition of 1900. Those interested are advised to obtain a copy of the January circular of the British Chamber of Commerce (Paris) 25, Boulevard des Italiens, Paris.

Paignton (Devon).—The District Council have passed a recommendation of the Electric Lighting Committee in favour of obtaining a Provisional Order, and of opening up negotiations with a company for lighting the district.

Penarth.—The District Council have declined the offer of the Penarth Electric Light Syndicate to take over the provisional Order.

Perth.—The Town Council have unanimously agreed to retain their electric lighting powers.

Redditch.—The charge for electric current for private lighting has been fixed at 5½d. per unit, for motive power at 3d, and for places of worship and hotels 5d. per unit.

South Africa.—The *British and South African Export Gazette* states that the whole of the plant for the electric lighting of Lourenço Marques, recently inaugurated, was supplied by the Compagnie de Fives, Lille, France. It includes six 40-kilowatt dynamo machines, 14 miles of cables, 12 1,500 c.p. arcs and 600 16 c.p. incandescents. The Durban Town Council have placed an order for an additional alternator with the Electric Construction Co. An order for three dynamos for Johannesburg clients has been received by Messrs. Davey, Paxman and Co. through their South African representative, Mr. J. W. Logan. The same firm are supplying an additional Peache engine for the Durban installation. The Town Council of Uitenhage, Cape Colony, is said to have requested Sir Jas. Sivewright, who is now in England, to nominate a suitable engineer to frame and carry out a scheme for utilising the water power in the district for electricity supply purposes.

Theatre and Music Hall Lighting.—The new Bedford Music Hall at Camden Town, London, N.W., which takes the place of one of the oldest-established music halls in London, was opened this week. The hall is fitted throughout for the electric light, the arrangements for which were entrusted to Messrs. Vaughan and Brown (Limited), the contract including the stage appliances, switchboards and ornamental fittings throughout, and covering the gas lighting, hot-water heating, fire hydrants, fire-proof curtain, wrought-iron work and outside canopy. In the dome of the hall a small motor is fixed, controlled by a change-over switch fixed on the stage, and so arranged that the motor can be used either for actuating the sliding roof or raising the fire-proof curtain. The outside of the building is lighted by means of Vanbe arc lamps run four in series and fitted with automatic cut-outs and resistances attached to the lamps. Messrs. Vaughan and Brown inform us that they have recently completed the lighting, &c., of theatres and music halls at Hammersmith (London), Dalston (London), Preston, Shrewsbury, Notting Hill (London), Bradford, Brixton (London), and Greenwich.

The electric light has been introduced into the Empire Theatre of Varieties, Bradford. The installation consists of 10 arcs and about 900 incandescents. The work was executed by Messrs. Sax, Slatter, and Co., to the specification of Messrs. Owen Lucas and Pyke, consulting engineers.

Ventnor (I.W.)—Progress is being made by Edmundson's Electricity Corporation with the electric light station at Ventnor. Two boilers are in position awaiting the makers' test before being bricked up, and two Belliss-Parker 84-kilowatt sets have been erected. The steam-pipes have not yet all been delivered. Some of the hotels and a number of shops and residences are the first customers of the undertaking, and a large load will be afforded by the consumption hospital, a mile distant from the station. The system will be the three-wire at 2 × 210 volts, with combination booster and balancing transformer sets, Callender triple-concentric feeders and three-core distributors. The work of laying the mains is proceeding rapidly. A good prospect is before the electricity supply undertaking as the gas and water company has quarrelled with the local authority. We hear that the Shanklin, Sandown and Newport local authorities are offering no opposition to the applications made for provisional orders for those districts. A lift from the esplanade at Ventnor to the railway station and downs is talked of, and if this is actually erected it will in all probability be worked by electric power from the lighting station.

Village Lighting.—Heacham and Snettisham, two neighbouring villages in Norfolk, are to be lighted electrically.

Rochdale.—Some time ago the Town Council applied to the Local Government Board for sanction to borrow £30,000 for electric lighting purposes, but the Board have now requested the Council to make a canvass of the town in order to ascertain the number of probable electric light customers. The Gas committee consider this an unusual request that will lead to no definite result.

Walsall.—The General Purposes Committee recommend the Town Council to purchase the tramways within the borough, with their electrical equipment (except the cars and power-house) if they can be acquired by agreement with the South Staffordshire Tramways Co. on reasonable terms, and to grant a lease of the lines to a company for a term not exceeding 21 years.

Whitby.—The District Council have instructed Mr. W. H. Preece to prepare an electric lighting scheme for the district, at a fee of 50 guineas. In a preliminary report Mr. Preece recommends the council to retain the electric lighting powers and to start by putting down plant capable of supplying current to the equivalent of 5,000 8 c.p. lamps.

Workhouse Lighting.—The Hampstead (London) Guardians have resolved to obtain electric current from the Vestry's mains for the electric lighting of the workhouse.

Worthing.—There is every prospect that this popular watering-place will shortly be provided with electricity generating works. The Town Council on Tuesday considered the report presented by a committee appointed to consider the question, and also reports from their engineers (Messrs. Burstall and Monkhouse) as to the cost of adapting the existing gas columns for public incandescent electric lighting or the substitution of new columns, and the cost of laying electric mains for the public lighting only. The report of the Committee recommends that the area should embrace the whole of the streets now lighted by gas, and that the maximum charge to private consumers should be 6d., and for public lighting 2d. per unit. A proposal to provide a refuse destructor in connection with the electricity works was rejected. The Council were recommended to authorise the completion of the preliminary plans and information preparatory to application being made for a loan of £35,000. The probable site for the station will be the disused waterworks in the centre of the town, which are the property of the Corporation. Councillor Ovenden (chairman of the committee) strongly urged the adoption of the recommendations. Ald. Linfield objected to the area proposed, and preferred that recommended by Prof. A. B. W. Kennedy, which included about nine miles of streets and embraced the whole of the borough that could be looked upon as a productive area. The length of streets lighted by gas was about 30 miles and to attempt to cover so large an unproductive area would be making a huge mistake commercially. Ald. Piper said the town must be better lighted than it was, and so must be lighted electrically. Councillor Ovenden reminded the Council that at Portsmouth the Corporation was successfully competing with gas at 2s. 6d. a 1,000ft, while they at Worthing would have to compete with gas at 3s. 6d. a 1,000ft. It was decided eventually to refer the entire question to a committee of the whole Council.

Wrexham.—Mr. W. H. Trentham has been instructed to prepare a report on the advisability of erecting combined electric lighting and refuse destructor works, and also on the question of electr tramways.

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PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom all information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete Specifications. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

January 23, 1899.

1,487. A. DAVIDSON. Sheffield. Improvements in electric light wire casing.
1,493. P. JOHN. Bristol. Apparatus for heating by electricity.
1,502. W. H. DERRIMAN and W. E. PHILBROW. Huddersfield. Improvements in electric igniters and vaporisers for internal combustion engines.
1,513. F. PLAYER and P. HOLMES. London. Improvements in electrical insulating cement.
1,522. F. O'CONNOR PRINCE. London. Improvements in dynamos and electric motors.
1,526. G. W. WALKER. London. Improvements in or relating to electric meters.
1,529. F. H. NALDER, E. THOMPSON and R. F. CURTIS. London. Improvements in electric measuring instruments.
1,553. W. M. MCDOUGALL. London. Improvements in secondary or storage batteries.
1,554. W. M. MCDOUGALL. London. Improvements in the manufacture of secondary battery plates.

January 24, 1899.

1,598. G. HOWSON and W. BARNES, Junr. Sheffield. Improvements in adjustable flexible metalic supports or arms for electric lights.
1,620. R. BAIRD. Glasgow. Improvements in trolley connections for transmitting electric power from overhead wires to tram cars and the like.
1,683. J. MELZER, F. HAFFNER and M. KOCH. London. Combined electric arc lamps and fans.*

January 25, 1899.

1,765. S. P. THOMPSON and M. WALKER. London. A surface contact electric traction system.
1,774. B. KELLERMANN and B. KELLERMANN. London. Electric boot or shoe.

January 26, 1899.

1,810. H. BOULANGE and E. FREGNAC. Improvements in electrical weaving frames or looms.*
1,834. H. HIRST and I. V. ZEALANDER. London. Improvements in rail bonds for electric traction systems.
1,835. H. HIRST and W. MEAD. London. Improvements in switches for starting and controlling electric motors.
1,839. L. FREDLER and E. JACKEL. London. Improved method of solidifying the contents of electric accumulators by chemical means.
1,841. R. N. TWEEDY. Improvements in and relating to collectors for trolleys for electric tramways and the like.
1,844. L. CHAMPAGNE. London. Improvements in the manufacture of plates for secondary batteries.
1,862. F. BRAUN. London. Electric telegraphy by means of condensers and induction coils.
1,863. F. BRAUN. London. Wireless electric transmission of signals over surfaces.

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1898.

143. DAVY and THOMAS-DAVIES. Electric arc lamps.
462. NISBETT. Electric mains.
591. GRAHAM. Telephone transmitters.
848. VONDER POPPENBURG. Galvanic battery.
2,723. CRUDGINGTON. Electric arc lamps.
3,032. JAMIESON and TROTTER. Steering torpedoes electrically.
3,219. HEAP. Electrical measuring instruments.
3,905. PASQUET. Suspension devices for electric and other lamps.
4,046. BLACKBURN, SPENCE and MOORE. Distribution of electricity on the three-wire system, with the neutral wire at earth potential.
4,075. MAXIM. Methods and apparatus for electro-thermally treating materials, more particularly for the manufacture of calcium carbide and other carbides, and the reduction of ores.
4,678. HEARSON. Insulation of wire for electrical purposes.
4,819. ELECTRIC REDUCTION CO, LIMITED (Gibbs). Method of electrically heating materials in closed chambers and apparatus for that purpose.
5,133. HUISMAN and GOVER. Electric lamp fittings.
9,106. GREENFIELD. Apparatus to be used in connection with the electro-deposition of metals.
12,829. MUSCHAMP. Apparatus for electrically signalling on railways.
14,614. LAARMANN and BROCKELT. Electric energy meters for alternating currents.
18,475. MILLS (Edison). Electric meters.

COMPANIES' MEETINGS AND REPORTS.

Anglo-American Telegraph Co. (Limited).

The ordinary general meeting of the proprietors of this Company was held on the 3rd inst., under the presidency of Mr. FRANCIS A. BEVAN.

The SECRETARY (Mr. T. H. Wells) having read the notice calling the meeting,

The CHAIRMAN, in moving the adoption of the report and the payment of the dividends therein recommended, said: Comparing the figures of the past six months with those of the December half of 1897, I find that there has been an increase in the receipts of no less than £14,418, the total receipts having been £190,520 against £176,102. But in addition to this increase in the traffic receipts we have also earned during the past half-year £3,800 by letting out the "Minia," and besides this we brought forward a balance of £17,580. We have, therefore, a gross amount to deal with of £212,493 against last year £187,832. I am sure that you will regard these figures as most satisfactory. When the traffic grows the expenses must also to some extent advance. I find that the increase in the working expenses has been £2,229 compared with those of the corresponding period of 1897, and that the cost of repairs of cables has also shown a rise of £2,668. Altogether there has been an increase in the expenses of £5,032, and deducting this from the gross increase of £15,558 in the receipts, we show an increase of £10,555. I think that the "Minia" was out on repairs for more than 200 days, compared with 157 during the previous year, but none of the repairs have been of any real consequence. There are always small repairs in the shorter cables, and our ship is pretty well employed either by ourselves or by our friends. The renewal fund has increased during the past year by £59,700, of which £24,000 has been taken out of revenue—a course which we agreed to; £21,400 has come from interest, and we have realised some of our securities, which seemed to show a very handsome profit, on which we made a gain of £14,300. The increase of the renewal fund has, therefore, been in round figures £60,000 in the past year, and I think that that is a very satisfactory circumstance. Your Board rejoice to say that the renewal fund is gradually attaining a very substantial amount, but we are convinced as much as ever that it is the right policy to pursue—for the present, at all events—to go on increasing this fund. The result of our larger receipts is that we are able to-day to give the deferred stockholders a dividend, and the Board heartily congratulate them on at last arriving at this most desired object. We are able to-day, after paying our preferred stockholders their 6 per cent., to give the Ordinary stockholders £3. 9s. per cent. for the year, and the Deferred stockholders 18s. per cent. But I would point out that of the amount required for this purpose no less than £17,558 has been derived from the earnings of the "Minia" during the past year, and those earnings represent a very precarious and uncertain item. It is only right that I should point out this, because if we had not had this windfall we should not have given the Deferred stockholders this substantial dividend. On the other hand, there is something which appears to the Directors as certain, and that is the very steady and substantial progress of the Company's receipts in the past few years. I am, therefore, not without hope, if business continues as it has begun, that we shall be able to give the Deferred stockholders something at the end of this year. Our receipts—not our net earnings, but our receipts from all sources—have increased in the last five years in a very gratifying manner. In 1894 they were £282,000, in 1895 £306,000, in 1896 £324,000, in 1897 £345,000, and in 1898 £390,000, showing, as I have said, a very steady and substantial increase. It seems, therefore, pretty clear that we shall be able, if we go on increasing this year in anything like the same proportion, to be able to again pay something to the Deferred stockholders. I am glad to be able to say that we have begun this year very well, and the gross receipts of the pool, of which our Company gets 55 per cent., amounted to £5,000 more last month than they were in January, 1898. I regret that the Directors have had this time to omit the statement in their report which has almost always been in it, that all our cables are in good working order. The 1874 cable is, however, broken down, but there will be no difficulty in repairing it. There is one other subject to which allusion has been made by the Chairman of the Direct United States Cable Co. I refer to the threatened or proposed German cable. You are probably aware that the arrangement, which has now been in operation for many years, by which this Company carried the German traffic, will expire at the end of this year, and the German Post Office have given us notice that from the end of this year we shall be no longer asked to carry their messages. This, of course, means that they are going to make arrangements to lay a cable for themselves. The Directors of this Company have had a great deal of negotiation with the German Post Office authorities, and we have endeavoured in every way we could think of to make some arrangement with them by which the laying of this cable might be avoided; but I regret to say that all our efforts have hitherto been unavailing. There has been no complaint against the Company—there has not been any hitch in our mutual arrangements, but they seem to think that they ought to have a cable of their own. We are not aware that the capital necessary for laying this cable has been subscribed, or that any cable has been ordered; but they may have made arrangements which we are not aware of. What I wish to emphasise is that if this cable is laid it will not be necessary for the traffic. I think that the Chairman of the Direct United States Cable Co. rather conveyed the impression—I do not know that he meant to do so—that the cables are pretty full, but I am inclined to take the view that we could carry a great deal more traffic than we do at present. If the Germans are to make any profit on their cable it must be through their having a substantial guarantee from their Government. I do not think, however, considering all the circumstances in connection with this question, that we need be too much alarmed.

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The DEPUTY-CHAIRMAN (Sir Gerald Fitzgerald) seconded the motion.

Sir JOHN SWINBURNE called attention to the expenses, which he regarded as heavy. He also desired to know the position of the French litigation.

Mr. JOHN GLOVER held that more consideration ought to be shown to the holders of the Deferred stock now that the renewal fund stood at the substantial amount to which it had been increased.

Mr. FAIRBANK stated that some days before the report was issued there was an official announcement of what the dividend would be, but many days before that announcement was made it was known on the market. He should like to know how it was that such information leaked out.

Mr. JOHN NEWTON said he thought that the stability of the Company would be interfered with if a less amount were put to reserve than the Directors thought necessary.

The CHAIRMAN, in reply, submitted that their expenditure was exceedingly small in relation to the amount of work done. In 1894 the percentage of their expenses and renewal fund to their total receipts of £282,000 was 48 per cent. Mr. Carson then assumed the management, and the percentage of expenses had fallen year by year since, the percentage last year being only 38·12 per cent. He held that they were conducting the business as economically as it was possible to do consistently with efficiency. With regard to Mr. Glover's remarks, the Directors had to look to the interests of the Company as a whole. Their cables were getting older every year, and he thought, with regard to the renewal fund, that they ought to be in the strongest possible position in view of the wearing out of their cables. He did not believe that the Stock Exchange—which, however, made forecasts—obtained any information from the office of the Company as to the dividend.

The SOLICITOR (Mr. Chapman) explained the position in which the French litigation stood.

The motion was then carried unanimously, and the proceedings terminated.

St. James' and Pall Mall Electric Light Co. (Limited)

The ordinary general meeting of this Company was held on Tuesday, at the offices, Carnaby-street Central Station, Golden-square, W., Mr. EUSTACE J. A. BALFOUR (Chairman) presiding.

The GENERAL-MANAGER AND SECRETARY (Mr. F. J. Walker) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN, in moving the adoption of the report and accounts, said: Since I had the pleasure of seeing you here at the commencement of last year the business of the Company has been carried on in a satisfactory manner, and I am in a position to congratulate the shareholders on the continued success of their undertaking. The extensions at Carnaby-street station have been completed and equipped with machinery of the most modern type, and the station is now in full working order, with a plant of 4,500 H.P. Mason's Yard station, which was remodelled and fitted with new engines to overcome the difficulties which we experienced from vibration, caused by the older type, have been running throughout the year, in conjunction with the Carnaby-street station with its full plant of 1,500 H.P., and there is no further cause for complaint. In the course of the year we have added a total of 12,026 lamps to our service, amounting to an increase of 13 per cent., and we have now connected a number of 142,853. Fresh orders are coming in daily, including several large consumers, and there is every reason to suppose that the business will continue to expand in the same steady manner as it has done in the preceding years. A further reduction has been effected in the working costs, and it is noticeable that, in spite of the serious and prolonged strike in the Welsh coal trade, the actual cost of coal per unit of electricity sold, which was already the lowest figure for any metropolitan undertaking, has been slightly reduced, and I may add that we were amongst the two Companies against which no complaint was made in the matter of smoke. As I informed you last year, the Directors had acquired a freehold site on which they proposed to deal with all future extensions; and to secure the economy which would be obtained from a large output, and to lessen the burden on the Company of initiating so large an undertaking, they arranged by agreement with the Westminster Electric Supply Corporation, whose business and requirements are altogether similar to our own, to promote a Bill under the title of the Central Electric Supply Co. (Limited), to erect the joint stations for the supply of electricity in bulk to our respective districts, and to share expenses. Unfortunately, this Bill was opposed in the last session of Parliament by the Great Central Railway Co., who succeeded in getting compulsory powers over our land for their own purposes, thus delaying this Company by a whole year, time which could ill be spared. A fresh Bill has been drafted for the ensuing session of Parliament, and a suitable plot of land has been scheduled for compulsory purchase, and in view of the favourable decision of the Joint Committee of Parliament, which had under consideration last year the granting of additional facilities to electric supply undertakings, there is reasonable prospect that the scheme will be carried through to a successful issue. The Central Electric Supply Co., which will be controlled by the joint boards of the St. James's and Westminster Companies, and placed under the same management and technical staff, will be financed by the two companies, and will be able to supply all their future requirements in the most economical manner. The result of the delay, however, has compelled the Directors of this Company to take steps to meet the immediate growth of their business. The present plant, as I stated last year, will suffice for our requirements for another winter season, for another winter season only, so that it is imperative that provision be made with further extensions for the winter of 1900. The Directors, therefore, are proceeding by Bill in the ensuing session of Parliament to acquire, by compulsory purchase, certain property at the back of Carnaby-street station, and they propose to extend their existing premises and to put down sufficient plant to enable them to meet all requirements until supply can be assured from the new central station. Provision will also be made for the necessary transforming plant for utilising the high-pressure current so transmitted, and you will be asked, at the conclusion of this meeting, to confirm a resolution approving a Bill for this purpose. Out of the profits of the year the Directors propose a dividend of 12½ per cent., with a further bonus amounting to 2 per cent. In accordance with the policy I foreshadowed to you in my speech of last year, when I pointed out that the dividend of 14½ per cent. was in a way fictitious, a full division being compelled by the founders' rights under the Articles of Association. Happily for the Company these rights have now been extinguished by purchase, and the Directors are in a position to shape their policy in such a manner as will best safeguard the interests of the Company, and secure a steady return to their shareholders. Referring to the capital account, as set forth in the report, you will note that the founders' rights have been practically extinguished by the issue to the founder shareholders of 12,000 Ordinary shares at *par*. The founders' shares are now held by me in trust for the Company, and will shortly be technically, as well as practically, extinguished, by final application to the Court. Our Ordinary capital will then stand at £160,000, and in view of the increased expenditure on works in connection with the Bills to which I have referred, the Directors propose to round off the Ordinary share capital by the issue of the remaining 8,020 shares at a premium, and at the same time they have deemed it advisable to pay off the £50,000 Four per Cent. Debenture stock, so that at the commencement of next year the capital of the Company will consist of £200,000 Ordinary and £100,000 Preference share capital, and the Company will then have clean borrowing powers to the extent of half its capital issue to deal with the expenses referred to. The premium on the issue of the 8,020 Ordinary shares will be placed, as on a previous occasion, to reserve, where it will considerably strengthen the position of the Company and enable us to place our loan capital to the best advantage. These shares, in accordance with the Articles of Association, will be issued *pro rata* to the shareholders, and although I am not in a position at present to fix the price at which the issue will be made, I may state that it is the intention of the Directors to base this price on combining the policy of building up a reserve with giving an adequate profit to the shareholders. I am sorry to say that on this question the Directors are in disagreement with certain large shareholders, who, until recently, represented the interests of the founder shareholders, and they have been compelled, in a circular dated January 31st, to lay their views before the shareholders generally and to seek their support to the line of policy to which have referred. In reply to this, two circulars have been issued and signed by the shareholders to whom I have referred as being in opposition to the Board, and in their second circular they state that, whilst having no objection to the formation of proper reserves, they are of opinion that these should be provided out of revenue. In dealing with this question the first thing I wish to point out is that the Directors are not departing from the settled policy of many years, a policy which has been repeatedly approved by the bulk of the shareholders. Were this policy to be reversed it would seem impossible to justify the action of past years, especially in reference to the exchange of ordinary shares for founders' shares. It should also be borne in mind that many precious years have been wasted by our previous inability to form such a reserve, owing to the legal position of the founders' shareholders. But, if the Directors wish to abide by this policy year by year, there are special reasons why, at the present moment, it should be adhered to. I have already pointed out the immediate necessity of two very large extensions requiring us to go to Parliament for compulsory powers of purchase. It would be a very strong argument, in the hands of counsel acting for the opposition to these Bills, to say, "Here is a public company working under a Provisional Order, with only a 33 years' unexpired term of existence, which is actually seeking powers of compulsory purchase of land, while in addition to paying a dividend of 14½ per cent., it is, out of its capital, distributing a further bonus of some 30 to 40 per cent. in addition, without putting by a single penny to reserve." That, I say, would be a very strong point for counsel to make, and I confess, if I were a member of such a committee, that I should hesitate very much before voting in favour of the preamble of such a Bill. In this connection I may note that gas companies are required by the Standing Orders of Parliament to sell new shares by auction to the highest bidders. But there is still another reason why the course proposed to us by this minority of the shareholders is at this moment especially unadvisable. We are undoubtedly on the eve of seeing inventions introduced in electric lighting which will very much reduce its cost. It is difficult to prophecy what exact effect this will have upon this Company, but it may be that it will produce an increased demand, so great and so sudden, that we shall have the utmost difficulty in meeting it. In that case the question of raising fresh capital very rapidly may arise, and our borrowing powers under the present scheme being untouched, we should be able to meet these circumstances by raising money at a comparatively low rate of interest. One further matter I wish to allude to, namely, the fact that we have reduced our scale of charges. I believe this, in view of our applying to Parliament for compulsory powers, and in view of other important considerations, to be a wise and politic decision. We must never forget that we are a public and not a private company. The local authority, and I would remind you that local authorities are about to be greatly strengthened, can bring the matter of charges before the Board of Trade. During last session, when certain electric light companies applied for compulsory power over land, the Lord Chairman's Committee of the House of Lords suggested whether, if electric light companies applied for such powers, they ought not to be put under Parliamentary conditions as to their capital, &c., and I feel sure that any complaints of excessive profits would be seriously taken into consideration by any Parliamentary Committee in considering our Bills. Therefore, let me say that, although the Board are always sorry to differ from any section of their shareholders, they feel bound, in this case, to adhere to [their

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policy, and I am glad to say that they are supported by a majority of the proxies. In conclusion, there is one matter to which I must allude, and that is the death of our late Director and colleague, Mr. Latimer Clark, F.R.S., vice-chairman of the Company, who died in October last. Mr. Clark had been associated with this Company from the commencement, and his professional knowledge, coupled with the keen interest he took in all matters affecting the welfare of this company, was of great service to us in pioneering such a new undertaking. His services to us were invaluable, and many of us feel his loss personally very keenly. The Directors have nominated Mr. Marlborough Pryor to the vacant seat on the Board, and I think the shareholders may be congratulated on securing the services of Mr. Pryor, who has a very wide experience of commercial administration as well as broad scientific knowledge. In accordance with the articles of association, Mr. Pryor retires at this meeting, and offers himself for re-election.

Sir JOHN H. MORRIS, K.C.S.I., seconded the resolution.

Mr. E. P. S. REED moved an amendment asking that the 8,020 ordinary shares which the Directors proposed to issue at a premium should, instead, be issued to the shareholders at par.

The CHAIRMAN ruled that the amendment was not in order.

Mr REED then moved "That the report and accounts be not adopted." He said that in the absence of any information as to the premium at which the shares were to be issued it might reasonably be assumed that it would be a substantial one of say, £6 to £8 a share, which would make the issue price of the shares about £12 each. The shareholders were, therefore, invited to put their hands in their pockets for the purpose of establishing a capital reserve fund. It seemed to him and to those whom he represented that it was unfair to call upon the shareholders to subscribe a heavy premium on a new issue of shares, the benefit of which would be solely for those who came after them.

Mr. D. HUTTON remerked that it was so clearly evident that it would be more profitable for the shareholders to receive the new shares at a premium, than to pay a large premium for them, that one turned with a little anxiety to see the reason why the Board had decided to charge a premium on the shares. They were to pay a large premium, and create a fund which was to be kept for 30 or 33 years, and then to be repaid to them under the name of redemption of capital—that meant that they would have redeemed their capital out of their own pockets. He hardly needed to point out that they might begin at once by keeping the money in their pockets, which would be far better than to redeem it at the end of the specified period.

Mr. STRATTON BOULNOIS remarked that it was within the power of any shareholder to make his own redemption fund out of his dividend. There were those who thought that it would be useless to create a reserve fund, in connection with the Company, because, at the end of 33 years, the arbitrator would take that into consideration and the money would be mopped up by the Vestry which acquired the Company's business. What would happen in 33 years concerned him very little indeed, but it did concern him that the shares should be issued at such a price, namely, at par, that he would receive a handsome dividend in the meantime, which he could spend or out of which he could create a reserve fund, if he thought fit.

Mr. C. FOSTER said he was a ratepayer in the parish of St. James's, and he could assure them that the ratepayers would watch with considerable interest the accumulation of the proposed reserve fund. By so much as the reserve fund amounted to in 33 years, by so much less would the ratepayers have to pay for the business of this Company when they took it over.

Mr. FRY appealed to the Chairman to alter his ruling and accept the amendment originally moved by Mr. Reed. He thought it would be much more convenient that the discussion should proceed on the lines of that amendment, especially as they were advised that that was the proper way to meet this question.

The CHAIRMAN said he very much regretted that he could not alter his ruling.

Mr. BOURN appealed to the Chairman to stop the discussion by giving the shareholders a frank answer as to the premium at which the shares would be issued. If the Directors were willing to restrict the proposed premium to a small amount, however, it was probable that the shareholders would not very much object.

Mr. W. HOLDER then moved, "That the report, with the exception of paragraph 5, be adopted."

The CHAIRMAN ruled that this amendment also was out of order.

The SOLICITOR (Mr. Sydney Morse) said that the section of the report which it was proposed to omit was an inoperative section, and, therefore, the amendment was not a proper one, having regard to the articles of association.

Mr. REED suggested that the Board should themselves frame an amendment which would meet the views of the shareholders he represented.

Mr. WALTER LEAF (a Director) said he thought it was the practice in all companies that the report of the Directors must be accepted or rejected as a whole.

Mr. REED contested this point, and said that nothing in the articles of association would bear out Mr. Leaf's contention.

Mr. HOLDER did not think it was wise to discuss the point any further. Having, himself, a considerable knowledge of municipal matters he might, however, just say that when any objection was raised to the minutes it was the usual practice to move that they should be adopted with the exception of the portion objected to. The point, however, which they had to consider was whether they should issue the extra 8,020 shares at par or at a premium. It would be an excellent thing for the founders' shareholders, and it would be an admirable thing for the original £5 shareholders if the new shares were issued at a premium, but it would be a most unfair thing to those shareholders who had bought their shares in the market at the price of 17 or thereabouts. The founders had received an immense amount of money for their shares, and he quite agreed that the Company did wisely in buying out their interests at the time, although, at the present time, they were not worth a quarter of the money paid for them under the altered Parliamentary conditions. If a decision were come to to put the premium on the new issue into the general funds of the Company, those founders shareholders would, in 33 years' time, participate equally with the other shareholders, even with those who had paid upwards of 17½ for their shares. He thought that the Directors should give those shareholders who had acquired their holdings at a high price, the chance of making something out of the new issue. The Chairman had said that Parliament would take a certain view of the matter, and that if the new shares were issued at par, he would hesitate, if a member of the Committee, before passing the preamble of the Company's Bill. It was his (the speaker's) opinion, however, that Parliament and counsel were sharp enough, whether the money was put into the shareholders' pockets or into the general funds of the Company, to regard the matter as being exactly on the same basis. It was really on all-fours whether the Company took the money and spent it, or whether the shareholders had it given to them as a bonus. It depended very much on the temper of the day in a few years' time what they would get for their concern, and, therefore, in his opinion, it would be wise to make money while they had the chance. If these 8,000 odd shares were bought it would be seen that they were worth, at £5 each, £40,000. If they were put on the market at 17½ they would get roughly £136,000 for them. There was an immense difference there, and the question was whether it should go to the Company or to the shareholders? They would be unable to get anything on account of goodwill at the end of 33 years, and he would point out that, when the valuer went over their business, what he would want to know would be how many £5 shareholders they had. The valuer would not ask what was the capital which they had expended, because there would be so many items of deterioration, but he would want to know how many £5 shares they had issued in order to arrive at the basis of arbitration. He (the speaker) could assure them that in making these remarks he had no antagonism to the Company. He should not like to sit down without thanking their engineer, Mr. Dobson, for what he had done for the Company. It was only by following on the lines of this Company that he had been able to bring his own municipal undertaking to a success. He had tested almost every electrical institution in the kingdom before adopting this Company as his guide, and he was not speaking out of any friendship when he said that there was no finer engineer than Mr. Dobson in the country. Whether the new shares were issued at a premium or not, he had no doubt that the Company would continue to be a success, and he should also like to thank the Board for their services, and he trusted that, in coming to their decision on the question now before them, some consideration would be had for the purchasers of the shares at a heavy price.

Mr. LEAF thought that if the shareholders would listen to him a minute or two he would be able to sweep away a large amount of misapprehension. It seemed to have been taken for granted that the Board intended to invest the accumulated reserve fund at 2¾ per cent. He did not know what ground there was for that supposition. So far as he was acquainted with the intentions of the Board, it was proposed to put it into the business, and use it in that way; therefore, all that had been said about accumulating the fund for posterity vanished at once.

Mr. REED remarked that Mr. Leaf could scarcely remember the speech of the Chairman last year, and from which he had quoted. The Chairman then spoke of the property as a leasehold one, and pointed out how desirable it was, in view of the redemption in 1932, that a capital redemption fund should be formed.

A SHAREHOLDER said that he would like to point out that the capital reserve fund had not previously been put into the business, but into Cape Three per Cents.

Mr. LEAF, continuing, stated that the words used by the Chairman were, "We shall then be at liberty to provide a proper reserve fund, which will render the credit and dividends of the Company more stable." On a previous occasion the Board did, no doubt, put the reserve fund into a certain security, but he did not know that they were bound by the action of the Board on that occasion. Those investments were pledged to the debenture holders, but now they were free, and he wished it to be understood that the Board claimed a free hand in regard to that reserve fund. There were many purposes to which it could be applied. Supposing they had a bad accident or fire at their station.

A SHAREHOLDER: I suppose we are insured?

Mr. LEAF said that he would put it in another way. They had had what might have been two very serious accidents. Partly by good luck and partly owing to the ability of their engineering staff no particular harm was done, but there had been the possibility of a serious state of things, and in a case like that they wanted a large reserve fund on which they would be at liberty to draw at once. Before very long they would have to reissue debentures, at a better rate he hoped, than the expensive debentures which they had paid off. What an advantage it would then be to them to have a large reserve at their back. He believed it would be worth to them something like ¼ per cent. per annum in the rate of interest. After all, the Directors were not only human beings, but also large shareholders, and they would be very pleased, and it would be very nice for them to sit round the Board table and put some thousands of pounds into their pockets and their friends' pockets, and also make things agreeable to the shareholders generally by deciding to issue the shares at par. But as they did not take that course the shareholders must believe that the Directors were disinterested, and had grave convictions as to the desirability, in the interest of the Company, of doing what they proposed to do. Another question he would like to touch on was that of competition. They could not, in their case, neglect competition. They had no monopoly; on the contrary, they had keen and active antagonists. They had the Board of Trade and the local authorities with certain vague, undefined powers of reducing their method of charging. They had to consider, too, what was even more important—public opinion, especially

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that form of public opinion which was concentrated in their own customers. The Board had, therefore, thought it advisable to reduce the rates of charge, and they were not the only company who were doing so. The Westminster Company were making a reduction. The Directors had been asked to name the issue price. How could they do so? They did not yet know when the issue would be made, and the premium would have to be fixed in accordance with the market price of the shares at the time the issue was made—perhaps three, five, or twelve months hence. He could say, however, that the Board meant to give the shareholders a substantial turn of profit, but more than that he could not say.

Mr. FRY said he could not agree as to the continuity of the policy of the Board. As to possible competition, they knew that the London Electric Supply Co. was the only company which could compete with them. This Company had met with competition in the past from that company, for in the year 1893, the Chairman, in regretting the falling off in the revenue, showed that the principal reason for it was that the London Electric Supply Co. had cut the rates. He understood that subsequently an agreement was made between the companies that nothing further in that direction should take place. What was the position at the present time? This Company had again lowered their rates. So far as he could make out from friends of his interested in the London Company, this Company had taken them rather by surprise. Supposing the London Company retaliated, and reduced their rates, where would this Company be? They would then have to enter on a war of rates, which could not fail to be detrimental to the interests of the shareholders. He maintained that a more continuous policy was what the shareholders looked to the Directors to carry out.

The CHAIRMAN: As a matter of fact, the London Company has been for many months trying to undersell us. I think we will now vote on the resolution. The amendment is, of course, a direct negative, so that to vote against the resolution will be the same as to vote for the amendment.

On a show of hands the resolution was declared carried by 26 to 21.

Mr. Walter Leaf and Mr. Marlborough Pryor having been re-elected Directors, and Messrs. Deloitte, Dever, Griffiths and Co. re-appointed auditors, a hearty vote of thanks to the Chairman terminated the meeting.

An extraordinary general meeting was then held for confirming a resolution passed on January 19th, rearranging the capital of the Company. This was agreed to unanimously.

A further extraordinary meeting was held to confirm the resolution sanctioning the introduction of a Bill into Parliament giving the Company power to acquire lands, &c.

This was also carried unanimously, and the proceedings terminated.

Waterloo and City Railway Co.

The tenth half-yearly meeting of the proprietors was held yesterday at Waterloo Station, London, Mr. WYNDHAM S. PORTAL (Chairman of the Board) presiding.

The SECRETARY (Mr. Godfrey Knight) having read the notice calling the meeting,

The CHAIRMAN said that he had to congratulate them on the completion and opening of the line. The value of the undertaking was not to be measured by its length of only 1½ miles, but by its importance to them, as the owners, and to the London and South Western Railway Co. as the workers of it; and also to the travelling public. As regarded the initial difficulties which had been experienced in working the railway he said that there was every reason to believe that they were not only being overcome, but that they would prove useful object lessons to the working company and to themselves, and would tend to their mutual advantage in the near future. The City terminus subways and connecting approaches were being proceeded with by the Central London Railway Co., and would, it was hoped, be completed by the end of the current year. It was estimated that their further capital outlay would amount to about £52,000. Should this estimate turn out to be correct, the total expenditure would not exceed the £600,000 originally contemplated. The revenue receipts for the four months and 24 days that the line was opened for traffic during the six months ended Dec. 31 last amounted, in gross, to £11,088. No less than 1,442,000 passenger journeys were made over their line, exclusive of season ticket holders, involving the running of 40,360 train miles. To the balance of £6,301 carried to the net revenue account, they had to add £347, the dividend on the consols for their parliamentary deposit of £25,000, which had been repaid to them, interest of £43 on banker's deposit account, and £1,987 in respect of a portion of the profit on the sale of their consols. That made up the total amount to £8,679, and, after meeting the interest payable on the debenture stock, namely, £288, they had £8,390 available for distribution, out of which, the Directors proposed to declare a dividend at the rate of 3 per cent. per annum for the half-year under review. The prospects of the undertaking, as a whole, looked promising, and he believed that, in each succeeding half year, the results obtained would be of a favourable character. So far, they had every reason to be satisfied with the number of passengers carried, and the Board had no doubt that the number would increase as time went on. He concluded by moving the adoption of the report and accounts.

Lieut.-Col. the Hon. H. W. CAMPBELL seconded the resolution, which was agreed to unanimously.

Cambridge Electric Supply Company (Limited).

The report of the Directors of this Company announces that the prospects of the Company continue to be satisfactory. During 1898 there has been added to the Company's mains the equivalent of 3,885 8-c.p. lamps, making the total 25,080. The number of units supplied has been 260,307, an increase of 38,800 (or 17 per cent.). Thirty-six new consumers have been added, making the total 365. There has been a general increase all round in the Company's extension of mains, and the capital expenditure for the year has been £3,035. 13s. 7d.; 16,706 yards of pipe and cable have been laid down, and the duplicate system of distribution referred to in last year's report is on the point of completion.

After paying all charges, placing £250 to the reduction of preliminary expenses, £300 to depreciation, and £84. 1s. 7d. to credit of suspense account, there is a balance of £3,037. 9s. 11d., which, added to £292. 16s. 10d. brought forward, makes £3,330. 6s. 9d. An interim dividend of £1,068. 9s. 3d., and interest on temporary overdraft, £71. 0s. 3d., have already been paid, leaving a net balance of £2,190. 17s. 3d., out of which the Directors now recommend the payment of a dividend of 4½ per cent., making, with 2½ per cent. already paid, 7 per cent. for the year. This will absorb £2,067. 5s. 6d., leaving £123. 11s. 9d. to be carried forward.

National Telephone Co. (Limited).

The report of the Directors of this Company for the half-year to Dec. 31, 1898, states that the income amounts to £573,707. 3s. 6d. compared with £507,602. 17s. 3d. for the corresponding period of 1897, an increase of £66,104. 6s. 3d. The working expenses amount to £312,462. 4s. 4d. compared with £283,085. 12s. 11d., an increase of £29,376. 11s. 5d. The net result (after deducting Post Office royalties amounting to £54,356. 12s. 10d.) is a profit balance of £206,888. 6s. 4d. compared with £178,457. 7s. 8d., an increase of £28,430. 18s. 8d. The rentals carried forward for unexpired terms of running contracts amount to £536,654. 3s. 4d. compared with £473,586. 17s. 10d., an increase of £63,067. 5s. 6d.

Out of the available balance of £172,037. 15s. 11d. shown by net revenue account the Board recommend the payment of a dividend at the rate of 6 per cent. per annum, less tax, on the First and Second Preference shares, 5 per cent. per annum, less tax, on the Third Preference shares, and 6 per cent. per annum, free of tax, on the Ordinary shares. The Board also propose to transfer £50,000 to reserve, and to carry forward £8,287. 15s. 11d.

Capital Expenditure.—£367,201. 7s. 6d. has been expended on capital account during the half-year in the erection of 6,932 additional exchange and private lines, and in the construction of underground lines.

During the recent Parliamentary enquiry much stress was laid upon the fact that the Company is exempt from the conditions as to service and charges, which, in the case of railway, gas and water companies, are usually imposed by Parliament. Mr. Hanbury, in his speech in the House of Commons on April 1, 1898, said "the Company had not only a monopoly, but one which was not under strict control or under stringent regulations. Railway, water, gas and electric lighting companies were all placed by Parliament under very strict limitations with regard to their capital, dividends, rates, and especially preferences, and on all these points this Telephone Company was absolutely unfettered. He thought that that was a strange state of things." Mr. Hanbury had apparently forgotten that this "strange state of things" was a direct consequence of the action of the Government themselves, who, in several Sessions, vetoed Bills lodged by the Company with the express object of obtaining powers to enable them to carry on their business efficiently, and upon such reasonable conditions as might be imposed. In view of what has transpired the Company have again deposited Bills, in order that the complaints against them as set forth by Mr. Hanbury may be removed.

The continued and rapid expansion of the Company's business will involve the expenditure of a further considerable amount during the next few years. The funds at present available on the basis of the existing capital powers are already appropriated to works now in progress, and the Board will bring forward at the meeting the question of provision for the future, and will propose a resolution on the subject.

Dublin United Tramways Co. (1896) (Limited).

The report of the Directors of this Company for the half-year to Dec. 31 states that the net profits of the Company's various tramways undertakings, after payment of dividends at the rate of 6 per cent. per annum on the Preference, and 5 per cent. (free of tax) on the Ordinary (absorbing £25,857. 16s. 10d.), leaves a total balance forward of £8,971. 2s. 6d.

The Donnybrook line has been working electrically since Nov. 22, 1898, and, having regard to the limited number of cars run, shows satisfactory results. The North Circular road line (Phibsborough and Phœnix Park) was opened electrically on Jan. 23, 1899, and the cars now run through from Donnybrook to the North Park Gate. The working of the Clontarf line by electrical power continues to more than fulfil the anticipations of the Directors. Considerable progress has been made with the construction of the power station at Ringsend, and the Directors expect that it will be working towards the end of the current half-year, when the greater portion of the remaining horse lines will have been reconstructed and electrically equipped.

The Board of Trade inquiry into the Dublin Southern District Co.'s application for an increase of speed has resulted in an increase to 10 miles an hour being sanctioned from Haddington-road to Williamstown, the maximum speed from that point to Dalkey remaining at eight miles an hour.

The Directors propose at an early date to issue the remainder of the Ordinary shares, and holders of the Ordinary shares have the right to the allotment of these shares at par in proportion to the number of Ordinary shares held by them at date of the new issue.

Central London Railway Co.

The report of the Directors of this company for the half-year to Dec. 31 last states that the expenditure for the period has amounted to £371,567. 18s. 1d., the total to date to £2,445,076. 13s. 7d. A further call of £2 per share was made payable on Jan. 13, 1899, and the Electric Traction Co. have been paid thereout the cash amount due to them under the

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contract, for work done to Dec. 31, as certified by the engineers. The engineers report that the main line and station tunnels are completed, with the exception of 100 yards which remain to be constructed at the Bank station. The lift shafts are sunk at this point and the roof of the public subway is now being put in. The low-level subway connecting the Lombard-street station of the City and South London Railway Co. with the Bank station is complete. Substantial progress has been made with the power station and depôt at Shepherd's Bush, and the large buildings necessary for the rolling stock and electrical machinery are approaching completion. A considerable portion of the generating plant has been delivered, and its installation will shortly be commenced. At several of the station sites building operations are in progress, and the erection of the electric lifts is in hand. The materials for the permanent way are in course of delivery, and the rails are being laid down.

Having regard to the special difficulties, entailing material delay in completing the large underground station in front of the Mansion House, the Directors are applying to Parliament for an extension of the time allowed for the completion of the works, and for an increase in the sum authorised to be paid as interest to the proprietors during the construction of the railway. A bill extending the time for one year from June 30 next will be submitted for the proprietors' approval at the meeting on Feb. 15.

NEW COMPANIES, STATUTORY RETURNS, &c.

SEARCH LIGHT SYNDICATE (OF AMERICA) (LIMITED).—This company was registered on Feb. 3rd, with a capital of £30,000 in 9,000 "A," 10,000 "B," and 11,000 "C" shares of £1 each, to enter into an agreement with Thomas W. Goad, and J. Noel Sparks, and to carry on the business of reflector and projector manufacturers, engineers, electricians, metal workers, &c.

"STEADY" ARC LAMP COMPANY (LIMITED).—This company was registered on Feb. 3, with a capital of £20,000, in £1 shares, to carry on the business of electric lamp manufacturers, electrical and mechanical engineers, millwrights, and undertakers for the supply of electric light, heat and motive power. The first subscribers are:—W. B. Clowes, J. S. Blackwell (electrical engineer), W. A. Charles (engineer), F. C. Geary (electrical engineer), E. E. Voss (electrician), D. Francis, A. Lock (electrician). The first directors are:—L. Simpson, J. F. Neal, A. J. Davies, J. Rollitson, A. Stahl, and W. A. Charles and J. S. Blackwell (managing).

YALE ELECTRIC POWER COMPANY (LIMITED).—This company was registered on Jan. 31, with a capital of £10,000, in £25 shares, to enter into an agreement with T. P. O. Yale, electrical engineer, and to carry on at Blaenau-Festiniog the business of an electric light and power company in all or any of its branches. The first subscribers are:—F. S. Percival, H. Percival, F. W. Percival, C. E. Green, T. P. O. Yale, W. C. Yale, E. H. Percival. The first directors are:—F. S. Percival, T. P. O. Yale, Maj.-Gen. H. Percival, F. W. Percival, and C. E. Green.

BROMLEY (KENT) ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual return to Dec. 19 has been filed. The nominal capital is £20,000 in £5 shares, of which 1,637 shares have been taken up and £1 per share has been called.

CENTRAL ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return up to Jan. 12 has been filed. The nominal capital is £100,000 in £5 shares; 307 shares have been taken up, and £1 per share has been called on 300.

CHELMSFORD ELECTRIC LIGHTING COMPANY (LIMITED).—The annual return to Oct. 24 has been filed. The nominal capital is £50,000 in £1 shares, of which 9,878 have been taken up. The full amount has been called.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 2, 1899). Price of silver $27\frac{7}{16}$d. per oz. (Feb. 9). Consols ($2\frac{3}{4}$ per cent.) $110\frac{7}{8}$—$111\frac{1}{8}$ for money, $111\frac{1}{16}$—$111\frac{3}{16}$ for account; $2\frac{1}{2}$ per cent. $103\frac{7}{8}$—$104\frac{1}{8}$ (Feb. 9). Stock Exchange Settling Days: Consols, March 1; Stocks and Shares Continuation Day, Feb. 22; Ticket Day, Feb. 23; Pay Days, Feb. 10 and 26; Mining Share Carry over Days, Feb. 21 and March 7.

ANGLO-AMERICAN TELEGRAPH CO. (LIMITED).—The *Statist* for Feb. 4 contains an exhaustive review of the prospects of the Anglo American Telegraph Co.'s stock.

BRISTOL TRAMWAYS AND CARRIAGE CO. (LIMITED).—The Directors of this company, in their report for the half-year to Dec. 31, state that the receipts from the tramways department show an increase of £8,143. Fair progress has been made with the work of constructing the authorised tramway extensions and the adaptation of existing lines and depots for electrical operation. The site of the central power station at counterslip has been cleared. The Directors will shortly issue 25,000 new shares as Four per Cent. Cumulative Preference shares at par to the holders of Ordinary shares in the proportion of one new Preference share for every two Ordinary shares held.

BRUSH ELECTRICAL ENGINEERING CO. (LIMITED).—An interim dividend at the rate of 6 per cent. per annum has been declared on the Preference shares for the half-year to Dec. 31 last, payable on March 1.

CITY OF LONDON ELECTRIC LIGHTING CO. (LIMITED).—Subject to final audit, the Directors recommend the payment of the following dividends:—A final Preference dividend of 6s. per share for the six months ended Dec. 31, making (with the dividend already paid) a total distribution of 12s. per share, or at the full rate of 6 per cent. per annum, and on the Ordinary shares a final dividend of $3\frac{1}{2}$ per cent. on the capital paid up, making (with dividend of $2\frac{1}{2}$ per cent. paid on account last July) a total dividend of 6 per cent. for the year 1898. The transfer books of this Company will be closed from Feb. 15 to March 1 inclusive.

EASTERN TELEGRAPH CO. (LIMITED).—An extraordinary general meeting of this company was held on Wednesday at the offices, Mr. J. Denison-Pender in the chair, to consider the confirmation of the resolution, which was passed at the extraordinary general meeting held on the 19th ult., for altering clause 29 of the Company's Articles of Association, by striking out the amount of £10 and inserting in lieu thereof £1. The Chairman briefly proposed the confirmation of the resolution, expressing his regret that the directors had been obliged to convene the meeting, although its object was only formal. Sir A. J. Leppoc Cappel seconded the motion, which was carried unanimously.

ELECTRICAL ENGINEERING IN SWEDEN.—A company entitled the Electriska Aktiebolaget Holmia has been formed in Stockholm, with a capital of 100,000 kroner, to act as Swedish Agents for Messrs. Brown, Boveri and Co., of Baden and Mannheim.

GATESHEAD AND DISTRICT TRAMWAYS CO. (LIMITED).—The company's Bill for power to work the tramways electrically has been approved by the shareholders.

W. T. GLOVER AND CO. (LIMITED).—The share transfer books of this company are closed from the 4th to the 17th inst. inclusive.

GREAT NORTHERN AND CITY RAILWAY CO.—At the half-yearly general meeting of this company, Sir Charles Scotter (presiding) said: It is now nearly nine years since the first parliamentary powers were obtained for making this railway, but no efforts appear to have been made to raise the capital until 1894. The application to the public was not successful, although a very large sum was subscribed. The investing public were not sufficiently acquainted with the probable result of working railways by electric power, and very naturally fought shy of investing in these new undertakings. Just after this the contractor died, and the scheme was allowed to remain in abeyance for some time. Applications have been made to Parliament, and granted, for extension of time and other powers, and the line is to be completed by the end of June, 1902. Later, when I was approached and asked to take an interest in the railway, I came to the conclusion that there was no underground electric railway scheme in London at the present time which has more justification for its origin or offers better prospects of ultimate success. This is a railway not solely dependent upon a limited area for its traffic, but it will practically be the City terminus of the Great Northern Railway, and the railway itself runs through, and will accommodate, a district which is said to be the most densely-populated part of London. This railway differs from other electric railways in the fact that the tunnels are larger and quite capable of taking the Great Northern rolling stock without difficulty; so that their suburban traffic can be efficiently worked to and from the City in through trains and in much less time than by any existing route. When the prospectus was issued to the public in June last, the amount subscribed was not sufficient, in our judgment, to warrant us in going to allotment, and the money was returned. Later the prospectus was again advertised for one day only, and on July 29 last we went to allotment with more than £1,000,000 of share capital subscribed, divided amongst about 400 shareholders. A contract was made by the late Board with Messrs. S. Pearson and Son (Limited) to carry out all the works and equipment for the railway. They have undertaken, in exchange for the capital, to construct, equip, and open this railway, they taking all risks of every kind and description. Our engineers, Sir Douglas Fox and Mr. Francis Fox, report that at the Regent's Canal the contractors are in possession of all the necessary houses (except one) for the temporary purposes of their yard, and for the permanent generating station. The working shaft at this point has now been sunk to its full depth, viz., 53ft. from the surface, and the heading to give access thence to the railway tunnels is being started. The foundations for the electric light engine and air compressor are in place, and some of the machinery has been delivered on the ground. I notice, also, that the Great Northern Company are promoting a bill to construct an electric underground railway from Wood Green to King's Cross, and then on to the Strand. We do not look upon this as in any way a competitor to your railway. I may mention that I am interested in the Waterloo and City Railway as a director, and, in fact, I may claim to be the promoter of that railway. It was opened in August last, and the traffic has been entirely satisfactory. Some little difficulties have arisen in the electrical equipment, and when these are remedied it is hoped that a four minutes' service will be maintained throughout the day. We shall be able to profit by the experiments which have been made on this railway.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LIMITED).—Subject to audit, the directors of this company recommend a dividend on the Ordinary shares at the rate of 12 per cent. per annum (including interim dividend of 4 per cent. already paid) and a bonus of 2 per cent. per annum less tax, payable March 1.

INDIARUBBER.—The Exchange Telegraph Co. announce that steps are being taken to organise a great indiarubber Trust, with Manchester as its centre.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING CO. (LIMITED).—The Directors of this Company report that during the year 3,678 equivalent 8 c.p. lamps were connected to the mains, bringing the total up to about 36,278, and 778,828 units of electrical energy had been supplied, against 642,969 units in 1897; 2,563 yards of main and branch piping had been laid, together with 10,386 yards of main and branch cable. The gross earnings during the year amounted to £7,546. 0s. 1d., and after paying interest and making provision for depreciation, a dividend of 5 per cent.

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for the half-year ended Dec. 31 (less tax) is recommended, which, together with the interim paid in August, makes 8½ per cent. for the year.

SCARBOROUGH ELECTRIC SUPPLY CO. (LIMITED).—The directors, annual report states that during the past year 53 additional consumers, and the equivalent of 2,227 8 c.p. lamps were added to the Company's system, making a total of 383 consumers and 22,344 lamps connected. The profit on the year's working was £2,331. 16s., against £2,044. 13s., for 1897. Adding £188. 12s. 5½d. brought forward, and £278 premiums on new shares issued, there was (after paying tax and interest and placing £416. 12s. 7d. to depreciation) £2,332. 14s. 6½d. available for distribution. The directors recommend a dividend of 5½ per cent., absorbing £1,964. 4s., leaving £368. 10s. 6½d. to be carried forward. In 1897 a dividend of 5 per cent. was paid.

SOUTH AMERICAN GENERAL ELECTRIC SUPPLY CO.—This is the title of a company which has been formed under the auspices of the General Electric Co. (U.S.A.), for engaging in electrical enterprise in South America.

SOUTH STAFFORDSHIRE TRAMWAY CO. (LIMITED).—An extraordinary meeting of this company was held on Wednesday to consider the provisions of the company's bill now before Parliament. The Chairman (Mr. Schuster) explained that the bill was the result of an agreement entered into in June, 1897, with the Electric Construction Co. The agreement was parted with to the British Electric Traction Co., who were really promoting the bill. Under Clause 5 the company would be authorised to grant a lease to the latter company. Under the lease there could be a minimum rent of 1¼d. per mile, the cars running not less than a certain mileage per annum. Clause 21 would restrain the local authorities of the district from exercising their powers of purchase for a period of 35 years from the passing of the act. The borrowing powers of the company would be raised from £50,000 to £100,000. The bill was approved.

"STEADY" ARC LAMP CO. (LIMITED).—The public have this week been invited to subscribe to an issue of Six per Cent. Cumulative Preference and Ordinary shares of £1 each in this company, which, with a share capital of £20,000, has been formed to acquire patent rights for England and other countries of the "Steady" electric arc lamps, "pronounced [the prospectus states] by eminent members of the electrical and engineering trade to be the simplest, cheapest, most reliable and economical lamp in existence at the present time." The prospectus further informs us that "there has been a long felt want amongst users of electricity as an illuminant, for a good and cheap arc lamp," and this the "Steady" is alleged to be; 17 advantages, which the inventors claim for this lamp, are set out, for which it is proposed to put down plant capable of turning out no less than 100 lamps per week. The estimated profits provide for the sale of these 100 lamps per week at £3. 10s., realising £350. The total inclusive cost of the 100 lamps is put at £160, net profit (therefore) £190. The list closed yesterday.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to appoint a special settling day in, and to grant a quotation to 20,000 £10 Six-per-Cent. Cumulative Preference shares of the *British Electric Traction Co. (Limited)*, and to 233,334 £1 Five-per-Cent. Cumulative Preference shares and £233,334 First Mortgage Four-per-Cent. Irredeemable Debenture stock of *Doulton and Co. (Limited)*. The Committee has been asked to allow the following securities to be quoted in the Official List:—27,500 £5 Fully Paid Six-per-Cent. Cumulative Preference shares of the *British Insulated Wire Co. (Limited)*, the further issue of £40,000 Four and a-Half-per-Cent. Debenture stock of the *Chelsea Electricity Supply Co. (Limited)*, and the further issue of 4,000 £5 Fully-paid Ordinary shares (Nos. 15,762 to 19,761) of the *House to House Electric Light Supply Co. (Limited)*. The Committee has also ordered £130,000 Five per Cent. First Debentures of the *Costa Rica Electric Light and Traction Co. (Limited)*, to be quoted in the List.

TELEGRAPH CONSTRUCTION AND MAINTENANCE CO. (LIMITED).—Subject to audit, the directors of this company propose to pay a dividend of 10 per cent. (£1. 4s. per share), in addition to the 5 per cent. already paid, making 15 per cent. for the year 1898.

WEST INDIA AND PANAMA TELEGRAPH CO. (LIMITED).—The estimated amount of the traffic receipts of this company for the half month ended Jan. 31 is £2,269, against £1,890 in the corresponding period of 1898.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Feb. 4	3,550	+ 64	...	...	...
Blackpool Corporation...	...	...	...	...	...	...
Blackpool and Fleetwood Co.	" 4	172	...	5	737	...
*Bristol Trams & Carriage	" 3	2,275	− 1	5	12,299	+ 469
City & South London Ry.	" 5	1,135	+ 72	6	6,688	+ 232
Dover Corporation	" 4	124	+ 31	44	7,910	...
Dublin United (Southern)	" 3	551	+ 154	5	2,905	+ 839
Liverpool Overhead Rly.	" 5	1,273	− 10	6	7,824	− 306
*Sheffield Tramways......	" 5	1,160	+ 221	5	6,022	+ 1155
*South Staffs. Trams......	" 3	587	− 16	5	2,895	− 62

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Feb. 1.		Price Wednesday, Feb. 8.		Rate per Cent. Yielded. £ s. d.	Dividends Due.	Business Done During Week Ending Feb. 8. Highest	Lowest
			TELEGRAPHS								
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	101	104	101	104	3 16 11	January and July	102	..
25,000	10	—	Amazon Telegraph	3	4	3	4	—	—	—	—
£125,000	100	5%	Do. 5 per Cent. Debentures	87	92	87	92	5 6 5	—	—	—
£905,560	Stock	15 0	Anglo-American	68	70	68	70	4 19 8	Feb., May, Aug., Nov	68½	
£3,047,220	Stock	30/0	Do. Preferred	120	121	120	121	5 0 6	" "	121	120
£3,047,220	Stock	..	Do. Deferred	16½	17	16½	17	—	—	16¾	16½
180,000	10	3 0	Brazilian Submarine	15½	16½	15¾	16¼	4 6 2	Mar., June, Oct., Dec	16 3/16	15⅞
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	110	114	110	114	4 7 9	June and December	..	..
10,000,000	$100	$2½	Commercial Cable Capital Stock	180	190	180	190	4 4 3	Jan., Apr., July, Oct	..	..
£1,332,523	Stock	4%	* Do. 4 per Cent. Debenture Stock	104	106	104	106	3 15 8	" "	105¾	105½
16,000	10	8/0	Cuba Submarine Ordinary (Deferred)	9½	10½	8½	9½	7 7 4	February and August	8½	—
6,000	10	10/0	Do. Preference 10 per Cent.	17	18	17	18	5 11 1	" "	—	..
12,981	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October	..	—
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 13 10	" "	..	—
£30,000	50	4½%	Do. 4½ per Cent. Debentures	104%	107%	104%	107%	4 4 1	January and July	..	..
60,710	20	3/0	Direct United States Cable	12½	12¾	12½	13	5 0 0	Jan., Apr., July, Oct	12⅞	12⅝
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	102	105	102	105	4 5 9	—	..	
£4,000,000	Stock	6%	Eastern Ordinary	175	180	177	182	3 17 2	Jan., Apr., July, Oct.	181	175
£1,295,000	Stock	3½%	Do. 3½ per Cent. Pref. Stock	103	106	103	106	3 6 0	" "	105¼	104
£1,432,265	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	125	129	125	129	3 2 4	May and November	127½	12 ½
£89,900	100	5%	* Do. 5 per Cent. Debentures, 1899	99	102	99	102	4 18 0	February & August	100	..
£500,000	Stock	—	Do. Provisional Certificates (all paid)	103	103	103	106	..	..	..	..
250,000	10	2/6	Eastern Extension	17¾	18¼	17¾	18¼	3 13 9	Jan., Apr., July, Oct.	18⅛	17¾
£120,000	Stock	4%	Do. 4 per Cent. Debenture Stock	124	128	124	128	3 2 6	February & August	124½	..
£16,200	100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Deb. 1900 (reg.)	99	103	99	103	4 17 1	January and July	..	..
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	" "	..	—
£35,100	100	5%	*Eastern and S. African 5 p.c. Mor. Deb., 1900 (reg.)	99	103	99	103	4 17 1	" "	—	—
£46,500	100	5%	Do, (Bearer)	100	103	100	103	4 17 1	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102	105	102	105	3 17 8	February & August	..	—
£200,000	25	4%	Do. 4% Mauritius Sub. Debs. (red.)	104%	107%	104%	107%	3 15 2	May and November	..	
180,227	10	1/9	Globe Telegraph and Trust	12¾	13¼	12¾	13¼	3 17 4	Jan., Apr., July, Oct	13¼	12⅞
180,042	10	6%	Do. 6 per Cent. Preference	16¾	17¼	16¾	17¼	3 9 7	" "	17 3/16	17⅛
150,000	10	5/0	Great Northern of Copenhagen	29	30	29	30	3 6 8	January, April, July	—	—
£150,000	100	5%	* Do. 5 per Cent. Debs., 1883 Issue Series "B"	101	104	101	104	4 17 7	March & September	—	—
£97,800	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red)	99	102	99	102	4 8 6	June and December	..	—
17,000	25	12/6	Indo-European	58	61	58	61	4 2 0	May and November	60½	—
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	109	112	109	112	5 7 7	March & September	..	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red)	104	107	104	107	3 14 9	June and December	104½	—
11,889	8	4/0	Reuter's	6½	7½	6½	7½	5 6 8	April and October	7	—
8,381	£100 Cert.	6%	Submarine Cables Trust	138	143	138	143	4 4 11	" "	—	—
15,609	10	—	West African Telegraph	..			—	..	—	—	—
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	100	103	100	103	4 18 6	March & September	—	—
30,008	2½	—	West Coast of America	½	1	½	1	..	—	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	103	106	103	106	3 15 9	June and December	—	..
88,321	10	1/6	West India and Panama	1½	1¾	1½	1¾	—	May and November	1 11/16	1⅝
34,563	10	6/0	Do. 6 per Cent. 1st Preference	10½	10¾	10½	10¾	5 11 7	" "	10½	10¼
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	9	10	8½	9½	6 6 4	" "	..	—
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	104	107	4 13 6	January and July	..	—
64,269	15	5/0	Western and Brazilian Ordinary	12½	12¾	12½	12¾	4 13 2	May and November	..	—
33,129	7½	3/9	Do. 5 per Cent. Preferred Ordinary	8	8½	8	8½	4 8 2	" "	8⅛	—
33,129	7½	1/3	Do. Deferred Ordinary	4	4½	4	4½	—	" "	..	—
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	105	108	105	108	3 14 1	June and December	107½	..
1,168,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	—		—		6 7 10	Feb., May, Aug., Nov.	—	—
£158,100	100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	98	103	98	103	5 16 6	March & September	..	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Feb. 1.	Price Wednesday, Feb. 8.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Feb. 8. Highest	Lowest
			TELEPHONES.						
£4,000	£5	4/0	Chill Telephone (fully paid)	2⅞ 3⅛	2⅞ 3⅛	6 8 1	August	–	–
£24,850	10/0	1¼d.	Consolidated Telephone Const. & Manufacturing	1/16 5/16	1/16 5/16	6 7 0	July	–	–
£8,000	5	4/0	Monte Video Telephone 6 per Cent. Preference	– ..	– ..	–	October	–	–
£90,000	5	3/0	National	5¾ 6	5¾ 6	5 0 0	February & August	6	5⅞
£5,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	14 16	14 16	3 15 0	" "	15⅝	..
£5,000	10	6/0	Do. 6% Cumulative 2nd Pref.	13 15	13 15	4 0 0	" "	–	–
£50,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	5⅝ 5¾	5⅝ 5¾	4 5 1	" "	5¾	5 11/16
£1,529,471	Stock	8½%	* Do. Debenture Stock 8½% (red.)	99 102	99 101	8 9 9	June and December	100½	99¼
£71,504	1	0/4	Oriental	⅜ ½	⅜ ¼	6 13 4	April and October	..	–
£8,000	5	6/0	United River Plate	4¾ 5¼	4¾ 5¼	5 14 3	July	5¼	–
£151,788	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	103 103	104 107	4 13 1	June and December	103	–
			ELECTRICITY SUPPLY COMPANIES.						
£10,000	1	..	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (10s pd.)	⅜ ⅜	⅜ ⅜	..	–	–	–
£6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	12½ 13½	12½ 13½	..	–	–	–
£6,000	10	6/3 3/16	Do. 4½ per Cent. Cumulative Pref.	10½ 11½	10½ 11½	4 4 0	–	11	–
£30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	11 12	11 12	2 18 4	February & August	11 11/16	–
£20,000	5	2/3	Do. 4½ per Cent. Preference	6 6½	6 6½	3 9 3	" "	–	–
£34,000	5	2/6	Chelsea Electricity Supply Ordinary	9 10	9 10	3 0 0	March	..	–
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	113 115	114 116	3 18 1	June and December	115	..
£1,200,000	£1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds(red)	103 105	103 105	4 15 8	–	..	–
£50,000	10	5/0	City of London Elec. Lighting Ord. 40,001 to 90,000	23½ 24½	23 24	5 4 2	February & August	24⅜	22 5/16
£10,000	10	1/9	Do. Ordinary 90,001 to 100,000	23 24	23 24	.. ..	..	22⅝	23⅛
£40,000	10	6%	Do. 6% Cumulative Pref.	15½ 16½	15½ 16½	3 11 9	January and July	14⅜	–
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	125 130	135 1 0	3 17 11	June and December	..	..
£30,000	10	..	County of London & Brush Prov. Ord. (1 to 30,000)	12½ 13½	12½ 13½	–	–	13½	12½
£10,000	10	..	Do. (30,001 to 40,000)	12 13	12 13	..	–	13	12½
£20,000	10	6/0	Do. 6% Cumulative Preference	14½ 15½	14½ 15½	4 0 0	March & September	14½	–
£5,660	5	2/6	House-to-House Electric Lighting Supply Ord.	9 10	9 10	2 0 0	–	–	–
£2,000	5	3/6	Do. 7 per Cent. Preference	9½ 10½	9½ 10½	3 6 8	March & September	–	–
£5,000	5	10%	Kensington and Knightsbridge Ord.	13 14	13 14	3 18 7	..	..	–
£10,000	5	6%	Do. 6% 1st Pref.	7⅞ 8½	7⅞ 8½	3 12 9	January and July	..	–
£10,000	3	–	London Electric Supply Ordinary	3⅞ 4½	3⅞ 4	–	–	3⅞	..
£8,050	5	–	Do. Preference	6½ 7	6⅞ 7	–	–	6⅞	6⅝
£100,000	Stock	..	Do. 4% 1st Mort. Deb.	103 105	103 105	3 16 2	Mch., June, Sept., Dec.	105	–
£2,500	10	5/0	Metropolitan Electric Supply Ordinary	19 21	18½ 19½	3 1 6	April and October	19⅜	18½
£3,500	10	–	Do. (£4 paid)	12 13	12 13	..	..	13	..
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	118 120	118 120	3 14 7	June and December	12 4	..
£6,452	10	6/0	Notting Hill Electric Ordinary	17 18	17½ 18½	3 4 10	March	18¼	18
£10,000	5	–	Oxford Electric Ordinary	6¾ 7½	6¾ 7½	..	–	–	..
£75,000	1	–	Rand Electric	1 1⅛	1 1⅛	..	..	–	..
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb	86 91	83 93	5 8 1	–	–	–
£50,000	$100	$2	Royal Electric Company of Montreal Shares	180 185	180 185	4 9 5	–	..	–
£30,000	100	4½%	* Do. 4½% 1st Mort. Debs.	105 107	107 109	4 8 9	April and October	..	..
£1,980	5	5/0	St. James and Pall Mall Electric Ordinary	17 18	16½ 17½	4 11 5	February & August	17½	17⅜
£20,000	5	8/6	Do. 7 per Cent. Preference	9 10	9 10	3 10 0	" "	9¼	9 1/16
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.)	.. ..	.. ..	..	June and December	..	–
£5,000	5	..	South London Electric Supply Ordinary (£3 paid)	3⅜ 3⅝	3⅜ 3⅝	..	..	3½	3⅝
£9,900	5	5/0	Westminster Electric Supply Ordinary	15½ 16½	15½ 16½	3 18 9	March & September	15	15½
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
£90,000	2	1/2⅝	Brush Electrical Engineering	1⅞ 2⅛	1⅞ 2⅛	2 13 5	–	2	1 15/16
£90,000	2	1/2⅝	Do. 6 per Cent. Pref. Non-Cumulative	2⅜ 2⅝	2⅜ 2⅝	5 1 1	..	..	..
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	111 115	111 115	3 19 0	February & August	..	..
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101 104	101 104	4 6 7	June and December	101	..
£20,000	5	5/0	Callender's Cable Construction	9½ 10½	10½ 1 ⅛	5 17 5	" "	11⅛	10⅛
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	110 113	1 0 113	3 13 8	November and May	..	–
200,000	1	9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛ 1⅜	1⅛ 1⅜	5 15 5	–	1 5/16	–
50,000	1	–	Chadburn's Ship Telegraph Ordinary	1⅛ 1⅜	1⅛ 1⅜	–	–	..	–
50,000	1	7½d	Do. 6 per Cent. Cumulative Pref.	1 1⅛	1 1⅛	4 16 0	–	–	–
32,098	3	1/6	Crompton and Co. (Nos. 1 to 32,098)	2½ 3	2½ 3½	4 12 4	–	–	–
£52,850	100	5%	* Do. 5% First Mort. Deb. (red.)	98 101	99 101	4 19 8	January and July	–	–
99,261	5	2/1½	Edison and Swan United ("A" Shares) (£3 paid)	2½ 3	2⅝ 3	6 11 9	February & August	2⅞	2 15/16
17,139	5	3/1½	Do. (£5 paid)	4 5	4 5	6 0 0	" "	..	–
£194,028	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	97 99	97 99	4 1 0	June and December	99	–
17,400	5	5%	Edmundson's Electric Corporation Ord (fully pd)	5 5½	5 5½	4 10 11	Half-yearly	–	–
112,100	2	1/2⅝	Electric Construction Co. (Limited)	2½ 2⅝	2½ 2⅝	4 12 0	January & July	2⅝	–
25 000	2	2/9⅜	Do. 7 per Cent. Cumulative Pref.	3 3⅜	3 3⅜	4 0 0	July	3⅜	–
£140,000	Stock	4%	Do. 4% First Mortgage Deb. (red.)	103 105	103 105	3 13 2	January and July	104⅜	103
91,196	1	–	Elmore's Patent Copper Depositing	⅜ ⅜	⅜ ⅜	..	–	–	–
12,500	10	8/0	Henley's Telegraph Works Ordinary	25 25½	25 26	5 0 0	February & August	25⅞	24⅞
3,000	10	7/0	Do. 7 per Cent. Preference	18½ 19½	18½ 1 ½	3 11 10	" "	1 1/16	–
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	110 115	114 116	3 19 1	" "	–	–
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	22 23	21 23	4 6 11	" "	22 7/16	–
300,000	100	4%	Do. 4% First Mortgage Debentures (red.)	102 106	102 106	3 15 6	March & September	–	..
£7,850	12	12/0	Telegraph Construction and Maintenance	37 41	37 41	4 6 2	March and July	4 1/16	39
£40,000	100	5%	* Do. 5 per Cent. Bonds (red.) 1899	.. ..	.. ..	..	January and July	..	..
£18,400	5	–	Do. Manufacturing Ordinary	8½ 9	8½ 9	–	–	–	–
13,400	5	..	Do. 5% Cum. Pref.	5½ 6½	5½ 6½	4 0 0	–	6⅛	–
£20,000	5	4/0	Williams and Robinson Ordinary	8⅛ 8½	8½ 8⅝	4 11 5	April and October	8⅝	8⅛
£30,000	5	3/0	Do. 6% Cumulative Preference	7 7⅜	7 7½	4 0 0	" "	7⅜	7⅛
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	103 104	106 107	3 18 8	May and November	–	–
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	..	Blackpool and Fleetwood Tramways	20 21	20 21	..	–	–	–
25,000	10	6%	Bristol Tramways and Carriage	21½ 22	22 22½	2 13 4	–	21½	22½
25,000	10	6%	Do. (£7. 10s. paid)	18⅝ 18¾	19 19½	2 6 2	–	20	19
£90,410	Stock	4%	Do. 4% Debenture	120 121	120 121	3 6 2	–	–	–
80,000	10	..	British Electric Traction Ordinary	17½ 18	17 18	..	–	17 1/16	17 1/16
10,000	10	2/4 7/16	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm pd.)	13⅜ 14	13½ 14	4 5 9	–	13 5/16	..
£100,000	Stock	6/2 3	Do. 5% Perp. Deb.	120 122	120 122	4 2 4	–	121⅛	..
40,000	5	..	Buenos Ayres & Belgrano 6% Cum. Pref. (£3 paid)	3⅛ 3⅜	3½ 3¾	..	..	3⅜	3 5/16
27,500	5	..	Do. do. do. (fully paid	3¾ 4⅛	4 4⅛	..	..	4⅛	4⅛
£260,000	Stock	..	Do. do. 5% Deb.	105 109	107 110	4 11 4	..	108	107
£35,250	10	3/0	Central London Ordinary	9¼ 10⅛	9¼ 10⅛	2 18 6	June and December	1 1/16	9 1/16
178,303	10	1/9⅜	Do. (£8 paid)	7⅛ 8⅛	7⅜ 8⅛	2 13 2	" "	–	–
£630,000	Stock	2½%	City and South London Railway Con. Ord.	69 71	71 73	2 15 7	January and July	72	70⅛
22,500	10	..	Do. Ordinary (£5 paid)	3½ 4	4⅛ 5⅛	..	..	..	–
9,251	10	5%	Do. 5% Perpetual Preference	14⅛ 15½	14⅜ 15½	3 4 6	January and July	–	–
£187,701	Stock	4%	Do. 4% Perpetual Debenture	131 133	133 135	2 19 7	May and November	..	–
20,000	10	6%	Imperial Tramways Ordinary (old £6 shares	20½ 21	20½ 21	2 17 2	March & September	21	21
10,000	10	6%	Do. 6% Preference	15½ 16	15⅝ 16	3 15 0	" "	..	–
£70,000	Stock	4½%	Do. 4½% Debenture	118 120	118 119	3 15 8	..	..	–
37,500	10	3%	Liverpool Overhead Railway Ordinary	10½ 10¾	10½ 10¾	3 1 11	February & August	–	–
10,000	10	5%	Do. 5% Preference	14½ 15½	14½ 15½	3 5 7	" "	–	–
125 000	Stock	4%	Do. 4% Debenture	106 108	105 108	3 14 1	January and July	–	–
20,000	5	3 3/4	New General Traction 6% Cumulative Pref	4⅝ 5⅛	4½ 5⅛	5 14 3	–	–	–
£540,000	Stock	3%	Waterloo and City Ordinary	109 112	109 112	2 15 1	June and December	–	–

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

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CONTENTS OF THE CURRENT NUMBER.

NOTES	561	Electricity Works Accounts	573
Meetings of Scientific Societies	563	WIRING RULES	574
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe	564	Review	575
		Wiring Rules.—*Discussion*	576
Electrical Utilisation of Niagara Falls. Illustrated	565	The Hiecke Meter. Illustrated	581
Magnetic Leakage in the Alternating Current Transformer. By A. Russell, M.A. Illus.	567	London County Council	582
		Legal Intelligence	582
		Trade Notes and Notices	583
Electric Traction by Surface Contacts. By Miles Walker. Illustrated	569	Companies' Meetings & Reports	588
		New Companies, &c.	591
		City Notes	592
		Companies' Share List	594

NOTES.

A NUMBER of important questions relating to the lighting of the City of London were decided on Wednesday by Mr. Justice KEKEWICH, in an action, particulars of which are given in our Legal Intelligence column. The most important item decided was that the Corporation is not entitled to have for its street lighting a system of mains and generating plant separate and distinct from the plant and mains for the ordinary consumers' supply. Another item of importance was decided in favour of the Corporation, viz., that after glow lamps had been fixed in a side street the Corporation would be entitled to order these lamps to be replaced by arc lamps, without being obliged to pay more than the cost of replacing the mere lamps.

THE report of the Highways Committee, which came before the London Council last Tuesday is, in many respects, an important document. Among many proposals for a closer control of the electric supply undertakings of the metropolis it is suggested that the employment of continuous current, as opposed to alternating current systems, should be enforced in new undertakings, excepting with the express consent of the Board of Trade to the contrary. It is also proposed to fix the limit of maximum price at 6d. per unit.

KINGSWOOD, a small village near Bristol, has just had the unpleasant experience of finding its electric supply suddenly cut off and seven miles of its streets in darkness. The interruption was not due, however, to any defect in the plant, but merely to the action of the mortgagees. It will be remembered that this village was equipped with electric supply on the Parfitt overhead system, the works being run by a syndicate which eventually sought to turn the business over to the District Council. Negotiations led to delays and, it would appear, misunderstandings; for the Syndicate lays the blame for the present state of affairs upon the Council, which, it states, has broken faith in regard to an alleged agreement to take over the undertaking. A writ has been issued.

THE severe weather which is now trying the "transportation systems" of the United States, not excepting the electric trolley and conduit, reminds us that it was just such another snowstorm as that which is paralysing traffic to-day that gave the trolley one of its earliest chances of showing its superiority over horse traction. It was in Philadelphia, in the early eighties, when the Philadelphia Traction Co., having erected a short length of experimental trolley, were fighting tooth-and-nail for powers to convert the remainder of their lines. A terribly severe winter played havoc with all the horse lines, not only in Philadelphia, but throughout the eastern States; but the trolley lines gave an uninterrupted and regular service. Rumour had it that the tramway company spent a small fortune on an army of men to keep the trolley lines open, while the horse car routes were comparatively neglected. Be that as it may, the hardihood of the trolley system was completely demonstrated; and, beyond dispute, that winter's experience in Philadelphia gave a wonderful impetus to the then almost untried trolley system.

WE hear that to-day the elements are somewhat less kind to the trolley in America, or else there is less care expended in keeping the lines open; for the extreme frost and heavy snowfalls are reported to have "paralysed the whole electric system." The cause of breakdown is said to be the thick coating of ice on the track rails. Doubtless ice has also accumulated around the trolley wire, insulating it from the trolley wheels; for, we remember that when in Cincinnati, where the double trolley has a considerable vogue, we were informed that it commonly happens in winter that the cars are run with great difficulty owing to the ice on the two trolley wires. So far as the single trolley is concerned, the effect of frozen snow on the running of the cars emphasises the objection to a track-rail return. With the conduit system and its insulated return this difficulty would not arise, but undoubtedly other troubles would take its place, especially when the tracks are covered with from 5ft. to 10ft. of snow, as have been those at Washington this week.

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About 400 Associates of the Institution of Electrical Engineers have so coveted the honour of being allowed to place five instead of four letters after their names, that they sent in their application without delay as soon as the new Articles of Association had been passed. This number corresponds to about one-fifth of the total number of Associates of the Institution, and is certainly a large proportion when it is considered that members of the new class have no privileges over the Associates than that of the extra "M" and the payment of higher fees. The voting power of Associates and Associate Members is still the same, though it is hoped by some that the latter class will have the rights of corporate membership conferred on them, as in the Institution of Civil Engineers. The result speaks well, at any rate, for the *prestige* which the Institution has among those connected with it, and is a most healthy sign.

The applications were all carefully examined by a Committee of the Council, with the result that only 284 candidates were transferred. Of the remainder, some are not considered to possess the necessary qualification, and the applications of others have been put back for further inquiries to be made. In announcing these figures at the meeting of the Institution last week, Prof. S. P. Thompson, who was in the chair, comforted the unsuccessful candidates in the following terms:—

The Council believed that the result of this very large transfer, as it would work out in the course of years, would be not that those who might be left behind in the class of Associates would be looked upon as being in any lower class, but that they would gradually become to be regarded as possibly even in a higher class than Associate Member. For, though they may not be professionally electrical engineers or electricians, there were a number of gentlemen in other professions, for example patent agents, closely connected with ourselves, or analytical chemists, men who have high standings in their own professions, whom we would wish to have with us as Associates. It is, therefore, no dishonour to any man to be left behind in the class of Associate if he does not actually come under the qualifications as required by the Council which entitle him to become an Associate Member.

Every person who was on the register as Associate on December 31st last was eligible for transfer if he were an electrician or electrical engineer, so that certainly no dishonour attaches to those who have failed to obtain transfer at this opportunity. They are simply not strictly speaking members of the electrical profession. But it must not be forgotten by those electrical engineers who have preferred not yet to avail themselves of the opportunity for transfer, that there will be a number of new Associates elected who are younger members of the profession, and while not having had the requisite training or experience to become Associate Members, yet come under the definition in Article 15:—"Persons, more than 21 years of age, who are interested in, or connected with, electrical science or engineering, or who are so associated with the application of electricity that the Council consider their admission as Associates would conduce to the interests of the Institution." Until the first part of this rule is expunged the Associate class will not consist merely of members of allied professions.

Personal.—Mr. W. H. Preece, C.B., F.R.S., retired from the post of chief engineer to the Post Office on Wednesday, having on that day attained the age of 65.

Cable Interruptions.	Date of Interruption.
Dakar—Bathurst	Feb. 9, 1899
Paramaribo—Cayenne	Feb. 10, 1899

Royal Society.—Among the Papers down for reading yesterday was one by Miss Sowton, "On the Reflex Electrical Effects in Mixed Nerve and in the Anterior and Posterior Root."

Institution of Electrical Engineers.—In deference to the desire of the Institution of Civil Engineers, the next meeting of the Institution of Electrical Engineers will take place on March 2nd, instead of on Thursday next, as previously arranged.

Municipal Electrical Association.—Mr. A. B. Mountain having resigned the honorary secretaryship of the Municipal Electrical Association, Mr. E. T. Ruthven-Murray has been appointed his successor, and all communications on Association business should be addressed to 21, Acton-lane, Harlesden, London, N.W.

The National Electric Light Association.—The twenty-second convention of this Association will be held in New York on May 23rd to 25th, the head-quarters being the Murray Hill Hotel, on Park Avenue. An electrical exhibition will simultaneously be held in Madison Square-gardens, under the auspices of the Association and in connection with the meeting.

An Omnibus Struck by Lightning.—The last omnibus to leave Penzance for Madron, eight miles north east of the Land's End, near midnight on Saturday, is reported to have been struck by lightning. This if correct would be, we believe, an unique occurrence. The vehicle, it is stated, was knocked over, and the shafts and lamps were smashed, but the horse escaped injury. The driver and several of the passengers escaped with nothing worse than cuts and bruises.

Conduit Explosion at Belfast.—A serious explosion, happily attended by no injury to person, occurred at Belfast on Monday morning last at about eleven o'clock, in one of the Kennedy culverts. Some 20 or 30 yards of flagway was disturbed, and manhole covers were blown out, damaging a gas lamp and a glass sign board. Gas is naturally assumed to have been the prime cause of the explosion, but it has not been discovered how the ignition occurred.

British Association.—In connection with the meeting of the British Association, to be held in Dover next September, the Mayor of Dover is organising an exhibition and parade of motor cars. Owing to the fact that the French Association will meet at Boulogne at the same time, it is anticipated that Continental makers will be very largely represented, and it is hoped that English makers will not be behindhand. Prizes of considerable monetary value will be offered in connection with the exhibition.

Wei-Hai-Wei.—In the House of Commons on Wednesday Mr. Firbank asked the First Lord of the Admiralty whether, in view of the fact that Wei-Hai-Wei was without cable communication with the Admiralty or Hong Kong, and that there was constant risk of interruption by land telegraph, the Government would consider the desirability of laying a cable from Shanghai to Wei-Hai-Wei. Mr. Goschen replied that the question of telegraphic communication with Wei-Hai-Wei had not escaped the attention of the Government, but he was not prepared to make any statement on the subject.

The Action of Electricity on Plants.—Dr. E. H. Cook, whose British Association Paper on this subject we published last October (*The Electrician*, Vol. XLI., p. 787), delivered a lecture last week to the Amateur Horticulturists' Society. He offered, in order to multiply experiments and to extend the knowledge of the subject, to submit to the action of electricity any seeds that may be sent to him, on the condition that the sender paid postage both ways, and consented to plant the treated seeds under the same conditions as an equal number of untreated ones, and to send in a report when the growth was concluded. It will be remembered that Dr. Cook found that, when seeds were electrified by a Wimshurst machine before planting, a larger proportion of seeds germinated, although no difference in the growth was observed.

Obituary.—It is with the deepest regret that we announce the death, on Friday last, of Mr. P. C. Dresing, the engineer-in-chief of the Great Northern Telegraph Co. Peter Christian

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Dresing was born at Aalborg in 1852, and educated in the grammar school of that town. He served his apprenticeship in pharmaceutical chemistry, but in 1871 came over to England, and entered the service of the Great Northern Telegraph Co. After having occupied important positions with the Company in Aberdeen and London, and on cable laying and repairing work, he was appointed in 1883 to the Company's head office in Copenhagen. Mr. Dresing has published several Papers on technical questions, and has frequently contributed to Danish and Norwegian technical journals. He was a member of the Institution of Electrical Engineers, and Local Honorary Secretary for Denmark, and in 1892 he was created Knight of the Order of the Dannebrog.

United States Pacific Cable.—President M'Kinley last week sent to Congress a Message, in which he says :—"As a consequence of the ratification of the Treaty of Peace with Spain, the United States will come into possession of the Philippines. The necessity of speedy communication, *viâ* Hawaii and Guam, is imperative. Such communications should be established in such a way as to be wholly under the control of the United States, whether in time of peace or war." Mr. M'Kinley suggests the construction and maintenance of a cable, either by the Government or by a private United States Corporation, under such safeguards as Congress shall impose. The Message concludes :—"At least two years must elapse before the entire system can be laid. Further soundings for a route west of Hawaii are required. Under circumstances of such paramount necessity measures will be taken in the present Congress to provide the means for the establishment of the proposed cable system."

The Long-Schattner Prepayment Meter.—The manufacturers of this instrument inform us that the defect mentioned in our recent description of the meter (*The Electrician*, November 25, 1898) has now been remedied. We pointed out that since the dimming resistance, which is automatically switched in circuit at the end of the pennyworth had the same value whatever current was flowing, only a very slight diminution in voltage would occur when but one or two lamps were switched on. If the consumer were tempted to make an over-draught, this would, it is true, be discovered by the inspector next time he came, but it might occasion unpleasantness between the latter and the consumer. The modification consists in dividing the dimming resistance into three parts, a high resistance, low resistance and the coil of a relay. The relay is biassed against small currents represented by two or three lamps, and the circuits are arranged so that, when the armature is attracted, the high resistance is short-circuited, the lower resistance and the relay coil sufficing to dim the lamps when a stronger current is flowing—and when the armature of the relay falls back, the high resistance is short-circuited.

Constancy of Composition of Natural Gas.—The constancy of composition of natural gas is a question of some practical importance to manufacturers in the Pittsburg region, and as the opinion has been frequently expressed that natural gas fluctuates in its heating power, it seemed worth while to see if these changes in composition really occur. The results of an investigation by Mr. F. C. Phillips on this subject are given in the *Proceedings* of the American Academy of Arts and Sciences for November, 1898. Since the nitrogen in the gas appeared to be the most readily determined constituent, attention was first directed to this element, and an apparatus devised by which comparatively large quantities of the gas could be completely burned by red-hot copper oxide, and the residual nitrogren collected and measured. The results of duplicate determinations on the same sample of gas were closely concordant, the variations not exceeding in any case 0·03 per cent.; but since samples of gas from the same well, collected at different times, showed variations of nearly 2 per cent., it would appear that fluctuations in the composition of natural gas do really occur.

Photography of Lightning.—Commenting upon photographs of ribbon lightning obtained by the Rev. J. Stewart-Smith, in the United States *Monthly Weather Review*, Prof. Cleveland Abbe remarks that they are not taken by moving the camera during exposure. He points out that a discharge of lightning is too fleeting to be influenced by the motion of the camera. With artificial oscillatory discharges one may so control the time of the discharges and the motion of the sensitive film as to produce the appearance of a ribbon; but no motion of the camera seems likely to explain the many details in these ribbon photographs of natural lightning. On the contrary, Prof. Abbe thinks there is one flash on Mr. Stewart-Smith's plate that has every indication of being certainly an oscillatory discharge, showing lines of flow identical with those photographed by Prof. Trowbridge at Cambridge, Massachusetts, and fully maintaining his conclusion, which was also that of Prof. Joseph Henry and J. Ogden Rood, that the lightning flash is an oscillatory discharge, repeated frequently to and fro within the crack in the air that is opened by the first discharge. The whole process requires but a few millionths of a second, and the motion of the camera within that short time is insignificant.

Trials of Motor Vehicles for Heavy Traffic.—The Liverpool Self-Propelled Traffic Association announces that, in conjunction with the annual show of the Royal Lancashire Agricultural Society, trials of motor vehicles will be made with the object of encouraging the development of types of heavy motor waggons suitable for trade and agricultural requirements in the neighbourhood of Liverpool. Such waggons are required, capable of taking the place of horse haulage and of competing with the existing railway rates, in the transport of heavy loads over distances up to 40 miles. Trials will be made from Liverpool over prescribed routes of 30 to 40 miles on two successive days, between Monday, July 31st, and Wednesday, August 2nd. The following gentlemen have consented to act as judges :—Messrs. M. C. Bannister, E. R. Calthrop, S. B. Cottrell, B. Redwood, H. H. West and Prof. H. S. Hele-Shaw. The Lancashire Agricultural Society offer a gold and silver medal in each of the four classes :—

Class.	Minimum load.	Maximum tare.	Minimum level platform area.
A	2 tons	2 tons	50 sq. ft.
B	3½ "	3 "	65 "
C	5 "	3 "	80 "
D	6½ "	4 "	110 "

The following are some of the rules and conditions :—There is no restriction as to the nature of the mechanical power employed. One of the manœuvres required will be the working in and out of a loading berth when cramped for room; the vehicle must be capable of working into and out of an embayment one and a-half times its own length. It must be able to start from rest on a 1 in 10 gradient, all working parts are to be properly encased, and all the manœuvres required are to be performed when the vehicle is fully laden and provisioned. The entry fee is 5 guineas, and it must be sent with a properly filled-in entry form by May 31st. Entry forms and further particulars may be obtained of the honorary secretary (Mr. E. Shrapnell Smith), Royal Institution, Liverpool.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

SATURDAY, February 18th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture II.—"The Mechanical Properties of Bodies," by the Right Hon. Lord Rayleigh, F.R.S.

WEDNESDAY, February 22nd.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "Electric Traction and its Application to Railway Work," by Philip Dawson.

THURSDAY, February 23rd.

INSTITUTION OF ELECTRICAL ENGINEERS.

2 p.m. Students' Visit to the Incandescent Electric Lamp Co.'s Works, Brook Green, Hammersmith.

FRIDAY, February 24th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Papers to be read: (1) "The Joule-Thomson Thermal Effect," by E. F. J. Love; (2) "A Study of an Apparatus for the Determination of the Rate of Diffusion of Solids dissolved in Liquids," by Albert Griffiths; (3) "Note on the Source of Energy in Diffusive Convection," by Albert Griffiths.

ROYAL INSTITUTION.

9 p.m. Evening Discourse, "Coherers," by Prof. O. J. Lodge, F.R.S.

SATURDAY, February 25th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture III.—"The Mechanical Properties of Bodies," by the Right Hon. Lord Rayleigh, F.R.S.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Mobility of Ions.—If the conductivity of dilute solutions could be accurately determined from the mobilities of the ions, not only would a valuable addition be made to the resources of quantitative analysis—as for the determination of the solubilities of "insoluble" bodies—but we should gain some knowledge of the structure of the solutions themselves. A good deal of work has already been done in this direction in Canada, notably by MacGregor, Archibald, and Mackay. F. Kohlrausch now furnishes some valuable tables of mobilities, whose importance is enhanced by the fact that the same ion shows the same mobility in different electrolytes, and that all ions show very nearly the same diminution of mobility with increasing concentration, except the very mobile ones, H and OH, and the ions containing divalent elements, where the diminution of mobility above deci-normal concentrations is two or three times more rapid. Taking the mobilities for K 65·3, and for Cl. 65·9 from the author's table, and adding them up, we obtain 131·2 for the conductivity of an infinitely dilute solution at 18°C. The observed value is 130·6—a very close agreement. The decrease of mobility up to 0·1 normal solutions is directly proportioned to the linear concentration of the ions. The mobilities of H and OH are 318 and 174 respectively. [Kohlrausch, *Wied. Ann.*, No. 13, 1898.]

Alternate-Current Magnetisation.—M. Wien has made some valuable researches into the behaviour of soft iron under the influence of very rapidly alternating currents. These were provided by the "alternate-current siren," giving frequencies of 128, 256 and 520 $\sim$ per second. The cores examined were small toroids made of thin iron wire, and wound with magnetising coils. By means of electric resonance—the introduction of suitable inductances and capacities—the form of the magnetising current was made very approximately sinusoidal. It was found that the magnetic induction was not simply sinusoidal, but that inductions of higher periods were superimposed upon the fundamental ones. These higher periods had their own eddy currents to complicate and increase the loss of energy by heat. As a general result, the author states that magnetic induction is not capable of keeping up with very rapid oscillations of the field. The effect is that the hysteresis loops representing the ordinary behaviour of iron in a steady field are shortened, and at the same time broadened out, thus imparting a virtual hardness to soft iron. An important observation is that it is practically useless to separately insulate the constituents of the core. The effect of the Foucault currents is the same in bare and in insulated wires, and is fully accounted for by Oberbeck's theory.

[Wien, *Wied. Ann.*, No. 13, 1898.]

Induction Coils.—The utilisation of the Kerr effect for the study of electric fields was first carried out by Colley, and improved by Des Coudres. Carbon bisulphide in an electric field has the advantage of instantly changing the plane of polarisation of transmitted light to an extent varying with the strength of field. When a liquid condenser containing CS_2 is placed between crossed Nicols, and the condenser is put in the secondary circuit of an induction coil, the field brightens up with every spark that passes. W. Hess further improves the apparatus by introducing between the CS_2 cell and the second Nicol a glass plate bent by screws, which, by virtue of its strain and its attendant double refraction, converts the dark field into a field of interference fringes. These fringes are displaced at every discharge, and their displacement can be analysed for personal observation by a stroboscopic method. For taking photographs of discharge curves, Klinkert's pendulum method is employed, and a cross section of the fringes is cut out by a slit. The new method has the advantage over the old pendulum methods of showing the whole course of the discharge, though the inevitable blurring of the fringes renders it less exact. Some of the curves reproduced show two or three oscillations, others a simple excursion and return, according to the inductance and resistance in the circuit.

[Hess, *Wied. Ann.*, No. 13, 1898.]

Gliding Sparks.—The length of sparks in air may be considerably extended by making them pass along the surface of a clean glass plate backed by tinfoil. In an arrangement devised by Max Toepler, two needle points are mounted on a glass plate, and one of them is connected with a strip of tinfoil which extends on the other side of the glass as far as the other point. When a difference of potential is applied to the two points, it is concentrated between the bare needle point and the tinfoil on the other side. A discharge is produced between that point and the glass about it, and rapidly runs along the surface to the other point. The properties of these sparks differ according to the manner in which they are produced. When they are due to a single application of the requisite potential, the length of spark at the higher potentials is practically independent of the potential. But when the plate is connected in parallel with a high inductance, thus producing an oscillatory discharge, the spark length is very nearly proportional to the maximum difference of potential. When the distance between the two needle points is too great to give a gliding spark, the bare needle shows a kind of brush discharge consisting of a large number of feelers or pioneer discharges, which do not, however, reach the other needle point.

[Toepler, *Wied. Ann.*, No. 13, 1898.]

Brush Discharge.—Dr. E. H. Cook has been endeavouring to bring our knowledge of the properties of the brush discharge up to date by investigating its action at a distance, its power of penetrating opaque substances, and its chemical action, especially upon sensitive films. He operated, as a rule, with Wimshurst machines capable of furnishing up to 50,000 volts. He found that when an electroscope was placed at from 2 to 3 metres away from the point, and a board 56cm. by 78cm. by 15cm. interposed midway in the path of the discharge, the beams were as easily affected as if the board were absent, but that the board produced a screening effect when placed near the electroscope. When the brushes were made to play upon a solution of potassium iodide, a much greater amount of iodine was liberated by the negative than by the positive brush, the proportion sometimes being 8·1. When, however, the brush discharge is due to an induction coil, the balance is in favour of the positive brush, though the disproportion is not so great. The author found a distinct action upon a photographic plate, very similar to that of light, but possessing some of the penetrative action of Röntgen rays. The bones of the hand could not be shown, but a startling effect was produced by photographing a printed invitation card inside an envelope. The author reassures the public by adding that it is difficult to decipher ordinary letters, since the writing on the different sheets is superimposed in the folding of the letter.

[Cook, *Phil. Mag.*, January, 1899.]

Magnetic and Meteorological Analogies.—At the Toronto meeting of the British Association, Dr. van Rijckevorsel called the attention of Section A to the fact that if the normal temperatures for every day of the year are plotted down in a curve, such curves are strikingly similar for stations spread over a very large area. But he has since found that it is not only temperature which shows these regularities, but that they are also exhibited by such diverse elements as the earth's magnetic force, the declination, the rainfall, and the barometric pressure, the means of the last 30 or 50 years being taken in each case, and the curves being smoothed down by taking the means of the neighbouring days instead of daily values. However dissimilar the behaviour of the individual curves may be, every single maximum and every minimum is, with astonishing regularity, repeated in all the others. The curves are not necessarily parallel. In many cases, also, a maximum occurs in one curve later or earlier than in most of the others. In still more cases, what is a large bump or a deep valley in one curve may find its correspondent in a hardly perceptible movement in another curve. But all the curves go to show that there is one potent cause, which for a large part rules all meteorological and magnetic phenomena, and influences them all in a similar way nearly simultaneously.

[Rijckevorsel, *Phil. Mag.*, January, 1899.]

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ELECTRICAL UTILISATION OF NIAGARA FALLS.*

I.—The Niagara Falls Power Co.'s Works.

Niagara Falls, from the very earliest date in the history of electric power transmission, has attracted the attention and stimulated the imagination of the electrical engineer. Its vast power, its steady flow, its magnificently large fall, all contributed to invest it with unusual charm for the engineering profession, and the means for utilising a portion of that almost limitless power became the subject of many projects, some rational, but before their proper time, others absurdly wild. Out of this early stage of speculation there have emerged three important undertakings for transforming Niagara Falls power into electric power and distributing it for various purposes. The most prominent of these undertakings, though not the earliest in point of history, is that of the Niagara Falls Power Co., whose works are situated on the American side a short distance above the Falls. The other undertakings alluded to are those of the Niagara Falls Hydraulic Power and Manufacturing Co., together with the works on the Canadian side; these we shall give some account of in a later part of the article.

The present may be regarded as an especially appropriate occasion to describe the Niagara Falls Power Co.'s station, inasmuch as quite recently the extension which has duplicated the capacity of the works has been completed and put in operation. It is not our intention, however, on this occasion, to give a complete account of the undertaking, but rather to supplement the descriptions of the progress of the works that have already appeared in these pages. We may refer our readers to the articles enumerated in the footnote* for further information.

Assuming that the reader is familiar with the location and general character of the original works, we pass on to describe the important extensions which have been made, these providing for additional five generating sets, each of 5,000 H.P., and raising the capacity of the station buildings to 50,000 H.P. The extension of the main building has been carried out with the same architectural design as that of the part first constructed. The new end is again closed by a temporary wall in anticipation of further extension. The dynamo room is now 45ft. in length, with space sufficient for ten 5,000 H.P. machines, of which eight are already installed and in working order. The high-tension transformer house and the wire passage leading to it remain as before. A single-motor 50-ton Sellers crane spanning the dynamo house, serves not only the main floor, but the wheelpit below, and is fitted with a separate rapid hoist, with a rope long enough to reach the tail race.

The extension of the wheelpit differs from the original cut for the four original wheels. The rock of the extension was quarried, not by drilling and blasting, leaving rough walls, as in the old pit, but by channelling machines forming the wall faces, the core being afterwards drilled and blasted out in steps. The walls were then bricked up to a thickness of about 32in. at the bottom and 8in. at the top.

Those who have followed the progress of this work may remember the rumour of the creeping together of the wheelpit walls. To stop the movement concrete brace walls have been put in below the turbine deck between each two wheels, dividing the lower part of the pit into stalls. These are about 13ft. thick and 22ft. high, and rest on brick arches crowning the lower part of the pit, which for a height of 21ft. serves as a tail race discharging into the great tunnel. Embedded within these brace walls, and scattered generally throughout the pit, are heavy, cast-iron, horizontal struts. The original arrangement of the racks through which the water entered from the canal has been entirely replaced, the individual racks across the mouth of each 14ft. intake or forebay giving the water passing through them such a high velocity that it was difficult to keep them clean. These have been removed, and the whole side of the main canal is now one continuous rack. The new head gates, 12½ft. high by 14ft. wide, are of the same construction as the old steel sluice gates, and are, like them, raised or lowered by motor-driven screws.

* *The Electrician*, Vol. XXVI., p. 144; Vol. XXXII., pp. 70, 98, 119, 194; Vol. XXXV., p. 380; Vol. XXXVII., pp. 535, 692.

The design of the wheels, so far as their power-transforming parts are concerned, has been unchanged, but the cases have been radically altered to give an improved method of support. These and other improvements of the mechanical features are the work of Dr. Coleman Sellers. As in the old turbines, there are two cast manganese bronze runners or bucket rings, over 6ft. in diameter, one above and one below the inlet, with outward radial flow, with cast iron guide chutes or distributors immediately within the runners, and ring valves or gates closely surrounding them.

The details of these gates differ somewhat from the original type. In opening they now rise instead of falling, so that, should any part of the supporting mechanism give way, they will shut the water off instead of turning it on. The long shafts transmitting the power to the dynamos above consist, as before, of 38in. tubes of ⅜in. steel boiler plate narrowing down to short solid sections at the guide journals, and to 11½in. forged hollow nickel-steel dynamo shafts at the upper end.

Coming up above the level of the dynamo-room floor the machines which have undergone the greatest changes are the governors. It will be remembered by those who have followed the details of this equipment that the original Faesch and Piccard governors are purely mechanical in their action. The gear train operating the vertical rack, which in turn is attached to the gates, is driven by the intermediate number of either one or another differential bevel-gear train. The bevel pinions of each of these differential trains are kept in motion by belts from the main source of power, and the third member of each is fitted with a pulley and strap brake. Either one of these brakes may be set by a shaft actuated in turn by a sector-shaped ratchet moved in either one direction or the other by one of two oscillating pawls, the engagement of the pawls with the ratchet being finally effected by the position of the centrifugal fly balls. So long as neither brake is set the main gear train remains motionless, but when either brake is set the intermediate member of that differential bevel train is forced to rotate, carrying with it the mechanism operating the gate. Dr. Sellers has made many improvements on this rather complicated and indirect arrangement, the latest development appearing in the governor of machine No. 5, which will be duplicated on all the machines, including the original three. In the new type the belt-driven differential bevel trains and strap brakes have been abandoned. The displacement of the revolving balls from normal position moves one or the other of two sets of brushes into electrical contact with a cylinder constantly rotating in an oil bath, and these contacts are respectively connected through collector rings and sliding brushes with the coils of two magnetic clutches, respectively gear driven in opposite directions. The excitation of either of these clutches drives the main train in one direction or the other. This governor has also several other ingenious modifications, such as the attachment of the cylinder of the fly-ball dash-pot to the gate-operating mechanism, so that whenever the latter starts the cylinder moves with it in such a direction as to tend to force the piston and fly-balls back to the normal position. This gives, so to speak, a restoring force whenever the gate is under way, and tends to prevent overrunning. The contacts are, as usual, differentially actuated by the displacement of the weights and the position of the gate, so that there is a 2 per cent. fall of speed between no load and full load. Still another modification is a device for instantly setting the mechanism in action to close the gate on the opening of the field circuit of the dynamo, this being intended for use in connection with an emergency shut-down system. The device consists simply of a heavy weight supported by a solenoid connected in series with the field-magnet winding of the dynamo. When released this weight sets a mechanical clutch so geared as to drive the gate towards the closed position, and at the same time opens the circuit of the governor contacts so that they cannot set the magnetic clutch for opening the gate. The operation of these new governors is noticeably different from that of the old. On change of load, the old governors hunt. The new governors on change of load move the gates slightly, hesitate and then move them again in the same direction, this difference in action being due to the dash pot. The

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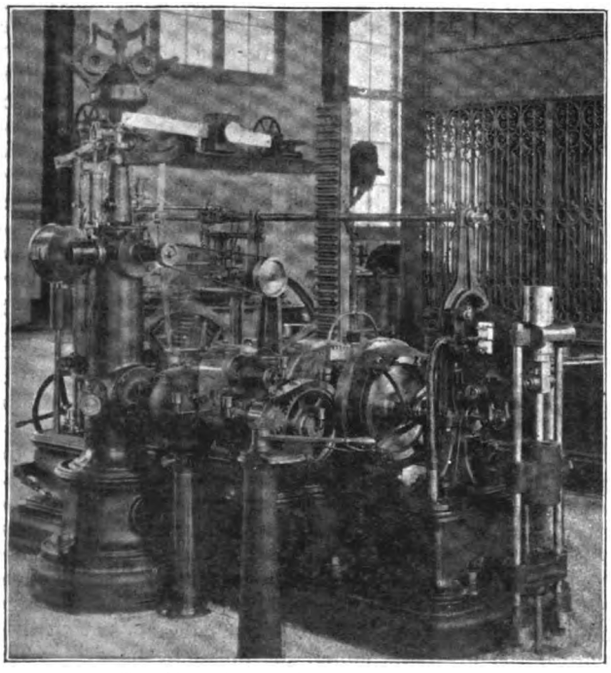
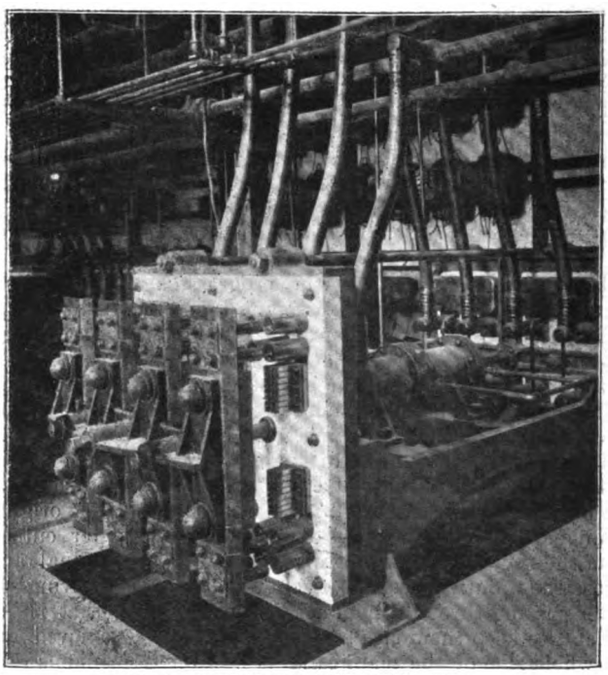
behaviour of the old governors is also dependent on the condition of the lubricant on the brake pulleys. No such variable element is present with the new arrangement.

A VIEW OF THE DYNAMO ROOM.



THE NEW ELECTRO-MECHANICAL GOVERNOR.



ONE OF THE PNEUMATIC MAIN SWITCHES.

The units may be run two or more in parallel with the governors of one or more up to all but one out of operation. The common practice is to leave one governor more sensitive than the others, which then act only on the greater speed changes. This makes one machine take all the small load variations, the others responding only to the greater variations. The new governor gives a very satisfactory action in case of the sudden removal of the whole load, checking the rise in speed under this condition at about 10 per cent.

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above normal. The older ones allowed about double this excess.

The dynamos themselves, and indeed the whole of the electrical apparatus, have undergone changes less than those of the hydraulic equipment. The same umbrella-type exterior revolving field, suggested by Prof. George Forbes, is used, making the forged nickel-steel yoke of the field circuit serve also as a flywheel with a peripheral velocity of 9,000ft. per minute. In external appearance the machines differ from their older neighbours only in the sinking of the nuts holding the field poles to the ring into counterbored holes below the surface of the latter. The ring is slightly heavier, some weight saved by the removal of flanges intended to hold a flywheel near the lower end of the long vertical shaft and by the boring out of the turbine and dynamo shafts having been added to the yoke ring. The winding of the inwardly projecting poles has been quite changed to give a readier dissipation of the 10 kilowatts there turned into heat. The conductor is a copper strap 1in. by $\frac{1}{8}$in. in cross-section, wound edgewise, the corners being turned while hot, the turns being insulated from each other by mica and shellac. There are four layers of winding on each pole held apart by mica-covered metal rods with an ample air-space for ventilation between layers. All the turns of the fields of each machine are in series, and the field current varies from 50 to 80 amperes, the field resistance being $1\frac{1}{2}$ ohms. The 12 poles themselves, as in the old machines, are steel castings, not laminated. They have extending pole shoes cast to them to increase the effective air-gap area, which is thus approximately made 70 per cent. of the whole armature surface. The horns are tapered back from the gap $\frac{1}{32}$ of an inch, in order to properly shape the electromotive force wave.

The armature itself has been modified in various ways, the most noticeable being the use of 12 $\frac{1}{2}$in. ventilating rings instead of the six 1in., formerly used. The laminæ of open-hearth steel are tightly bound together by end plates locked to the spider. The armature conductors are copper bars 2in. by $\frac{7}{32}$in. over all, with rounded corners, mica-insulated and mounted one in each slot, instead of two, as in the first design. The slots, of which there there are 322, are almost, but not quite, twice as numerous, as the number of turns has been reduced about 15 per cent.

While high efficiency, as a saving of power, is not of very great importance in machines with power so cheap as it is at the shafts of this installation, it is of importance in consequene of the coincident reduction of the heating. The iron losses of the new machinery have been estimated by driving them under test by motors and noting the increase in the power absorbed when the fields were excited. The copper loss can be readily calculated, and the iron loss under load can be estimated from that obtained by the test described by assuming an increased maximum induction due to load distortion and correcting the hysteresis loss. The iron loss at full load is thus determined at only 32·1 kilowatts, the armature copper loss being 28·7 kilowatts and the field copper loss 7·4 kilowatts, giving an electrical efficiency at full load of over 98 per cent. The new machines, as noted above, have a lower iron loss, more ventilating passages in both armatures and fields, and are also fitted with vertical water-cooling passages cored in the cast-iron spider, into which the armature laminæ are dovetailed. Without using these, however, and without hoods similar to those mounted on the old machines, it is found that the new ones on continuous run at full open gate, about a 10 per cent. overload, reach a limiting temperature only 47°C. above that of the atmosphere.

The modern tendency towards close regulation has not been followed in these new machines, which have as high a ratio of armature to field ampere turns as have the first three. The air gap has been shortened from 1in. to $\frac{3}{4}$in., reducing the field ampere turns by about the same proportion as the armature ampere turns. They require a 50 per cent. increase of the no-load exciting current to maintain the same potential difference between terminals with a non-inductive rated load, and the machine on dead short circuit with full load excitation only gives about twice full-load current. With a battery of such mammoth machines running in parallel with the great momentum of their rotating parts, if they were fitted with powerful fields and were consequently able to give six, eight or more times their rated energy current on short circuit, the conditions in case of such an accident would resemble at the weakest point of the circuit all too closely the detonation of a charge of dynamite. It is almost needless to state that it is impracticable to fuse or otherwise break electrically such large powers. It also takes some little while for the field to die down after its circuit is opened. The high armature reaction gives what might be termed an automatic limit which can be depended upon to cut the energy output off at a predetermined point. For testing these machines there has been erected in the new part of the station a 2,000-volt switchboard with switches fitted with carbon breaks each connected to a resistance of bare iron wire wound on a long, flat, wooden frame much after the fashion of carded cotton. These frames, or ladders, as they are termed, are immersed in one of the forebays about 18ft. by 12ft. by 8ft. high, and serve to absorb the load of a 5,000 H.P. generator.

(To be continued.)

MAGNETIC LEAKAGE IN THE ALTERNATING CURRENT TRANSFORMER.

BY ALEXANDER RUSSELL, M.A.

In *The Electrician*, Vol. XXXVIII., p. 725, a few formulæ are given for the alternating current transformer which can be used to predict the currents, secondary voltage and efficiency of a transformer for various loads. The only important assumption made in proving these formulæ was that there was no magnetic leakage between the primary and secondary windings. This assumption, although practically true for many commercial transformers of ordinary sizes, yet is far from true for some types of transformers and for many large transformers. A discussion, therefore, as to how magnetic leakage affects these formulæ is necessary.

Manufacturers generally recognise that magnetic leakage is a drawback in the design of their transformers, and that if they could get rid of this leakage they would be able to make them more cheaply. Whether their new transformers have as high an efficiency as their old ones is another matter and one which the formulæ given below enable us to see. It is well for manufacturers to bear in mind that a transformer with no magnetic leakage has an efficiency of less than 98 per cent. at full load. For example, some tests of an 850-kilowatt transformer recently published state that its efficiency is 98·46 per cent. at full load and 92·7 per cent. at one-tenth load. If by full load is meant a drop of two per cent. in the secondary volts, then in this transformer there is very considerable leakage producing a lag of 10deg. in the secondary current behind the effective E.M.F. caused by the flux in the core. Another point also which they ought to bear in mind is that the efficiency alters very much with the shape of the wave of the E.M.F. of the alternator used in the test. It has been noticed that the core loss in transformers, tested in large central stations where there are several different kinds of alternators running, varies from day to day. This is sometimes attributed to the "Partridge" effect, but is more probably due to the varying height of the centre of gravity of the resultant E.M.F. wave due to combinations of different machines.

The only practical method hitherto employed for measuring leakage in transformers is to give the "inductive drop in volts" in the secondary at full load. This is got by subtracting from the open circuit secondary voltage the secondary voltage at full load and the "copper drop." As the total drop of volts at full load is only 2 per cent. of its initial value, and as we rarely find as much as half of this due to leakage, it is not very easy to measure leakage in this way. This "inductive drop" also is not proportional to the secondary current, and so the voltages at other loads cannot be readily deduced. Now, the angle of lag of the secondary current behind the E.M.F., caused by the driving flux in the core, occurs in nearly all the formulæ for a transformer, and as this

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angle is practically in direct proportion to the secondary current and can easily be measured by at least four different methods, it seems that to determine this angle is the best way of measuring leakage. This angle varies with the shape of the E.M.F. wave and here again the necessity of knowing something more than the effective value of this wave is shown. Knowing, however, the leakage lag per ampere of secondary current for a given applied E.M.F. wave, the primary and secondary resistances when warm, the magnetising current and the magnetising watts, then we can calculate to a 1 per cent. accuracy the currents, angles of lag, secondary voltage and efficiency for any load. The efficiency perhaps can be calculated to an accuracy of within one-tenth per cent. if certain corrections are applied to the ordinary formula, but as small variations in the height of the centre of gravity of the applied wave greatly affect the efficiency such great accuracy is seldom wanted.

We shall first consider the theory of the transformer and get the trigonometrical relations connecting the currents, voltages and angles of lag. It will be seen that some of the equations are very simple and that some of the others can be simplified in practice so that calculation by means of them is easy. It is instructive to note that all the formulæ come from a simple diagram consisting of two triangles which has been called the fundamental diagram of a transformer (Fig. 1). Clerk Maxwell's method of analysing the E.M.F.'s in the primary and secondary has not been followed, and the diagram seems greatly simplified in consequence. Fig. 1 applies, of

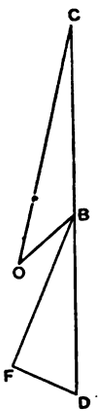

FIG. 1.—Diagram of a Transformer showing Magnetic Leakage.

OC = primary E.M.F. = V_1. OB = RA_1. BF = $V_2 + SA_2$. $\frac{BD}{BC}$ = constant = n.
DBF = angle of lag due to leakage.

course, equally to the air core transformer. If there is no magnetic leakage F coincides with D and the lower triangle becomes a straight line. It is surprising how accurately the formulæ predict what happens. My senior students carried out rapid tests on two leaky transformers, some of them even taking readings down to a 20 per cent. drop in the secondary voltage to the great danger of the transformer without, however, finding any serious divergence from the calculated results.

Instead of giving tests on these transformers, it will be more interesting if we apply the formulæ to published tests.

The most interesting and instructive tests of a transformer ever published are undoubtedly Dr. Roessler's tests on a small transformer when acted on by both "rounded" and "peaked" E.M.F.'s. They were re-published in *The Electrician*, Vol. XXXVI., p. 125, &c. His experimental results have been compared below with those calculated from certain experimental data he gives. This is a very severe test of the formulæ as the open circuit loss in the half-kilowatt transformer he used was one-tenth of the full load in one case, and one-twentieth of the full load in the other. The copper resistance of its primary was also very high so that the induction in the core is diminished by 3·3 per cent. at full load. For this reason a comparison of the observed and calculated results is specially interesting as slight divergences may point out unnoticed effects. To read the voltages Dr. Roessler used simply Cardew voltmeters, and hence he did not directly observe the secondary voltage on open circuit. His tests prove, however, that scientific ability far more than counterbalances the lack of costly apparatus.

The other experimental results analysed below are Dr. Fleming's tests on a 6-kilowatt Swinburne "Hedgehog" transformer. This was chosen, not because the calculated results agree very closely with the observed, but because it was an open iron circuit transformer which shows considerable magnetic leakage.

The Diagram of a Transformer.—In Fig. 1 let OC represent the effective value of the voltage applied to the primary terminals, OB the E.M.F. required to drive the primary current A_1 through the primary resistance R, and let BC be the back E.M.F. set up by the varying flux of induction embraced by the primary coil. These three E.M.F.'s balance one another and, therefore, always form a triangle whatever the load on the transformer may be. We shall call the angle COB the angle of lag of the primary current and shall denote it by ϕ_1. At full load in actual transformers OB is about 1 per cent. of OC and hence the flux of induction in the core is about 1 per cent. less at full load than at no load, since the E.M.F. BC is caused by this varying flux. We see, therefore, that whether there be magnetic leakage or not, the flux in the primary in an ordinary transformer remains approximately constant. Now, consider the secondary coil. The total E.M.F. set up by that part of the varying flux in this coil due to the primary circuit must be in the same phase as the E.M.F. BC, and it must always bear a constant ratio to it. Hence if we produce BC to some point D, BD will represent the total E.M.F. in the secondary coil in magnitude and phase. If there be no magnetic leakage,

$$\frac{BD}{BC} = \frac{n_2}{n_1}$$

where n_1 is the number of turns in the primary and n_2 is the number of turns in the secondary. If there is magnetic leakage, then at all loads we shall have

$$\frac{BD}{BC} = \frac{kn_2}{n_1} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where k is a constant less than unity. In ordinary transformers k is nearly equal to unity. When the secondary is open circuited, the E.M.F. at its terminals is in phase with BD, but when there is a load on the secondary, the terminal E.M.F. is in phase with the secondary current and gets out of phase with BD. If, then, A_2 be the secondary current, S the resistance of the secondary coil and V_2 the secondary E.M.F., we have, in addition to the driving E.M.F. BD. and the resistance E.M.F., $V_2 + SA_2$, an E.M.F. FD which we may call the leakage E.M.F. This leakage E.M.F. is proportional to A_2 so long as the shape of the current wave in the secondary is constant. In transformers the shape of this wave does not practically alter between no load and full load, and hence no appreciable error is introduced by the assumption that the leakage E.M.F. is proportional to the secondary current. The leakage lines in the secondary sometimes do work in hysteresis and eddy currents, but the amount of work done, comparatively speaking, is exceedingly small, and it would only complicate the formulæ quite unnecessarily to take it into account. We shall, therefore, assume that the secondary leakage lines do no work, and hence DF is drawn perpendicular to BF.

In Fig. 1, then, OC represents V_1, the applied volts which are supposed constant, OB equals RA_1 and BF equals $V_2 + SA_2$; OC gives the phase of V_1, OB the phase of A_1 and BF the phase of V_2 and A_2. The angle DBF we shall call "α," and refer to it as the angle of lag in the secondary due to leakage. When the secondary current is zero the angle of lag is also zero, and F coincides with D. In this case BD represents the secondary E.M.F. on open circuit (E_2), and OB equals RA_0 where A_0 is the magnetising current. It is obvious that E_2 lags by nearly 180deg. behind V_1 in phase. Now, since the angle OCB is very small, BC is practically equal to $V_1 - RA_0 \cos \phi_0$, hence—

$$\frac{E_2}{V_1 - RA_0 \cos \phi_0} = \frac{BD}{BC} = \frac{kn_2}{n_1} = n. \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

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This equation enables us to determine the value of $\frac{kn_2}{n_1}$ which we shall denote by n in order to simplify the formulæ.

Equations Connecting the Currents.—The magnetising turns that produce the flux in the primary which causes the back E.M.F. BC are n_1A_1 and kn_2A_2. The resultant of these magnetising turns must be very nearly equal to n_1A_0, and must be inclined at an angle very nearly equal to ϕ_0 to BC. The reason of this is because BC and, therefore, the flux causing it is nearly constant at all loads, and hence also the hysteresis is nearly constant. We could easily take account of this variation by noting that the flux at any load is proportional to $V_1 - RA_1 \cos \phi_1$, and so the resultant magnetising turns at that load will be $n_1A_0\frac{V_1 - RA_1 \cos \phi_1}{V_1 - RA_0 \cos \phi_0}$, they, therefore, diminish by about 1 per cent. at full load. Again, Steinmetz's law enables us to take into account the variation in the hysteresis, and hence the variation in the angle the resultant makes with the E.M.F. caused by the flux. In commercial transformers this variation can be neglected as taking it into account only affects the fourth or fifth figure in our answers. Resolving, then, the magnetising turns along and perpendicular to DBC (Fig. 1), we get

$$n_1A_1 \cos \phi_1 - kn_2A_2 \cos \alpha = n_1A_0 \cos \phi_0,$$

and

$$n_1A_1 \sin \phi_1 - kn_2A_2 \sin \alpha = n_1A_0 \sin \phi_0.$$

These equations may be written thus,

$$nA_2 \cos \alpha = A_1 \cos \phi_1 - A_0 \cos \phi_0, \quad . \quad . \quad . \quad (3)$$

and

$$nA_2 \sin \alpha = A_1 \sin \phi_1 - A_0 \sin \phi_0. \quad . \quad . \quad . \quad (4)$$

We have, therefore, the choice of the following three equations to determine the leakage angle α,

$$\sin \alpha = \frac{A_1 \sin \phi_1 - A_0 \sin \phi_0}{nA_2}, \quad . \quad . \quad . \quad . \quad (5)$$

$$\cos \alpha = \frac{A_1 \cos \phi_1 - A_0 \cos \phi_0}{nA_2}, \quad . \quad . \quad . \quad . \quad (6)$$

and

$$\tan \alpha = \frac{A_1 \sin \phi_1 - A_0 \sin \phi_0}{A_1 \cos \phi_1 - A_0 \cos \phi_0}. \quad . \quad . \quad . \quad . \quad (7)$$

If W_1 be the watts given to the primary, then

$$W_1 = V_1A_1 \cos \phi_1 \text{ and } W_0 = V_1A_0 \cos \phi_0.$$

Equation (6) may, therefore, be written

$$\cos \alpha = \frac{W_1 - W_0}{nV_1A_2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Equation (7) is independent of n, and α is calculated from the readings taken on the primary wattmeter and ammeter only. Equation (5) can also be usefully applied to find α; equations (6) and (8) can only be applied when all the readings have been taken very accurately. Even with careful measurements we sometimes find that cos α comes out greater than one. By measuring, however, the five quantities involved several times and taking the mean we can find α sufficiently accurately for practical purposes and they are the simplest of the formulæ which do not directly involve the resistances.

Expression for the Secondary Voltage.—From Fig. 1

$$\cos \alpha = \frac{BF}{BD},$$

$$\therefore \quad BF = BD \cos \alpha,$$

$$\therefore \quad V_2 + SA_2 = n \cos \alpha \, BC$$

$$= n \cos \alpha \, (V_1 - RA_1 \cos \phi_1).$$

Hence from (3)

$$V_2 = nV_1 \cos \alpha - \{S + (n \cos \alpha)^2 R\}A_2 - n \cos \alpha RA_0 \cos \phi_0,$$

$$= nV_1 \cos \alpha - (n \cos \alpha)^2 QA_2 - n \cos \alpha RA_0 \cos \phi_0 \quad . \quad (9)$$

where $Q = R + \frac{S}{(n \cos \alpha)^2}$.

On substituting from (2) this becomes,

$$V_2 = E_2 \cos \alpha - (n \cos \alpha)^2 QA_2. \quad . \quad . \quad . \quad . \quad (10)$$

The following approximate equation can, therefore, be used to find α,

$$\cos \alpha = \frac{V_2 + (S + n^2R)A_2}{E_2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

When a reflecting mirror electrostatic voltmeter is available, and the source of alternating E.M.F. very constant, this is a good method of finding α.

The Efficiency of a Leaky Transformer.—By equations (8) and (9)

$$A_2 = \frac{W_1 - W_0}{nV_1 \cos \alpha},$$

and

$$V_2 = n \cos \alpha (V_1 - RA_0 \cos \phi_0) - (n \cos \alpha)^2 QA_2.$$

The efficiency $\eta = \frac{V_2A_2}{W_1}$

$$= \left(1 - \frac{W_0}{W_1}\right)\left(1 - \frac{RA_0 \cos \phi_0}{V_1} - \frac{n \cos \alpha \, QA_2}{V_1}\right)$$

$$= \left(1 - \frac{W_0}{W_1}\right)\left(1 - \frac{QW_1}{V_1^2} + \frac{QW_0}{V_1^2} - \frac{RA_0 \cos \phi_0}{V_1}\right)$$

$$= \left(1 - \frac{W_0}{W_1}\right)\left(1 - \frac{QW_1}{V_1^2} + \frac{W_0S}{V_1^2n^2 \cos^2 \alpha}\right). \quad . \quad (12)$$

In commercial transformers we can, therefore, use the equation

$$\eta = \left(1 - \frac{W_0}{W_1}\right)\left(1 - \frac{QW_1}{V_1^2}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

to determine the efficiency. Again, since $Q = R + \frac{S}{n^2} \sec^2 \alpha$, and the maximum value of $\sec^2 \alpha$ is 1·03, no practical error is introduced by finding Q from the equation

$$Q = R + \frac{S}{n^2}.$$

The graphical construction, therefore, given in *The Electrician* of March 25, 1898, for the efficiency curve of a transformer can always be used in practice. It is, of course, equivalent to equation (13).

Again, since $\eta = \frac{W_2}{W_1}$, formula (13) may be written

$$W_1 - (W_0 + W_2) = \frac{Q}{V_1^2} W_1(W_1 - W_0). \quad . \quad . \quad (14)$$

The left-hand side of this equation obviously represents the copper losses in the transformer. Hence, if we plot the copper losses as a function of W_1, we get a parabola. Also,

since

$$W_2 = (W_1 - W_0)\left(1 - \frac{QW_1}{V_1^2}\right), \quad . \quad . \quad . \quad (15)$$

we can at once write down W_2 when we know W_1. In practical work we take the value of Q when the copper is hot, as an error in the value of Q has very little effect on the calculated efficiency at small loads.

(To be continued.)

ELECTRIC TRACTION BY SURFACE CONTACTS.*

BY MILES WALKER.

We cannot put forward any surface-contact system as a practical substitute for the overhead wire in electric traction unless we can answer in the affirmative the following three questions:—(1) Is it possible to lay surface contacts in a roadway so that they do not cause any obstruction to traffic? (2) Is the method of picking up current from studs by means of a skate feasible under practical working conditions? (3) Can the studs be made perfectly safe? If affirmative answers to these three questions can be established, the future of surface contacts for town traction is a great one. If the answer to any question is unsatisfactory, there may be grave objections to this system of conveying electrical power to a moving car. Nothing but a long trial can give us conclusive answers, but an Institution like that of the Electrical Engineers can form a very fair judgment upon the probabilities of a scheme on being supplied with experimental data, and it can, moreover, give a diversity of criticism and suggestion which will be of the highest value to a scheme in its infancy. It is to obtain that judgment and to profit by that criticism and variety of suggestion that I have brought forward the details and experimental data of a surface-contact system, upon which Mr. C. E. Holland and I have been at work under the direction of Prof. Silvanus Thompson.

1. To arrive at an answer to the question as to the obstruction in the roadway we must find by what amount the studs ought to project, and also what amount of inequality is ordinarily found and

* Paper read before the Institution of Electrical Engineers.

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is admissible in a roadway. During the last few months I have been making observations of roadways in city streets and along tramway tracks, and I have been surprised to find how great the depth of inequalities in pavement really are when we come to measure them. Hollows ½in. or even ¾in. deep are hardly noticeable if of 2ft. or 3ft. in extent. Hollows 1in. in depth, and with gently sloping sides extending 4ft. or 5ft. from the centre are of very common occurrence in roads which a casual observer would call good. The track between tram rails is generally to be found much more uniform as to levels than the other parts of the road, but even here sudden changes of ½in. or ¾in. in the level of the crowning are so common that we never notice them. It is difficult for the eye to detect slight changes of slope in a groundwork of rough granite setts.

In order to give an idea of the sort of inequalities which commonly occur unnoticed in roadways, I have made a drawing (Fig. 1) to scale of the section of a fair average piece of well-worn roadway in the Holloway-road. The section is taken parallel to the rails and midway between them. The straight line gives the level of the rail. The upper line gives the inequality of the paving-stone surface. The average hollow that one meets with is about ½in. deep. In places the stones have sunk until they are nearly level with the rails, while the original crowning between rails seems to have been about 1⅛in. Of course, it looks very much worse in section than it does in the street. For comparison with this piece of paving I have given a section (Fig. 2) drawn to the same scale of our experimental line at Willesden Junction. This, of course, represents a piece of track just newly laid and without the inequalities which are sure to come with time and traffic, but one can see at a glance that if we impress the inequalities of Fig. 1 upon those of Fig. 2 we do not get anything which is substantially worse than either. In order to show the sort of hollows that one meets with in roads which are in bad condition I have given a section (Fig. 3) of a hollow in a rather bad piece of roadway. I do not know that

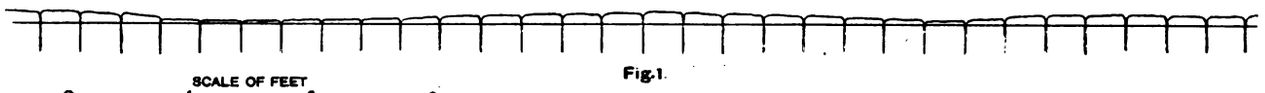

Fig.1.

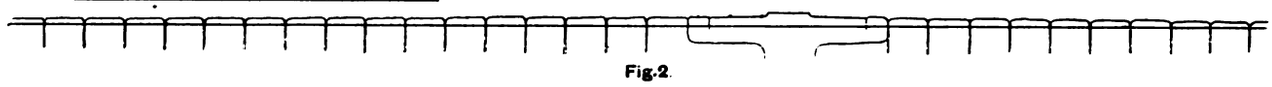
Fig.2.

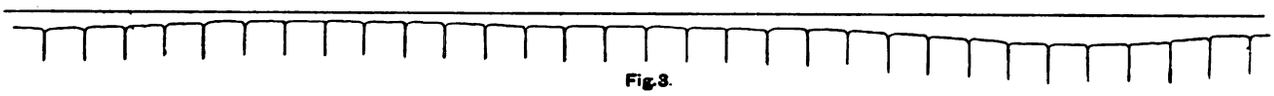
Fig.3.

Fig.4.

Fig.5.

the thoroughfare from which this was taken (and which contains many hundreds of similar hollows) bears at all a bad name. People seem to put up with them very quietly. Figures 4 and 5 show sections of roadway at right angles to the rails, one with a surface contact and the other without.

Now the projection of the stud shown in Fig. 2, innocent though it may seem in comparison with ordinary paving-stone inequalities, is amply sufficient to give the required clearance to the skate. Its top is, on the average, 1⅛in. above the level of the rail, and the clearance between the skate and the crowning of the pavement between two studs is ¾in. This is sufficient to clear all but very deep mud. The effects of mud and water are considered at length below. If a paving-stone happened to project some way above the others it would do no harm until it projected above the level of the stud, and a rare occurrence of that kind could be very easily dealt with.

2. This brings us to our second question as to the feasibility of picking up current from studs. It should be noticed in the first place that a row of studs is a very much better thing than a sectional rail. A stud is much easier to insulate than a rail. The leakage from a rail in wet weather would be 20 times as great as from a stud. A rail is much more difficult to renew, and though it gives greater facility upon sharp curves, its advantage in this respect loses weight as soon as we show that the studs can operate on the sharpest curves met with in practice. When studs are used, it is, of course, necessary, to carry below the car a long metal skate which will maintain its contact with one stud while it passes on to the next. And the question naturally arises, Can a skate be made to run smoothly over a row of studs? That is a question upon which we had considerable doubt until we tried it. The answer (so far as an answer can be obtained from an experimental line) is that it can be made to run at the highest speed smoothly, in fact almost noiselessly. We have tried the effect of various obstacles on the line. Anything big, like a brick or a tin canister, is simply knocked out of the way without even causing a spark. Stones standing about an inch high generally suffer the same fate. Sometimes, however, if a stone is wedged carefully into a hollow in the road the skate will glide over it and be prevented from touching the stud. The effect of this is that the car is deprived of power from that stud, but running on by its impetus contact is again established with the main. This is an accident of no moment, and would, in fact, very seldom occur in a

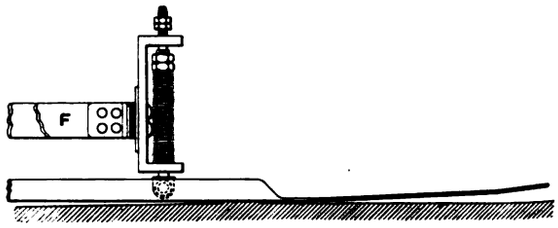

Fig. 6.

paved street. A shovelful of gravel thrown upon and round the stud has the effect of causing considerable sparking, but does no great harm. Gravel upon the track will cause sparking in any electric traction system in which the rails are used for a return.

One method of supporting the skate (in the case of a four-wheeled car) is shown in Fig. 6. A frame (part of which is shown in the figure and marked F) is supported on bearings running on the axles of the car. To this is bolted a pair of stout brackets of the shape seen in the figure. A vertical pin, 1¼in. in diameter, with a thickened base pivotted to the skate, slides freely in each bracket, and carries two pairs of lock nuts. The lower pair press upon a spring, and can be adjusted to take any required fraction of the weight of the skate, while the upper pair act as a back-stop and prevent the skate from falling below a certain fixed limit. In practice the back-stop should be adjusted so that it allows the skate to fall as low as the lowest stud on the line (say, about an inch above the level of the rail), while the spring is adjusted so that when running on an average stud the pressure is about 10lb. The spring being a long one and much compressed changes its forces very little with a lift of ¼in. or ½in. The little friction that occurs on the pin is just sufficient to deaden any tendency to dance when running at a high speed. The skate is composed of a U-shaped steel girder 4½in. by 2½in., and is 18ft. long. The side webs of this girder are cut off for a length of 3ft. at each end of the skate, so as to give the point a certain amount of springiness. The springy portions are then bent up at a very gentle slope (about 1 in 100), and the tips are still further curved upwards. By supporting the skate on springs at two points about 4ft. from its ends a very useful pitching motion is given to it as it slides over the studs. This is shown in Figs. 7 and 8, in which the vertical scale is exaggerated so as to make a small drawing sufficiently clear. The greater part of the weight of the skate being borne by the springs, so long as a stud is under the central part, the ends are kept well above the ground. But as the stud gets nearer and nearer the hind end more and more weight is thrown upon the front end, until just before the skate reaches the next stud, the front end is down upon its back-stop, as seen in Fig. 8. This stop is about 4ft. from the tip, and the slight tilt of the skate throws the tip a little lower than it otherwise would do, and at the same time presents the striking surface at an exceedingly small angle (about 0° 30′) to the horizontal. Thus the contact with the studs can be made almost silently, even at the highest speeds. The tip of the skate, which is ordinarily well above the ground, dips down to accommodate itself to a worn stud

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just at the point where it is required. Having once touched the stud and excited the magnet under it, the attraction of the magnet helps to stop any jumping. The ends of the skate being very springy accommodate themselves very well to studs differing considerably in height. In practice it will be possible, by setting the boxes directly upon ties between the rails, to ensure that the studs do not in the ordinary course vary by more than ¼in.

The method by which one stud is made alive before the car leaves the stud behind will be considered in the next section, but while considering the skate it is important to note what amount of overlap must be allowed to it. In designing an experimental line we wanted to be on the safe side, so we allowed a 3½ft. overlap, knowing that the switches took about $\frac{1}{10}$sec. to close. Thus the skate was made 18ft. long with 14½ft. between the studs. This overlap is more than sufficient. We have run at a measured speed of 16 miles an hour without experiencing trouble from the non-closing of switches, and could probably go quicker but for the inconveniences of our short track. Now as the Board of Trade regulations limit the speed at which cars in towns may run far below this, we might have a much shorter overlap or a longer distance between the studs. The Board of Trade regulation for Dublin runs as follows :—"The speed at which the carriages shall be driven or propelled along the tramway shall not exceed the rate of eight miles an hour, and the speed at which the carriages shall pass through facing points,

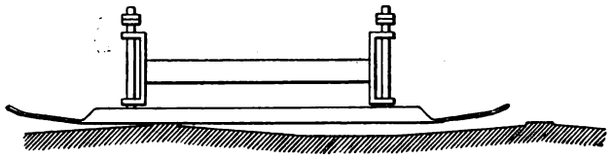

Fig. 7.—Vertical scale exaggerated, showing how skate rests on stud.

whether fixed or movable, shall not exceed the rate of four miles per hour." Further, in the regulations relating to the motor carriage it is provided—"It shall be fitted with a governor which cannot be tampered with by the driver and which shall operate so as to cut off all electric current from the motors whenever the speed exceeds 10 miles an hour." While it is possible to go at the speed of 15 to 20 miles an hour with a moderate overlap, we can, by shortening the overlap, positively prevent the car from going at a speed greater than a certain fixed limit. We find that we can increase the length of skate to 22ft. for a 25ft. car and have 18ft. 6in. between the studs. Lines on which bogie cars are employed would allow of still greater length of skate and a smuch as 30ft. between the studs. In wet weather a certain amount of leakage occurs from the stud which is for the time supplying current to the car, and it is important to inquire how much this leakage is. It is

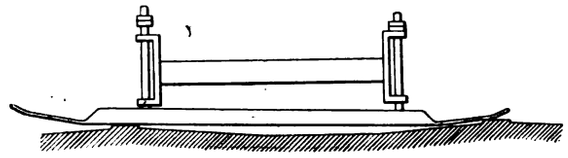

Fig. 8.—Vertical scale exaggerated, showing the dipping action of skate.

easily ascertained by actual measurement with street mud and water placed around the stud and skate. The following data were obtained by experiment. The pressure on the line was 500 volts.

Particulars of Leakage from Studs.

Condition of road.	Current leaking in amperes.
Track covered with very wet mud and water ½in. to ¾in. deep so as to make the very worst street condition. The skate resting on two studs at 500 volts above earth. The mud between the studs touching the skate at intervals along its length. Total leakage from the *two studs*	3·9
The same after standing five minutes	4·5
After one stroke of a brush so as to reduce the depth of mud and water to ¼in.	2·3
One stud with short skate resting on it. Wet mud about ¼in. deep	1 2
The same with mud deeper. Very bad road conditions..	2·5
The same with thin mud and water as it would be on an ordinary wet day	0·4
The same dry	Practically none.

It must be remembered that the sloping asphalt round the studs tends to become clean in very wet weather. After a heavy shower, the bulk of the mud having been removed, the leakage will be very little indeed. It is probable that the average leakage in wet weather will be about half an ampere per car; while under exceptionally bad road conditions it may approach five amperes. By carrying a brush in front of some of the cars to sweep away the deepest mud it can be kept at about one ampere, even under the worst conditions. Taking only five fine days to one wet one, the average leakage will be under a quarter of an ampere per car, or about 2 per cent. of the total power of the station. It is difficult to say what effect this will have upon the coal bill, but it is certain it cannot increase it by 2 per cent. Of course, on a dry year like the one we have just had the average leakage would be almost negligible.

Ease in going round curves and over crossings is a matter of great importance in any system of electric traction in towns. When a long skate is used on a simple four-wheeled car it is necessary to put the studs nearer together on a sharp curve, because the ends of the skate do not keep to the centre of the track. On a 34ft. radius curve it is desirable to have studs every 8ft. This, of course, adds to the cost of construction, but as the greater part of a tramway company's rails are straight or nearly straight it is not a serious matter. The length of the skate is really limited by the radius of the sharpest curve on the line. If a line has many 34ft. radius curves, a suitable length for the skate is about 18ft. for a four-wheeled car. It is a great advantage in a surface contact system to have only one row of studs in the centre of the track. It is also an advantage to have each stud self-dependent; that is to say, capable of being exerted without inter-connections from other studs. In systems having two rows of studs it must be very difficult to keep the right skate on the right stud when going round a curve, unless the skates are quite short and the studs very near together in each row. At crossings the difficulties would become greater. We have found that by employing a single row of studs in the centre of the track (where full advantage can be taken of the crowning of the paving-stones) there is no difficulty in going round sharp curves and over crossings. In electric traction systems it is not usual to provide a means of bringing the car off the rails and taking it round an obstruction on the line. If it is thought desirable to do this, it can be done very easily on a surface contact system by carrying with the cars properly protected flexibles which can in an emergency be attached to the studs and to the rail.

3. We now come to the most important question—the question of public safety. The automatic switches must be designed so that they can only be closed when a car is over the stud, and the provision for guarding against the accident of a stud being left alive in the street must be absolutely without a flaw if the surface contact system is to be permitted for a moment in England. It is exceedingly difficult to form an estimate of the safety of any particular device. Things that we are accustomed to use every day without injury to ourselves we come to regard as harmless, often not so much because they have no element of danger in them, as because in common experience accident does not happen. Who, seeing for the first time a railway train steaming at 60 miles an hour, would care to trust himself on board it? The more he might know of the laws of motion, the attraction of gravitation, and the strength of materials, the less would he be inclined to listen to arguments to prove that it could not come off the rails. The reason that we dare go railway journeys is not because we are satisfied with the proof, it is because in common experience trains do not run off the rails. Upon the introduction of anything to which we are unaccustomed, anything that contains a conceivable element of danger, we are at once afraid, and it is exceedingly difficult for any one to satisfy us that it is perfectly safe. It is so with surface contacts. The more we know about mechanism, the less we feel inclined to trust in the safety of a device which is proved to be safe by unanswerable arguments. There is only one way of bringing conviction to the mind of the timid, and that is to simplify the issue upon which safety depends until it becomes identical with something with which we are perfectly familiar and in which we have perfect confidence. It is in this way that we have tried to bring home the safety of surface contacts.

Take something that we are sure about. Can a magnet attract the air? It cannot. If we are sufficiently sure of that, it will do for a principle upon which to base a safety switch. But we want something more than a principle, we want a moving part to make a switch. Then let us take one of the simplest and surest of all moving things, a heavy cylinder sliding in a very loose vertical tube. Is it possible for it to remain suspended in the tube when the only force upon it is gravity? If it is impossible, then that cylinder will do for our moving part. The problem now is to make a switch whose safety depends, and depends only, upon a magnet not attracting air, and a cylinder which will not stick. If we can do so without introducing other issues of a more complicated character, and with which we are less familiar, then we have a switch upon which we can rely. If we take an iron plunger with expanded ends, like that numbered 2 in Fig. 9, and surround it by a solenoid of wire, carrying a current, it is possible to choose the size of the heads so that the tendency of the plunger to assume a central position is balanced by the attraction of the solenoid on the iron heads. With properly chosen heads the solenoid

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exerts no force whatever on the plunger. Gravity being the only force upon it, it will, of course, take up the position No. 2. If, now, a piece of iron is placed over it, as shown in No. 3, the plunger may be raised by the attraction between the two. In case a heavy plunger is used it is possible to support part of its weight by merely increasing the size of the

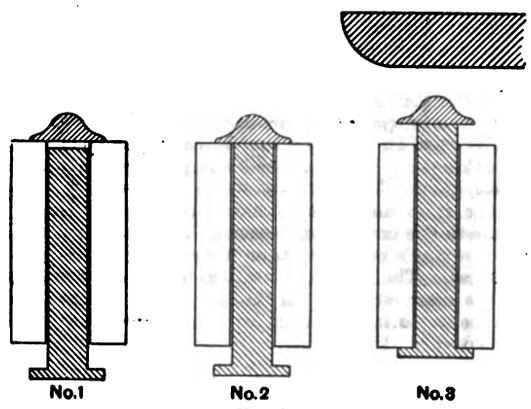

FIG. 9.

lower head by a small amount. Thus, we have a simple piece of mechanism whose movement is entirely dependent upon the presence of a mass of iron in its neighbourhood, and which cannot be moved by the solenoid itself, even though the magnetising current carries the iron up to the saturation limit. This has been converted into the operating part of the switch, in the manner

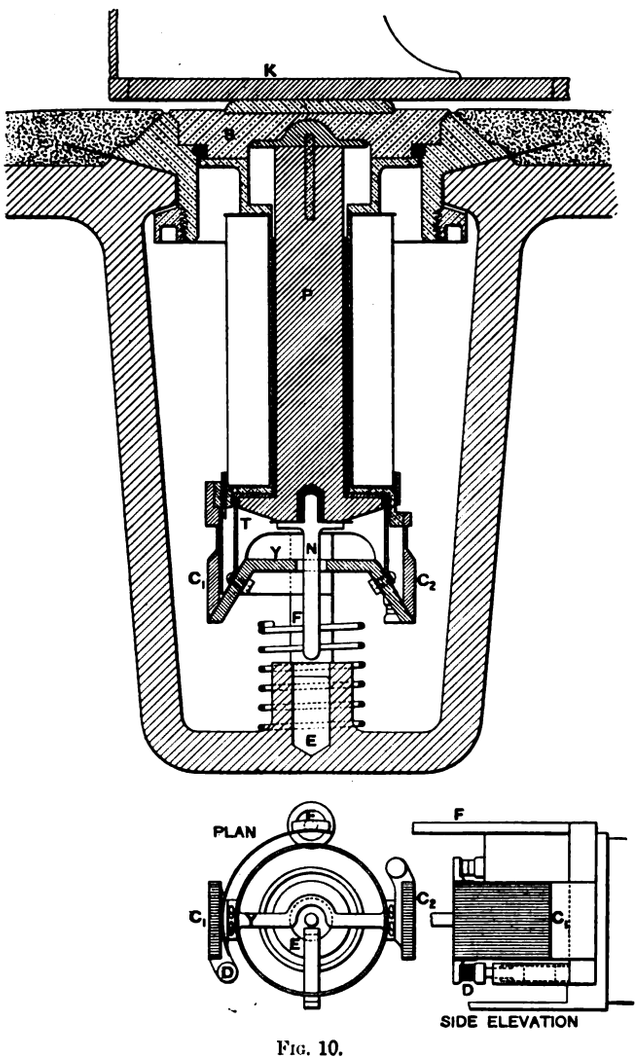

FIG. 10.

described below. Now, though the force of attraction is sufficient to lift a fairly heavy plunger and operate a switch, it is desirable to have something more than this. We want a switch which will, notwithstanding its massive moving parts, close in an exceedingly short space of time. We want a very great acceleration upon the moving parts during the first part of their motion. This is easily obtained by merely separating the upper head from the plunger by a short air-gap, as shown in position No. 1 of Fig. 9, and arranging matters so that the mass of iron comes over the switch before current is put through the magnetising coil. As soon as current passes, the attraction upon the head is so great that the plunger gets up a high velocity before the two come together, with the result that the switch operates as though it had been hit with a hammer. A very simple device—a mere film of oil acting as a cushion—can be employed to prevent the switch from being injured by the concussion. The connection of this operating part to the contact points of the switch has been the subject of some very varied experiments. If we are to preserve our original simple issue, we must not hamper this plunger with any gear at all. The safety of street passengers must be made dependent upon nothing else than the falling of the plunger when the mass of iron is removed. The attachment of any

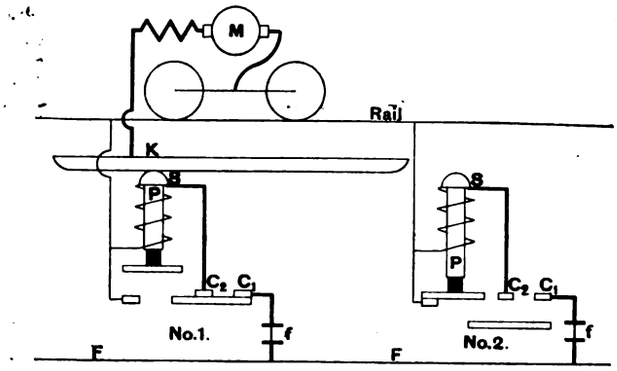

FIG. 11.

gear at once introduces the risk of friction, whose amount may be a variable quantity. Fig. 10 shows the construction of one of our safety switches. The switch is in the closed position. The plunger P is the same in design as that shown in Fig. 9. It is surrounded by a very loose tube which is enlarged at its lower end, T, so as to enclose the expanded end of the plunger, which is free to slide in the tube, the clearance being as great as we like. The tube T can itself slide in an outer tube, and is attached by insulating brushes to the yoke-piece Y, which, when the switch is closed, makes electrical connection between two brushes C and C_2. As the whole switch is immersed in oil, a considerable suction exists between the plunger P and the tube T, notwithstanding the large clearance, so that when the plunger falls it carries the yoke Y with it and opens the switch. Before describing the details of the switch it will be

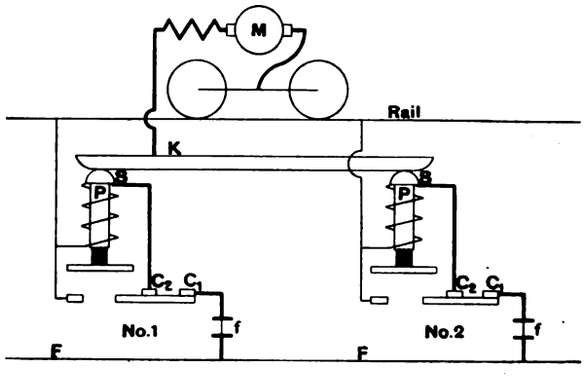

FIG. 12.

best to look at the general method of operating the switches in succession. Figs. 11 and 12 are diagrams of the electrical connections. Switch No. 1 of Fig. 11 is closed, and current is flowing from the feeder main F F through the fuse *f*, through the yoke piece from C_1 to C_2 and to the stud S, thence by means of the skate K it passes to the motor and then to the frame of the car truck. In this particular method of making the connections the plunger is magnetised by means of a shunt coil connected between the stud and earth. The comparative advantages of shunt and series coils in switches of this kind was discussed in our British Association Paper, and I need not go into that matter again. It is sufficient to describe here the method which we have found to be simplest and most satisfactory. It will be seen that in the diagram the yoke between C_1 and C_2 is drawn as a piece separate from the plunger, but it is to be understood that in the ordinary course they rise and fall together as mentioned above. Thus in No. 1

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Fig. 11, the plunger is up and the yoke is up; in No. 2 they are both down. Fig. 12 shows the car in the act of passing from one stud to the next. As soon as the skate K touches the stud of No. 2 current passes from it round the shunt coil, magnetising the plunger, which rises and is held up by its attraction upon the iron skate K. A moment later the skate K leaves switch No. 1, and, as the plunger has no longer anything which it can attract, it falls and opens the switch. The forces required to open the switch are very small, and the 3lb. weight thrown upon the yoke piece upon the removal of the iron of the skate gives a very ample factor of safety. But the safety of street passengers does not depend upon the opening of the switch in this way. If, for any reason whatever, the yoke piece did stick up (a thing which it practically never will do), the plunger will slide down the tube T and make connection between the yoke piece and the earth in the manner shown in Fig. 13. This will connect the main to earth through the fuse *f*. The fuse will, of course, be blown immediately, and the switch entirely cut off from the main. The switch shown in Fig. 10 can now be described in greater detail. In the first place it is contained in a round cast-iron box, the lid of which is of gun metal and forms the stud. The lid is fixed into a gun-metal ring which is insulated from the cast-iron box by means of micanite. The whole is designed to bear a weight of 15 tons and to take a heavy blow, having a considerable horizontal component, such as would be received from a heavy waggon jogging on to it. The space round about the stud is filled in with asphalt up to the level of the road, but the micanite is designed to insulate the stud sufficiently by

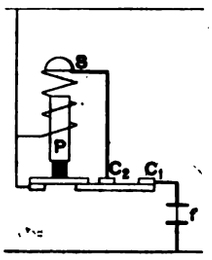

FIG. 13.

itself even if the asphalt were broken away and the space filled up with water. In still later designs we are insulating the studs by supporting them entirely upon a block of granite. The stud is faced with a plate of hard phosphor-bronze to take the wear, and this plate can be replaced when worn down.

(*To be concluded.*)

ELECTRICITY WORKS ACCOUNTS.

Waterloo and City Railway Co.

Date of commencement of working	1898.
System of electrical lines	Third rail.
Chief Engineers	W. R. Galbraith. A. B. W. Kennedy.

The official statement of accounts for the half-year ended December 31, 1898, indicate a total capital expenditure of £549,457, including £25,000 on interest during construction, leaving a balance in hand to capital account of £11,543 out of a total subscribed capital of £561,000. The revenue account shows the following items :—

Revenue Account.

RECEIPTS :—	
Gross revenue, less Government duty from August 8th (date of opening) to December 31st	£10,888
Rents and transfer fees	69
Total receipts	10,957
EXPENDITURE :—	
Amount retained by South-Western Railway Company in respect of working expenses	4,119
Directors, auditors, salaries, &c.	309
Rents	227
Total expenditure	4,655
WORKING PROFIT :—	
Balance carried to net revenue account	6,301

With the balance of £6,301, added to a general interest account of £2,378, a sum of £8,679 was available for distribution. A sum of £289 was paid in interest on Debenture Stock, and 3 per cent. per annum for the half-year on the Ordinary shares, with the balance of £8,391.

Blackpool and Fleetwood Tramroad Company.

Date of commencement of working	1898.
System of electrical lines	Overhead trolley.
Tramway Manager	John Cameron.
Chief Engineer	J. McMahon.

The accounts of this electric traction undertaking indicate the following principal items for the period ended December 31, 1898 :—

CAPITAL—	
Authorised capital	£180,000
Subscribed share capital	120,000
Mortgage debentures	40,000
Sundry loans	6,440
Total capital received	166,440
Balance added from profit account	8,006
Total capital expended	168,659
REVENUE—	
Traffic receipts	14,476
Total expenditure out of revenue	5,892
Working profit	8,584

The working profit amounts to 59¼ per cent. of the gross receipts, leaving 40¾ per cent. as the ratio of expenses to revenue—needless to say, a very excellent performance for the short period the line has been in operation.

Bristol Tramways and Carriage Company (Limited).

The impending conversion of the whole of the Bristol tramways system from horse to electric traction, quite as much as the fact that some 8½ miles of track are now run by the trolley, makes this undertaking specially interesting. At the present time the work of erecting a large power station in a central locality is rapidly progressing. In examining the half-yearly accounts, however, it will be necessary to keep well in view the fact that the bulk of this Company's business at present is with horse-drawn vehicles. An abstract of the accounts below gives the items of chief interest to electric traction engineers:—

Date of commencement of working electrical lines	1895.
System of electrical lines	Overhead side trolley.
Managing Director	George White.
Chief Engineer	W. Wood.

Half Year ended	Dec. 31, 1897	Dec. 31, 1898
Passengers carried*	11,060,817	12,644,476
Miles of electrical track constructed	8·5	8·5
Number of motor and trailer cars	46	66
Capital authorised, share	£500,000	£500,000
Capital received, total	442,250	578,500
,, ,, share	325,000	437,500
,, ,, loan (*including Debentures*)	117,250	141,000
Capital expended	490,915	576,480
Electrical depreciation fund	3,308	6,000
Amount carried to electrical depreciation fund	1,692	1,000
Repairs of plant, machinery, and rolling stock‡	4,376	4,657
Electrical renewals and repairs	1,146	1,124
Working profit for half year	16,860	22,453
Balance available for dividend†	8,750	14,219
Ordinary dividend paid (per cent. per annum)	6%	7%

* Proportion on electric lines not stated.
† Total for entire business.

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WIRING RULES.

In a leading article last September we dealt very fully with the question of wiring rules, insisting particularly on the needlessness of the various codes issued by supply undertakings in this country. We pointed out that, if it is necessary for the engineers of these concerns to issue regulations, these should be confined to a statement of the limiting power that might be taken from any one pair of terminals, and to such instructions as are necessary to define where the contractor's work ends and that of the supply authority begins. We cited some examples of the contradictory rules resulting from the station engineers specifying as to the actual wiring work, and expressed the opinion that the majority of supply undertakers had no authority to enforce any detailed wiring rules, or to refuse a connection unless the Board of Trade regulations were violated. We next reviewed the new rules which Mr. Wordingham had then just issued in Manchester, and concluded by recommending that the latest edition of the wiring rules of the Institution of Electrical Engineers should be so extended as to obviate the necessity for any other code, whether issued by a fire office or by a central station engineer. To effect this in the most satisfactory manner, and with the greatest probability of success, we recommended that the Council of the Institution should form a joint Committee of central station engineers, consultants and contractors, and invite the fire offices to be represented also. If the latter held aloof, we pointed out that the contractors would still have it in their power to wire exclusively according to these new rules, and so render those of the fire offices ineffective.

We confess our satisfaction that three Papers on the subject should so shortly afterwards have been read before the Institution of Electrical Engineers, and that both the Papers and the discussion on them, to a great extent, supported the views we had expressed. Mr. Crompton, in his Paper, gave a brief account of the labours of the Committee that had framed the 1897 edition of the Institution wiring rules, and invited representatives of the fire offices to make suggestions for their emendation and extension, so that a single set, acceptable to all, might be compiled. In his supplementary remarks, however, he unwisely, as we think, gave in to Mr. Wordingham in allowing that modifications might be necessary "to suit local conditions and risks." Mr. Wordingham appeared theoretically to advocate uniformity, in that he suggested the thrashing out of the subject at one or more meetings at

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which all parties interested were to be represented; that rules should then be made, and that people should "sink their own individual preferences, and it may be their own *amour propre*, and abide loyally by the decision arrived at." Mr. WORDINGHAM, we fear, will have to sink a great number of his individual preferences. He was on the Committee that framed the Institution rules, but yet his new Manchester rules differ widely from these, both in general spirit and in detail. Mr. PIGG and several speakers compared the items of the various codes of rules, and effectively demonstrated that the differences followed no law; that the local conditions, which caused the variations, were only the whims of the resident engineers, and not the peculiarities of the supply systems. On the question of the certification of fittings, the majority of speakers were certainly not with Mr. WORDINGHAM, although some, notably Mr. DRAKE, who had also been a member of the Institution Committee, wished that this testing and certification should be performed by the Institution. A section of the debaters advocated uniformity by the reduction of the number of rules to zero, others spoke on points of detail in the Institution rules, and two speakers ridiculed the haphazard way the fire offices enforce their regulations by sending the contractors sheets of foolscap paper. With regard to the latter point, several suggested that ordinary business considerations would compel the fire offices to grant policies, whether the installation had been put up in accordance with their rules or not. Finally we may mention Mr. HIRST's suggestion, put forward in all seriousness, that no one should be allowed to remain a member of the Institution unless he were prepared actively to conform with its standards.

Members of the Institution having now spent two evenings discussing the question, it is of interest to examine how much nearer we are to having one set of wiring rules. The following resolution has been passed:—

> That this meeting is of the opinion that the Institution should take such steps as it thinks best to secure uniformity of rules, by pressing on supply companies, municipal engineers, and fire offices the advantage of adopting some rules, to be drawn up by the Institution, based on the present ones, as a standard, with such modifications only as local conditions may necessitate.

By-the-way, as this resolution was introduced after 9:30 p.m., does it not violate Article 58, which provides that nothing of the kind shall take place at an ordinary general meeting "later than one hour and a-half after the time fixed for the commencement of such meeting?" As to the belated resolution itself, if such a resolution is necessary or expedient, surely it should have been put at the time the 1897 Institution rules were formulated. It cannot be the fact that the Chairman of the Committee has only now discovered, eighteen months after the publication of the rules, that uniformity is desirable; for the opinion and counsel of the representatives of the fire offices was sought at the time, and central station engineers of eminence were members of the Committee. A new set of regulations are to be framed, therefore, and let us hope that this time a generally acceptable code will be evolved. Let those central station engineers who do not find the present regulations sufficient, send in proposals for amendment and addition; and if these proposals are all considered in an impartial manner, by a committee elected, say, at a general meeting, we feel confident that the representatives of the supply undertakers will abide by the ultimate decision, and accept the final code of rules, in conformity with the desires of the majority of members. If the electrical advisers to the fire offices do not accept the invitation to take part in the conference, it will be merely to their own disadvantage; for, if the new rules are generally adopted by the central station men, and worked to by the contractors, few of the latter will trouble to read through such voluminous and uninteresting treatises as, for instance, the twenty-eighth edition of the Phœnix Office rules.

It is a matter for regret that notice had not previously been given of Mr. CROMPTON's motion and Prof. AYRTON's amendment; for, had the speakers been compelled to confine their remarks to a definite resolution or amendment, or to proposing further amendments, not only would the debate have been kept more within bounds, but the result would have carried more weight. If proper time had been devoted to the discussion of the resolution there is no doubt that its last nine words would have been voted unnecessary, for such was certainly the opinion of the members present. Much time would also have been saved by the omission of that part of the discussion which related to earthing the middle wire, if it had been known at the opening instead of nearly at the end of the discussion, that another opportunity would be afforded of speaking on this question in connection with the Paper foreshadowed by Mr. ARTHUR WRIGHT. Prof. SILVANUS THOMPSON, although displaying great patience and tact as chairman, might also have helped to a better employment of the time at disposal. While some intending speakers were not granted opportunities of distinguishing themselves, one member was allowed to speak four times, once at very great length; another was for the space of 10 minutes audible at the reporter's table only; and a third was not suppressed even though he made an attack on Mr. WORDINGHAM and his employers of such a nature that we have been obliged to omit a considerable portion from our report of his remarks.

But the debate has now taken place, and the Council is practically, even if not in strict form, pledged to do its utmost to produce a set of rules, suitable alike to the requirements of the consumer, the fire offices, and the central station engineer, and without imposing unreasonable restrictions on the wiring contractor or on the manufacturer of fittings. Codes of regulations fulfilling these conditions have been evolved in the United States and in Germany, and there is no reason why a similar thing should not be done in this country, which is equally, if not more, advanced than either in the design and economical management of electric supply stations. But such a set of regulations must be exhaustive; they must be worded to apply equally well to alternating and continuous-current systems, to two, three and five-wire networks, and to any supply pressure. If any additions are needed, we may expect each central station engineer to immediately find scope for displaying his originality, and in course of time a comparison between the rules "modified as local conditions may necessitate," would probably bring to light as many points of difference as are existing at present.

REVIEW.

Michael Faraday: His Life and Work. By SILVANUS P. THOMPSON, D.Sc., F.R.S. (London: Cassell and Co.)

No better service can be rendered to the cause of science than by encouraging and stimulating young students with the example of its great masters; and of all the famous men included in the "Century Science Series" none can rival Faraday as a pattern for them to imitate, and an inspiriting guide for them to follow. We may say at once, also, that the task of portraying Faraday's life and work in a popular form could not have fallen into better hands than those of Prof. Silvanus Thompson. His lucid and graceful pen has drawn a delightful picture of this hero of science, whose personality has evidently won his profoundest admiration. Faraday's work, and its influence upon recent developments of electrical engineering, need not be retold to readers of this journal; but many circumstances connected especially with

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his early life, and the motive power which impelled him on a course of hard study, self-denial and unceasing labour are well worth recalling, as well as the disadvantages under which he laboured compared with the average students of these days. To them it will be probably a great surprise that Faraday had very little schooling, was a bookbinder's apprentice until the age of twenty-one, and, so far as we can gather, had no special gifts for the calling he then adopted. His memory was always treacherous, and the mental equipments usually deemed essential were in his case all, or nearly all, to be acquired in later life by observation, imitation, never-tiring perseverance, and passionate devotion to the study of natural phenomena. This and a happy buoyant temperament carried him through trials, hardships and humiliations which to any other man would have proved disastrous, but which he took little heed of, cheerily pursuing the absorbing object of his life without thought of profit or distinction. Naturally, in these conditions distinction was very soon thrust upon him, and he lived to attain a position in the field of scientific research higher than any of his contemporaries at home or abroad. Reward, too, of the kind he valued least came to him in due course, but unsought, and was spent largely in private charity. He never took out a patent, and he quickly threw up his outside professional earnings at a time when he could ill afford the sacrifice, because they interfered with his research work at the Royal Institution, which paid him a mere pittance.

Mention has been made of the motive power which did such wonders for Faraday, and we naturally search these pages to discover what it was. Thoughtful readers will not fail to see how great a part religion must have played in the formation of Faraday's character, and the enthusiasm with which he investigated the secret wonders of nature, every new discovery being, to him, a kind of Divine revelation, and a confirmation of the faith that was in him. He quitted trade because he held it to be "vicious and selfish," and pursued the paths of science because he felt them to be fruitful of higher and more spiritual things. To say, as Tyndall did, that "when Faraday opened the door of his oratory he closed that of his laboratory" is a shallow and misleading statement of the facts; and although Prof. Thompson quotes the saying with approval, we cannot believe that he wishes the young men who read this biography to understand that no man can pray in both oratory and laboratory. Yet that is what Tyndall's smart saying means. A more accurate view of the case would seem to be that Faraday accepted his Bible as the highest revelation for the moral and religious life, valuing it so much that he accepted it as inspired—a reverent attitude which is common also to the professors of Biblical criticism, though the terms they employ are different. Had Faraday elected to become one of the "higher critics," he would have been as exacting and as sceptical as the rest. "I was never able to make a fact my own without seeing it" is a saying of his; and in a striking passage describing Faraday's life in his laboratory, Prof. Thompson tells the same story: "Incessantly framing hypotheses to account for the facts, and incessantly testing his hypotheses by the touchstone of experiment, never hesitating to push to their logical conclusion the ideas suggested by experiment *however widely they may seem to lead from the accepted modes of thought*, he worked on with a scientific precision little short of miraculous"; and, we may add, with a devotion that was essentially religious. It was, of course, "unique," as Prof. Thompson calls it, that a man of Faraday's eminence and world-wide renown should all his life belong to, and during the greater part of it occupy the position of, elder in one of the most obscure of religious sects. But this may be set down chiefly to the accident of his birth, and the loyalty of his character, not to narrowness or insincerity, or even to wilful blindness. His answer to Cardinal Wiseman, quoted in these pages, is sufficient answer to that.

Both as a biographical sketch, and as descriptive of the achievements of this great man, the book before us can be confidently recommended to students of all classes. The spirit in which Faraday pursued his researches, and the methods he employed are applicable to all persons and all times.

J. L.

WIRING RULES.

The following is an abstract of the discussion which took place on January 26th and February 9th in connection with the Papers on wiring rules by Mr. Cromption, Mr. Wordingham and M. Pigg, published in our last two issues. Speakers who have revised the report of their remarks are indicated by an asterisk.

January 26, 1899.

*Mr. R. E. B. CROMPTON had very little to add to his reasons—given in his Paper—for advocating a uniform set of rules with only such modifications as were necessary to suit peculiar local conditions and risks. The Wiring Rules Committee, which had sat for a very long time, was selected of gentlemen who had the widest and longest experience of the problems connected with electrical supply. The rules had been many times revised, and many engineers outside the committee had been consulted as to their preparation. He did not say that the Institution rules were perfect, but in his opinion they were not very imperfect. He begged those who took part in the discussion to call attention to points in the Institution rules which they might consider insufficient for the interests that they represented, in order to help in the amendment or addition to them, and so reach a standard of perfection. Then all who had power to enforce rules would only have to refer to the Institution rules, put in the word "must" where the world "should" appeared, and add, as an appendix, the conditions which they required to suit their own particular risks and local conditions.

*Mr. C. H. WORDINGHAM wished to emphasise the pressing importance of arriving at some definite set of regulations, acceptable to all parties. The subject was hackneyed, no doubt, but so was the subject of getting one's bread and butter. No one, probably, felt the necessity of uniformity more strongly than the contractors, because they often had to deal with two, or three or even four different authorities, each one having a different set of regulations, in which certain regulations often clashed. Central station engineers were equally interested in having a uniform set of rules, but there was a difference between ordinary wiring rules and rules in connection with supply. He hoped that the discussion arising from these Papers would lead to some practical result. It was of no use talking about a thing if the people who talked were not really determined to do each one his best to arrive at the result. They must all be prepared to give up some thing in order to secure uniformity, even to giving up a pet regulation.

Mr. B. M. DRAKE, as a member of the committee that framed the Institution rules, and as a contractor, regretted to see to what a small extent these rules had been taken as a standard. The cause was, in his opinion, the tacit opposition of the insurance companies. There was considerable personal element in this. The insurance companies thought, with some truth, that as they had to pay the piper they should be allowed to call the tune. If the Institution rules did not commend themselves to everyone the sooner suggestions were forthcoming the better. One often found a building that was under two or three insurance companies, and the contractor had to undertake that he would satisfy all of them—often an impossibility. Perhaps one company said that all ceiling roses must have fuses, and the next that no ceiling rose should have a fuse. The cost of material was very considerably increased, because it stood to reason that if ceiling roses had to be made in half a dozen patterns they could not be made at a uniform price. Some concerted action on the part of the contractors was necessary. They should all agree—even at the risk of losing work—to follow the Institution rules and no other. The insurance companies would then accept them. Mr. Pigg had mentioned the great variation that existed on the subject of insulation resistance, and he thought this could be got over in a similar manner to that adopted in arriving at the Whitworth standard screws, viz., by collecting the screws of all the leading makers, and striking a mean. Mr. Wordingham's suggestion that the Institution should undertake the testing and certifying of apparatus was a very excellent one, but he thought this should be restricted to certifying the results obtained under test, and that the manufacturer should be allowed to witness the tests. To say whether or not apparatus was, according to the opinion of the inspector who held office for the time, to be passed or not, was a responsibility too great for any inspector. The inspector should simply certify that the apparatus when connected in a certain way gave certain results.

*Mr. A. H. HOWARD referred to the formula in the Institution rules, which gave the sizes of wires and cables. It was the result of careful investigation and experiment. Curves of temperature were plotted out, showing the rise due to particular currents in the particular sizes of wire when they were placed in wooden casing. The committee had decided that a safe rise was 20° F. The currents given in the German rules were found to correspond very closely with this 20° F. rise, a curve was drawn from the German figures, and the law given was calculated to approximate closely to it. It was advantageous to everyone except the cable manufacturer to work to this formula, as it allowed greater current densities than the old rule of 1,000 amperes per square inch; therefore, smaller wires could be used.

*Major-General C. E. WEBBER thought that if the members had all along tried to work the Institution rules into their specifications, there would have been, ere this, fewer differences than those which Mr. Pigg had described. Already, in 1882, the Council appointed a committee to report on the subject, and in 1883 their "Rules and Regulations for the Prevention of Fire Risks arising from Electric Lighting" were issued. There were 19 rules, and they occupied only three pages of the *Journal*. How many of their members had read them? They dealt with danger to buildings and to person, and, so far as they went, were nearly as sound now as they were then. He had an idea that one of the earliest specifica-

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tions on wiring was framed on these rules, showing that engineers at that time looked upon these rules as the foundation of the wiring specifications which they issued to their consumers. In 1888 the Institution appointed a committee to revise the rules of 1883. This revision produced 39 rules, which occupied six pages of the *Journal*. Both the rules of 1883 and 1888 were strictly general, and avoided all attempt to specify how work should be done. On both occasions they had been cast with a view to satisfying both the Institution and the insurance companies, but each time the Institution had been unsuccessful. It appeared, then, that the idea of the technical officers of the insurance companies seemed always to be to frame rules which, on the one hand, attempted specification, and, on the other, left certain conditions for reference to the personal verdict of the responsible officer of the Company. The result was that whereas during 1883 and 1888 the Institution rules only required revision once, there were in the same period 9 or 10 revisions in the Phœnix Fire Office rules. In the latest edition of the Institution rules a new departure had been made, and they were called "Wiring Rules." The number had been reduced to 15, and they occupied 14 pages of the *Journal*. Their character had been changed. Their preamble stated that they were arranged in such a form that they could be used as a specification of requirements for precaution. For instance, in dealing with the conductivity of copper, they had some information specified which was outside the scope of the 1888 rules. It was his impression that most of those interested in the subject had not sufficiently perused the Institution rules. As regards the suggestion that they should have a testing laboratory, he cited the example of the Kew laboratory, under the guidance and direction of the Astronomical and Royal Societies, and he did not see why such an institution should not be established under the patronage of the Institution of Electrical Engineers. Doubtless, if it could be shown that this would further the cause of uniformity, the necessary funds would be obtained without much difficulty.

*Mr. F. BATHURST agreed with Mr. Crompton that the present Institution rules were the most representative set published. There must have been considerable difficulty in providing for so many systems of wiring. Before discussing rules, systems of wiring should first be discussed so as to get down to the elementary first principles upon which all wiring should be based. If they looked through the electrical papers at the present moment there were no less than eight or ten different systems all competing with each other, and the insurance companies could not be expected to make rules to cover all the systems in existence. It was evident that they were only in what Herbert Spencer would call the "second stage of progress." Insurance companies had the right of first consideration in this matter from the fact that they were financially interested. He had tried to raise a scare by saying they would have serious fires if they did not adopt a certain system of wiring, but both the Institution and the insurance people told him there were no fires; he would therefore argue that as things were so satisfactory the insurance companies should reduce the premiums. On the other hand, they had to admit that they could have electrical fires, and that electricity was the most versatile of all fire fiends that the insurance companies had to deal with. In America the insurance companies had found it necessary to class electrical fires under about a hundred different headings, but the English had had a pleasant experience in hardly knowing what an electrical fire was. He agreed with Mr. Wordingham that the general tendency with station practice was towards three-wire continuous current, and, as was pointed out in the Paper, there was a great difference between considering wiring from the safety point of view and from the point of view of satisfactory utilisation. Of course, the contractor did not want to study the safety point of view; he would rather do it at as low a cost as possible. He did not agree that their switches and fuses were not perfect, and that station engineers should take up the testing of them. A better way would be to have a discussion at the Institution, and to allow the station engineers to say what their troubles were and leave it to the manufacturers to design proper fittings. He thought they would never get to a standard system of wiring until the insurance companies, Board of Trade, and everyone interested, allowed them to go in for earthing. Earthing would put them in the way of reducing cost, and if they could compete with gas piping they would have every builder fitting up his new buildings with provision for electric lighting. Mr. Wordingham had stated that they would have electrolytic troubles set up if they earthed, on account of a heavy current flowing down from the middle wire of a three-wire system. But Mr. Wordingham had already pointed out that it was an easy matter to balance the wiring. But even if the wiring were not balanced in the houses, it would be easy to increase the section of the middle wire, and so reduce the drop in volts which occasioned electrolytic troubles.

*Prof. W. E. AYRTON asked for information from the fire insurance companies as to why they had decided on demanding a certain insulation resistance after a house was wired. Some companies were satisfied with 12 megohms per lamp and others wanted 112, as Mr. Pigg had pointed out. He did not suppose that the companies had arrived at their decisions at random, and he would like to know on what principles they had arrived at their figures. It was no use acting on the suggestion that had been made that evening: that it would be better to take an average of all of the standards of insulation resistances per lamp specified to the various companies, and then generally adopt this mean value. It was a totally different thing from the question of screws. There was no danger in this; it was a matter of convenience as to which screw-thread they used. But in this matter of megohms, a company that stipulated 112 must have an idea there was danger in using anything much less.

*Mr. C. A. GAWTHORP thought they must all recognise the troubles of the electrical contractor when he had to wire a building insured in three or four companies, and when he had several sets of rules to work to. He realised that the Institution rules were upon a sound, scientific and practical basis. To some extent they were more stringent than the rules of the North British and Mercantile Insurance Company, which he represented, while in a few sections they fell below the requirements of his company, and in one or two small sections there was a serious difference. The differences between the two sets of rules were, however, not so wide as to preclude all possibility of agreement. He believed, speaking unofficially, they would come to an agreement. Did not they think the insulation resistance required by the Institution, and by some of the supply undertakings, was rather hard on the contractor, when he had to wire a new building with wet plaster all over it? He knew of several cases where the wiring had been carried out on the most approved system, but when they came to test at the full working pressure they could not get the resistance up to the required standard. It was often lost sight of that the number of different rules issued by supply undertakings was ten times that of insurance companies. Until the supply undertakings fell in with the Institution he thought it was not of much practical use for the fire offices to do so. It had been said that the fire offices did not recognise the Institution rules in the slightest degree, but this was a slight mistake. A case came under his notice where the electrician had certified that the work had been carried out according to the Institution rules, and he immediately passed it. This was sufficient to show that they were recognised.

*Mr. H. HUMAN, of the Guardian Fire Office, sympathised with Mr. Crompton in his laudable endeavours to bring the rules to a common basis, and would be pleased to help him in any way he could. At the same time he saw difficulties in the way of adopting a single standard set. For reasons well understood the engineer found it necessary to impose very stringent conditions, particularly in the matter of insulation, but the insurance offices, having only the fire risk to consider, could be content with less; and having to meet such varied conditions their rules must necessarily be more flexible. If they adopted a mean, that would imply levelling up on the one side and levelling down on the other. While he saw no difficulty in levelling up, he doubted whether the engineer would consent to come down in his high requirements. At the same time he saw no reason why the several rules should not be brought into line on all essential points, in which case the Institution rules would form a connecting link between the others, and thus be regarded as a standard for all. Dealing with the Institution rules, he pointed out that the clause referring to concentric conductors implied that an earthed return was not admissible; that the clause prohibiting the use of conductors spaced and separated from walls, unless protected throughout their entire length, was going further than any fire office would be justified in doing; and that the rule dealing with motors required strengthening. Coming to the question of the insulation resistance, 10 megohms divided by the number of amperes was certainly sufficient for fire purposes, but he doubted whether the engineer would regard it as sufficient. Some few years ago *The Electrician* had published a diagram of curves, plotted from the rules then in force, showing a lamentable disagreement in this matter, and suggesting the need for a simple formula to meet all cases. He submitted such a formula to the editors, in which he divided the volts by the number of lamps and let the quotient equal megohms. It had the merit of allowing for varying pressures, which no rule at the present does; but in the face of 250 volts now in vogue, probably one-fourth of the quotient would better meet the case. While, strictly speaking, they could not neglect the amperes in dealing with insulation, in practice it was found better to divide by the number of lamps, as representing surface leakage, and neglect their candle-powers.

*Mr. L. J. LANGRIDGE, of the Royal Insurance Co., had such hopes of the Institution rules being universally adopted that he had advised his company not to draw up any of its own just yet.†

*Mr. R. J. WALLIS-JONES said that there was one point in connection with the testing of insulation that he did not think was touched upon in any of the rules, viz., the atmospheric conditions under which the testing was made. On a wet day it was impossible to get a figure which they could easily get after two or three weeks dry weather. The main points to be considered were a safe standard of insulation and the protection of the circuits by safety fuses. He thought the rules of the Institution were very excellent in the latter respect. It practically came to this, that they were quite safe if their circuits were run with five-ampere fuse distribution for the 100-volt distribution and three-ampere for 200 volts and upwards. If these rules were adhered to right through, there would be very little trouble in the general wiring. On the question of the advisability of earthing the motor frame, this was open to doubt, for the reason that they were very apt to receive an unpleasant shock if they had an earth very close to the attendant.

*Mr. E. T. RUTHVEN-MURRAY said that, as a station engineer, he was looking forward to the day when they would have a standard set of rules throughout the country. He was now waiting patiently for the Institution rules to be amended, as, if they were shortly forthcoming, he intended to adopt them at Willesden.

*Mr. F. C. RAPHAEL said that, like Mr. Pigg, he had had occasion to examine the various rules issued by supply undertakers, and had made a summary of the more important, as Mr. Pigg had done, with the intention of including them in a pocket-book, which would be published this year. Had he known that Mr. Pigg was working in the same direction, and that he would have produced such excellent results, he might have saved himself the tiresome task, and have asked Mr. Pigg's permission to make use of his excellent summary. On seeing such a pile of rules, it occurred to one whether it was not possible to make one set of rules more stringent than all of them, so that a building wired according to this set would be within all of the other rules. So far as insulation resistance was concerned, it was quite possible simply by taking a curve which touched the highest points of all the insulation curves. In other matters, however, it was impossible, because while one set of rules said a certain thing must be,

† [As mentioned in our issue of Feb. 3, the Royal Insurance Co. has just compiled a set of wiring rules. These differ in many respects from the code issued by the Institution of Electrical Engineers.—ED. *E.*]

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another set said it was not allowed. Dr. Drake had mentioned the fuses in ceiling roses, and there were many more such examples. He (the speaker) had come across one central station which issued two sets of rules in which there was an apparent contradiction. One set was "General Installation Work Rules," and the other was for those houses originally wired for 100 volts, and which were to be changed over to 200. The first set specified:—"All fuses to be of pure tin wire, with copper terminals soldered to the fuse wire. Fuses composed of copper wire will not be allowed. Every fuse must be carefully adjusted, so that it will melt at 50 per cent. above the normal current it has to take;" while the other set said:—"Pure tin wire should always be used for circuits of 2½ amperes at 200 volts and upwards. But where fuses control from one to three lights it is better to use *a single strand* of No. 38 or 40 copper (taken out of a piece of flexible), for very fine tin wire is too soft and liable to be broken under the heads of the screws in a fuse fitting." With all due deference to Mr. Wordingham he thought the differences in the rules issued by different undertakers could not be accounted for by local conditions, and that one set would suffice for all purposes. If the Institution rules were not sufficient as they stood they could easily be extended. Some differences might be necessary for 2, 3 and 5 wire networks, and for 100 and 200 volt systems, but these could easily be met by adding a few paragraphs. As Mr. Wordingham was anxious to have a uniform set of rules he had no doubt put the matter before the other members of the Institution Committee, and possibly it was because he had been unsuccessful in this that he had gone back to Manchester and made an additional set of his own. As it appeared in order to ask questions as to the Institution rules, he would mention the rule specifying the conductivity of copper. It was given at the figure recognised as Matthiessen's standard for pure annealed copper, but Matthiessen's figure referred to B. A. ohms. If the word ohms in the rules meant "International" ohms, it defined a lower conductivity than Matthiessen's standard. Perhaps it was intended to allow the wire manufacturers to go to this lower limit of something like 98 per cent. conductivity. He thought Mr. Pigg was somewhat unkind to the framers of the various rules in criticising their unscientific language, especially as in the last two columns of his table he had been guilty of something very similar. Why could not he use the expression "megohms per mile," allowed by long usage, but if it was necessary to say megohm-miles, then "Insulation Resistance per 64-Watt Lamp" was erroneous.

*Mr. H. HIRST said that everybody seemed to have got up and agreed that they wanted standards, but nobody seemed to be doing much to get them. His suggestion for attaining this object was that the Institution should exercise some authority over its members, and *make* them adopt the Institution rules. It was the desire of most, or all, electrical engineers to be able to decorate themselves with the initials A.I.E.E. or M.I.E.E. Why not make the granting of this honour subject to an acknowledgment that the Institution has a right to dictate certain rules to which its members should adhere? The suggestion had been made that the Institution should appoint an officer to test apparatus, but he thought they should appoint a committee, not only to test, but to consider all the different functions that formed the link in the chain of success of wiring and cheapening electric lighting, and by this means they would be able to fix and enforce rules on the members. In a political club they had to obey the leaders, and he saw no reason why the same law should not exist in the Institution, always provided that the Institution took great care to have a committee which was thoroughly representative of all factions concerned. It would then only be a question of inducing the fire insurance companies to come into line, and from what had been heard that evening, they seemed most anxious to do so.

Mr. M. H. GALSWORTHY thought some condition should be made with regard to the insulation testing of new buildings by allowing a low test to pass at first, and after a few months it should be made to pass a higher test. He had often found that on testing a building which had been thoroughly well wired, that the test had come out absurdly low, but that in about two months he had got a most excellent test.

Mr. F. BROWN said that it seemed to be the plan to send out a sheet of foolscap paper with a lot of questions on, and he had found that very many small contractors, who took on a number of jobs at any price without much knowledge of the work, would fill in the questions somehow and would sign the paper. He was referring to jobs taken by country contractors. Co-operation between contractors and corporations was a thing to be greatly desired, and if some step could be taken in the Institution towards this, he believed good to the whole trade would result. It was a very difficult and wide thing, but if some of the leading contractors in London could arrange for a meeting of representatives, he felt sure it would be a step in the right direction. As regards earthing, he thought this was rather dangerous, especially while the tendency was to increase the voltage. Later on they would be using higher than 200 or 300 volts. If they got up to 400 volts, and somebody got a shock through earthing a motor, he thought there would be considerable disturbance made about it.

February 9, 1899.

*Prof. W. E. AYRTON said that as no answer had been given to his inquiry at the last meeting as to why such totally different standards of insulation resistance per lamp should be specified by the various supply companies, he had endeavoured to find it out by searching through the different rules. It would seem possible that the companies who used any kind of transformation would desire to avoid the possibility of any leakage extending from the primary to the secondary circuit, and therefore would be inclined to ask for higher, insulation resistance per lamp than a company which worked entirely on the low-pressure system. But this did not seem to be the reason, because Nottingham, which worked entirely on the low pressure, asked for an insulation resistance of 75 meghoms, whereas Oxford, which transformed down, only asked for 12·5 megohms per lamp. Again, the standard of the Westminster Supply Corporation, which was also a low pressure system, varied from 60 to 112 megohms per lamp according to the lamps installed. He was still more at a loss than ever to understand why these specified standards were so different for the various supply companies. In towns like London, where there were a number of supply companies, they could imagine houses on opposite sides of a street built at the same time in a perfectly similar manner, having about the same number of lamps and wired by the same firm in exactly the same way, and both with an insulation resistance of, say, 20 megohms per lamp. The contractor might be told that in one house the supply company would pass his work, but in the other house, which was in another company's district, that his work was extremely bad and that they would not pass it if the insulation resistance was three times as good. Another curious result in London was that houses had been changed over from one company to another intentionally, because of the difference in the standard. He could mention a house not very far from there, which had been condemned utterly, and the company would not supply current to it. It was pointed out to the company how inconvenient this was, as there was to be a reception there that evening. The company consented to supply for that evening, but on condition that their inspector should be present the whole of the evening with permission to turn off the main switch if he felt so disposed. As soon as convenient the consumer was changed over to another company who raised no objection as their standard of insulation resistance was so much lower. One insurance company had arrived at their standard by choosing one lower than any known supply company required, so that it should be quite certain that if any work was passed by a supply company it would pass their test. Another company had stated that competition in insuring was so great that they passed any electric lighting work if it was done at all safely. He wished to correct the impression that his remarks at the previous meeting seemed to have produced—viz., that he was in favour of a low standard. He was in favour of a high standard, but he wanted to know why some companies were satisfied with a very low standard. Coming to the question of the specified insulation resistance per mile, given in the Institution rules, he said that all sorts of numbers were given as the insulation resistance per mile after 24 hours' immersion in water at 60°F. and one minute electrification. Were consulting engineers, as a rule, in the habit of testing any of the wire supplied to any of their specifications; and, if so, what were the results? For some years past he had made a point of making a very detailed specification, and endeavouring to get what he asked for. In a recent specification the flexible wire was to have an insulation resistance of 300 megohms per mile. In two cases he had only got a 200th and a 100,000th of this insulation. In another sample one of the wires had an insulation resistance of but 23,000 ohms, and the other 1,000 ohms, per mile; this was supplied only two weeks ago by a firm of the highest reputation. After this test he cut the coil up, and found that it was equally bad throughout. To-day this wire had an insulation resistance of 200 ohms. It might be said that it was impossible for the poor contractor to make wire up to his (Prof. Ayrton's) high standard; but he had some flexible wire with him that had no less than eight times the insulation resistance specified. This particularly good wire stood a stress of 9,800 volts for half a minute before it broke down.

*Mr. J. S. RAWORTH regretted that Mr. Wordingham had been to Manchester, that worst of all schools of municipalisation. He hoped that Mr. Wordingham's ideas would not be carried out, or followed by other municipal engineers. He held pretty strong views on this fire question, and had given the matter very great attention, for he was the first to introduce the fuse cut-out for the purpose of glow-lamps in this country, and he was the first to get switches and fuses made with porcelain bases. But the conditions of the industry had entirely changed since then. They now made fittings quite as well as gas fittings, and even more ornamental. Electrical manufacturers generally had on their own initiative done everything that was possible to make these fittings safe. How was it that electrical people were the only people that went in for running down their own trade? Did they ever know of a case when an institute of gas engineers sat to consider fire rules for gas? (A voice: "Yes.") With all the bad and dangerous electrical fittings, was any one of them so dangerous as a water-slide chandelier, or as a swivel-arm bracket standing out from the centre post of a window between two lace curtains and without any shade upon it? They had not got to get the permission of a fire office inspector to use either of these contrivances. They knew perfectly well that the very worst electric light installation in the world was enormously safer than the very best gas installation. At Cardiff, in 1886, a number of shops were lit by Brush machines at 2,000 volts, with the lamps distributed on the group-series system. The wires were twisted round the rods that held the goods in the windows, and yet they never heard of an accident. Then there were the exhibitions, where they had all the conditions for making a first-class conflagration. They had wires which in many cases were only insulated with tape; they had wooden bases to the switches and lamps; yet they never burnt down any of these exhibitions. He thought they would have done, but they did not. Did they want Mr. Wordingham to put these rules of his all over the country, enforcing inspection of premises and fittings. In Glasgow they had carried municipal interference with personal liberty so far that a policeman could knock at their doors in the middle of the night and turn them out of bed and demand to see their marriage certificate.

*Mr. LL. B. ATKINSON agreed with Mr. Raworth that there was a much broader principle involved at present than the mere examination of details in the rules. He thought it a very admirable thing that the Institution rules had been formulated, but only as representing a concensus of engineering opinion on what was at all events a perfectly safe practice. The fire insurance companies' position was only a strong one in so far as, generally speaking, a man had made up his mind in what office he was going to insure. He may have already effected a policy, and then had his installation put in and asked the insurance company to pass it. In his view, the insurers should go the other way to work. He recently placed a policy of about £50,000 on premises containing an installation of some years' standing, and he asked

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several insurance offices to quote. All, with one exception, stated that the whole installation must be altered, but he had told them that he would alter nothing, and it was simply a question of who quoted the lowest. The result was that they all quoted the same rate as if he had altered the installation. He admitted that the companies had a proper right to exercise a little supervision over the risks they took, but, as Mr. Raworth had already said, it was only the electrical industry that was picked out for this. In these particular premises, fires started about twice a week, due to the boiling tallow vats, but the fire insurance company took no notice of this. Coming to the rules made by the supply companies, in so far as the insulation of the installation was concerned, where a job was directly connected, as in a continuous-current system, there was a reason why they should interfere, because it might make it difficult for them to test and localise their own faults; but if the supply was a transformed one, he did not see how the insulation resistance concerned the supplier. There was another thing which he thought supply companies and corporations were to a certain extent entitled to regulate, particularly with motor loads; there might be a maximum rate at which the current should be put on, but even that was after all only getting over the fact that they were not in the position to supply a sufficiently regulated current, and therefore the consumer had to bolster up the company's faults and not his own. But when it came to a question of specifying how the fittings should be constructed, how they were to be tested, and so on, before they came into the house, he thought they were passing the line of reason. It had been argued that if any fire occurred with the electric light due to defective fittings, it had a prejudicial effect upon the industry. That time had long since passed away. The case of water fitting inspection had been cited, but where meters were used no inspection took place. He knew of an instance where no less than 500,000 gallons of water a quarter were being leaked through a meter, and the authorities never objected. In gas they never tested either. He had leaked 1,000ft. a day up a chimney and ventilator. Why should they have these numberless rules, therefore, in electricity; in fact, the industry was being strangled by these attempts to regulate. They had the consulting engineers, the fire offices, and now they were threatened by the municipal engineers; all with regulations none of them fitting one another. It made it impossible to make standard articles. They had to alter their standard from place to place and from week to week, in addition to which the corporations were now asking for the right to become trade competitors. Perhaps then the only thing they would allow to be used would be the thing they sold. He thought the time had now come when the trade should, with no uncertain voice, speak out and have done with this regulating business.

*Mr. C. H. COTTAM corrected an error in the Hampstead rules. The supply would be cut off if the insulation dropped below 5,000 ohms, not 500 ohms. He was not responsible for framing these rules, but he saw no reason for altering them. He asked Prof. Ayrton why they should reduce the insulation test, when, with good work and materials in dry buildings, it could easily be got? They had to make allowance for damp work in new buildings, but if they had a lower test and then had to make allowance, the consumer might not get any light at all, but yet have an appreciable registration on his meter. Nothing was permanent in this world. Sooner or later the insulation would deteriorate, and the better the work, materials and test, the longer would the consumer be free from troubles of breakdown. He thought the fire insurance companies might well come into line with the Institution regulations, as, although he spoke subject to correction, he could not conceive that if the fuses were all in order how a fire could originate if the engineer's test was good. Some years ago he was called to see some wiring, and found that the consumer had added to his number of lights without giving proper notice; also that he had no main switch. On leaving, he noticed on the door in large letters, "Agent to the Phœnix Fire Office." He was of the opinion that ceiling fuses might be done away with if the circuits were properly fused on the wall. Prof. Ayrton had remarked upon the Hampstead high insulation test; would he allow him to say that he knew of an establishment connected to the Hampstead mains to which Prof. Ayrton was consulting engineer, and where they would have passed the test had it been in their hands, but Prof. Ayrton would not, because the building was damp? He envied a station engineer who had time like Mr. Wordingham to go into such minutiæ as in compiling the Manchester rules, but he hoped they would not be taken as a guide for the Institution. What they wanted were some rules much more simple and concise, and which an ordinary wireman would not have to spend too much time in reading and learning. He had made several attempts to read them through, but had been interrupted so often that he had given it up in despair. What he had read of them reminded him more of grandmotherly Germany or autocratic Russia than freeborn England.

Prof. W. E. AYRTON here explained once more that he was not in favour of lowering the standard, as Mr. Cottam seemed to understand.

Mr. J. D. F. ANDREWS did not agree that the Institution rules should be made compulsory as Mr. Crompton had suggested, but thought they should take an advising nature. In the present state of the electrical industry it would almost be impossible to devise rules which could control or regulate the details. For instance, in one of the Institution rules, No 14 wire was given as the highest wire that should be of a single strand. He had for a long time been accustomed to using No. 12 with a very considerable advantage. If they used stranded wires in armoured conductors which had to be drawn into buildings, there was a chance of the strands breaking and touching the armouring. Above No. 12 he had found it necessary to use strands. He recognised the difficulties that would have to be met in earthing, but he thought they could be met. One objection to earthing was chiefly electrolysis, but perhaps the main objection to it was the difficulty of making the change. With regard, however, to the former, he thought that if the conductor was earthed at a sufficient number of points along its length—at each house connection, for instance—the pressure between each point would be so low that the electrolysis would be practically nil. Another way of guarding against electrolysis would be not to have the conductor exposed to earth, but only to expose it at certain points, at each house connection again, and to expose it then in such a way that if any electrolysis had to take place it would take place at a point where it did not matter. One method might be to use iron earth plates. He suggested iron because by using copper they had a battery influence between the pipes and the earth plate. Of course the most perfect way of earthing would be to take an earthed concentric system throughout. In that case the outer conductor would be only a very little insulated, just sufficient to prevent there being a material electrolysis. The advantages of earthing were very great, every house would be practically self-testing. Wiring would be considerably cheapened, and above all it would allow of introducing the concentric system on a large scale.

*Mr. SAM MAVOR saw no reason why a set of rules drawn up by the Institution should not be adopted by everyone generally. Such a set of rules he thought would bear more weight than any others issued. Mr. Wordingham had truly stated in his Paper that individuals who had drawn up rules of their own were very loth to set them aside in favour of suggestions from outside. Yet at the same time he had advocated the obtaining by municipalities all over the country of compulsory powers for the enforcing of their rules. The prospect opened up by this was that eventually they would have the engineer of every little municipality drawing up his own set of rules, and as he would have powers to enforce them, he thought such state of affairs would be absurd. With all due deference to the representatives of insurance companies present, he thought the companies knew nothing about megohms. He had never seen an insurance inspector with a testing set in his hands. The companies still continued to send to his firm the ordinary schedule to be filled up, trusting to them to fill it up truly. He did not know whether this confidence was extended to the profession generally. Under these conditions he thought the companies might just as well fall in with the Institution rules which really covered all the ground touched by insurance companies. In connection with the same matter he said that the tariff committee had recently issued a rule with regard to the enclosing of motors which was a very bad and vexatious one. It provided that in buildings such as woollen mills, spinning mills, &c., all motors must be entirely enclosed in iron casings. A case at present in his hands was a 60 H.P. motor on the floor of such a factory. The motor was placed on a concrete base and entirely surrounded at a suitable distance by a wood and glass partition. The insurance companies had insisted on the building of an iron box round the motor. To what end? To make an oven of it? The error and futility of such a rule must be quite obvious. If the Papers which had been read and the present discussion led to the adoption by the insurance companies of the Institution rules, the issue of such ill-advised and unnecessary regulations would be prevented. And in the event of additions or modifications being at any time required, the fire offices might have the advantage of the advice and guidance of a committee of this Institution. He thought it seemed of very much greater importance to give attention to the switching arrangements and resistance appliances rather than to the motors. In cases where it was desirable to enclose the motor it was generally desirable to do so for the protection of the motor itself. There was nothing in a motor to set fire to anything. With regard to the insulation, everyone knew that in a dry house they might have 100 megohms between the gas and water pipes, and an installation might be excessively bad and still give a ridiculously high insulation resistance, or it might be perfectly sound and give a lower insulation resistance than any allowed for by any rules.

*Mr. J. N. SHOOLBRED thought the idea of basing insulation tests upon lamps or points was proving itself fallacious, and his attention had been drawn to this a good many years ago when discussing with Major Cardew a series of by-laws for the Bradford installation, which were to have been passed by the Board of Trade, and the form advised by Major Cardew had to a certain extent been adopted in several places. It took into consideration the energy and not merely the number of lamps. When 110 volts were being generally used, Major Cardew had advised 10 megohms divided by the number of lamps, but later on, when 220 volts came into use, this was raised to 20 megohms. Wiring rules differed considerably from supply regulations, and persons having charge of each should distinguish between them, and not, as he had noticed in several of the rules, mix the supply regulations with a number of wiring rules. The wiring rules affected the insurance companies, and the other the supply companies. He was very happy to hear at the last meeting the expression of willingness on the part of the insurance companies to work with the Institution. It had been his invariable rule, as suggested, to insert the word "must" use the Institution rules, and to conform to the fire offices rules. He approved of the suggestion to seek the opinion of makers of fittings on certain points. He thought the regulation lately issued by the Board of Trade with regard to earthing of the middle wire would be found to have a considerable bearing later on, and possibly it might bring about to some extent the advantage Mr. Andrews spoke of.

*Mr. A. A. C. SWINTON said that it seemed to him that all a municipality could do, without special parliamentary powers, was to enforce such regulations as would ensure that what the consumer had on his premises did not interfere with the supply, and so long as he conformed to that he did not think either a supply company or municipal supply had anything to say in the matter. With the insurance companies it was a different question. He felt very much as Mr. Mavor and Mr. Atkinson did. Directly an insurance company made an objection, they had only to mention that there were other companies willing to take the risk, and they got all they wanted, provided it was reasonable.

*Mr. CHARLES BRIGHT thought that the main reason of the high insulation clause had been lost sight of. In submarine telegraph work all insulation was usually specified that was far beyond what was actually required for insulation purposes. This was because the only two materials that proved to be durable for submarine work possessed such a specific

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value. The specification was as a guarantee for securing the article specified, as this could practically only be assured by an electrical test. He presumed electric supply companies similarly specified a number of megohms quite apart from considerations of leakage. This clause should be based on previous tests of the material more from the durability point of view. Abnormally high was almost as significant as abnormally low resistance. Almost any value could be obtained by an expert manufacturer of compounds.

*Mr. ARTHUR WRIGHT thought central station engineers had no business to enforce fire risk rules. They all appreciated the work done by the Institution and Mr. Wordingham in drawing up rules which they could recommend when called upon to do so, but a great many central station engineers did not consider it in their province at all to enforce wiring rules; this belonged obviously to the fire office. The central station engineer had to see that the pressure was maintained fairly constant, that no user should take current so intermittently as to interfere with the pressure, and that the general leakage should not be serious. The amount of leakage permissible in each installation was difficult to decide, but he thought that 10 megohms per point wired was safe and easy to obtain. Central station engineers had as much as they could do to get the business waiting for them, to help the wiring contractor as much as they could, and to keep their pressure constant. Why should they take up the duties of a fire inspector? They were very highly-paid people, and central station engineers were very badly-paid people. He thought these rules were interfering with the business and apt to frighten the public. The public would begin to think that electricity was very dangerous if it required 47 or 48 pages of rules to make it safe. If central station engineers had sufficient plant they should occupy their time in keeping up their pressure; if they had not the plant, they should occupy their time in getting it. Supposing they were forced to work under the restrictions of the Electric Lighting Acts and for every drop in pressure below 4 per cent. they were fined £10, and for every shut-down fined the £100 named in the Acts, what would become of their business and position? He would not discuss the very important point of earthing the neutral, as he hoped someone would read a Paper on that subject shortly, and also because he thought it would lead the present discussion on a side track. He thought the most important point of the discussion was the unwisdom of the supply companies enforcing fire rules.

*Mr. W. M. MORDEY expressed no opinion on the general question, but wished to know why Manchester, which had municipal gas and electricity supply systems, imposed numerous restrictions on the user of electricity, but practically none at all on the user of gas.

Mr. SYDNEY EVERSHED said that a few months ago, when hanging a picture, he pulled a nail out of the wall for the purpose of putting it in higher up when he was nearly blown away by the gas coming out of the hole. The nail had been for many years in the compo pipe which was buried in the walls. That house was insured in the Phœnix Fire Office. He knocked the nail further into that compo pipe and put a fresh one in higher up. He believed the house was still insured in the Phœnix Fire Office. Gas was introduced nearly 90 years ago into London; if there had been an Institute of Gas or "Gaseous" Engineers, with rules analagous to the present electric wiring rules, and the present station engineer's rules, he did not believe there would have been a single prosperous gas undertaking in the kingdom at the present day.

*Mr. SAM MAVOR called Mr. Wordingham's attention to a slip in his Paper. He spoke of concentric wiring as an "earth" return system. He supposed he meant "earthed."

Mr. WORDINGHAM said that that was so.

*Mr. H. H. BERRY had, during the last twelve months, visited almost every city in the United Kingdom that could boast its supply of electrical energy. As things were at present, the manufacturer was between the devil and the deep sea. He could not possibly stock the whole of the apparatus required to conform to these many different regulations, and there was no doubt that some means that would answer the purpose, and which could be generally adopted by manufacturers, should be arrived at. His original intention had been to support Mr. Wordingham strongly, and to advocate the matter of an electrical testing laboratory, but since hearing Mr. Raworth his views had altered somewhat. But he was of opinion that this matter should be left entirely to the manufacturers.

*The CHAIRMAN (Prof. S. P. Thompson) mentioned that De Keyser's hotel on the Thames Embankment was wired on a plan that violated all fire rules—without any insulation whatever on its conductors. A past president of the Institution, who was responsible for the wiring, informed him that the insurance company had been told that if they did not accept the risk the installation would not be altered, but would be insured elsewhere. He could conceive no more likely source of fire than the wood casing at present so much in use. He would not allow an inch of wood casing anywhere in his house.

*Mr. R. E. CROMPTON, replying, thought it followed from the discussion that there ought to be but a very little pressure on the insurance companies to get them to adopt the Institution rules as a standard, altering them to suit local conditions if necessary. He thought the most peculiar feature was the extraordinary insulation resistance demanded by some of the municipal engineers. Nearly all these municipal engineers were members or associate members of the Institution, and, now that the meeting had shown itself in favour of uniformity, the best thing to do was to pass a resolution to that effect if it would be in order. Under the Articles of Association no question was to be discussed or motion made at an ordinary general meeting relating to the direction or management of the concerns of the Institution; but he thought that this would not come under that head. He then asked the President to put the following resolution:—"That this meeting is of opinion that the Institution should take such steps as it thinks best to secure uniformity in rules, by pressing on supply companies, municipal engineers and fire offices the advantage of adopting the Institution rules as a standard, with such modifications only as local conditions may necessitate."

*The CHAIRMAN said that proposing such a resolution was unusual, but, being a recommendation to the Council, not out of order.

Mr. W. P. FAWCUS seconded the resolution.

*Mr. SAM MAVOR suggested that the resolution might be slightly altered. Mr. Crompton had said that they should "press" upon insurance companies the adoption of the rules. Many of the fire insurance companies had rules of their own, and persuasion might be more effective than pressure in securing the setting aside of these rules in favour of those of this Institution. It would perhaps be better if they "invited" the insurance companies to discuss the matter with the Institution.

Mr. CROMPTON: That is one of the steps the Institution would take. It is natural the Institution will persuade, and not try to force, the companies.

Mr. MERVYN O'GORMAN asked that Mr. Crompton's proposition be open to discussion, and not carried immediately, because there were several points in the rules to be considered from different points of view. They were not inclusive enough to be forced upon the entire community.

*Major-General WEBBER said that if this proposal of Mr. Crompton's was carried unanimously, as it doubtless would be, there would have to ensue a very considerable correspondence, and meetings would have to be held, to which, no doubt, all those interested in the subject would be summoned, and everybody would have a voice in making suggestions. This had been the case when the present rules had been drawn up during Mr. Crompton's presidency.

Mr. PIGG stated that he would send his reply in to the *Journal*.

Mr. WORDINGHAM, in replying, was glad that Mr. Drake approved generally of the course he had adopted. He seemed to think, however, that in the event of an electrical testing laboratory being established, that manufacturers would not be allowed to see the tests. This was not his intention. Anyone whose apparatus was being tested was more than welcome to see the tests. Dishonesty on the part of the inspector was impossible, because the tests were perfectly definite and nothing was to be left to his discretion. In reply to Major-Gen. Webber he stated that his book of rules was drawn up for the requirements of Manchester, and was not intended by any means to be a model to other towns. The model of wiring rules given in the book were the Institution rules. They were specifically referred to, and were held up as a model to wiring contractors and consumers. Mr. Bathurst, like a good many others, wanted no rules. A good many people did not want rules, or laws either for that matter, but he did not think it would be found possible, in a large station, to continue for very long without rules of some kind. Mr. Bathurst also objected to testing of fittings, but the only reason he (Mr. Wordingham) saw for this was that his fittings would not bear testing. He had said, let the manufacturers design proper fittings. So did he (Mr. Wordingham), but who was to say whether they were proper? Surely not the man who made them? Mr. Bathurst's suggestion that central station engineers should put down enormously heavy mains in order to save cost in wiring was not likely to be adopted. Prof. Ayrton's chief point was the basis of the figures taken for specifying the insulation resistance. He did not know what other people had done, but his own method was absolutely unscientific and might not commend itself. He had taken the average of, perhaps, 50 or 60 installations that he knew had been well done. It happened to come out very nearly at 50 megohms divided by the number of lamps, and he had settled on that figure. With regard to the earthing of the frames of the motors, he considered it a great safeguard. If it were not done, and the coils came in contact with the frame, they might under certain conditions render a whole length of shafting "live." He quite agreed with Mr. Galsworthy that the insulation resistance did go up in damp buildings after the current had been turned on a little while, and he always made a reasonable allowance for this. Coming to Mr. Raworth's speech he thought it very amusing. Mr. Raworth's wit was always amusing, even if it was not always decent. Mr. Eversheed, Mr. Mordey and Mr. Campbell Swinton all practically followed the same line as Mr. Raworth, and he hoped they would all pardon him when he reminded them that they were not central station engineers, exclusively at any rate, and although the remarks had been supported by Mr. Wright, and to a lesser degree by Mr. Cottam, he still ventured to differ from their line of argument. Of course he was aware that he was tarred with the brush of being a municipal engineer. He could not help that and did not want to particularly, but would remind them that people were not municipal engineers for life, and that one was obliged to form opinions even to be a municipal engineer. They all seemed to think that he advocated the making of rules by municipal engineers. Not at all; he advocated the making of rules by the Institution. They all practically said, as did Mr. Bathurst, that there should be no rules, but he did not believe they seriously meant it. Did they think they were benefiting the consumer by having none? Surely not. Did they think they would benefit a straightforward contractor who desired to do good work. Certainly not. The only effect of having no rules, or very lenient rules, would be that the market would be flooded with cheap German rubbish, and that the jerry wireman would have it all his own way, and would drive out of the field everybody who could not do wiring at 5s. or 7s. 6d. per light. And this was not the only result; it would bring utter discredit on electric lighting generally. He felt rather strongly on Mr. Wright's remarks, because, coming from a man of his standing, they must carry some weight. He was rather surprised to hear that he had such an enormous amount of difficulty in keeping his pressure constant. He (Mr. Wordingham) did not bother his head very much about it. He generally managed to keep within 2 per cent., and as he was only bound to keep within 4 per cent., he felt satisfied. It is true that for two nights they were nearly out because they had no plant, but they had now got this and kept well within the required standard.

*The CHAIRMAN announced that Prof. Ayrton had suggested, as an amendment to Mr. Crompton's resolution, the substitution of "some rules to be drawn up by the Institution based on the present ones," instead of "adopting the Institution rules."

Mr. Crompton and Mr. Fawcus having accepted this,

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*The CHAIRMAN put the resolution to the meeting:—"That this meeting is of opinion that the Institution should take such steps as it thinks best to secure uniformity of rules by pressing on supply companies, municipal engineers and fire offices the advantage of adopting some rules to be drawn up by the Institution, based on the present ones, as a standard, with such modifications only as local conditions may necessitate."

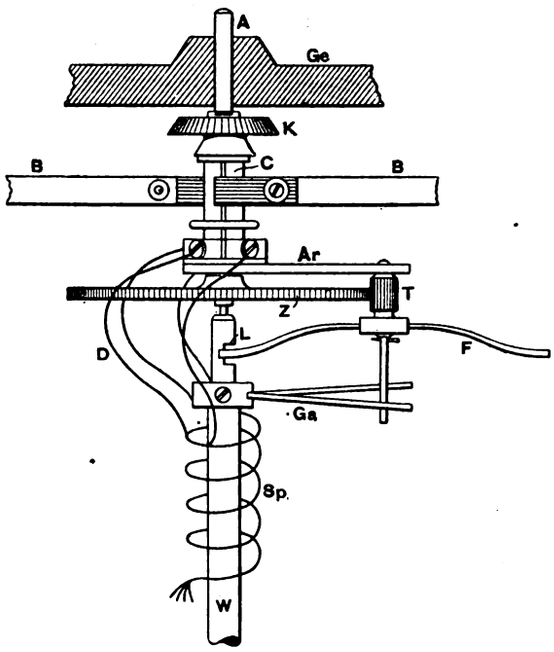
The resolution was carried unanimously.

A hearty vote of thanks was given to the authors of the three Papers, and the meeting adjourned.

THE HIECKE METER.

In a Paper recently read before the Electrotechnical Society of Vienna, Dr. R. Hiecke described a meter designed on a new and most ingenious principle. The instrument is a motor meter, but the object aimed at is to make it perfectly independent of the varying friction of the brushes and the counting train. This is accomplished by using an independent source of energy, viz., an electrically-wound clockwork, to drive the commutator and the counting train, while the latter is yet absolutely controlled by the motor part of the instrument.

In the figure a shaft A is fixed to the frame *Ge* of the instrument. This carries a toothed wheel Z at its lower end, and also the pivot on which the upper end of the armature spindle W revolves. On the former shaft a sleeve is placed, which can rotate easily, and to which is fixed, at its upper end, a bevel wheel K, at its lower end an arm *Ar*, and between the two an insulated four-part commutator C. The brushes B rest on the commutator C. The bevel wheel K serves equally to connect the clockwork with the sleeve, and the sleeve with the counting train. The arm *Ar* carries the axis of a pinion T, the latter gearing in the wheel Z, and being provided with two arms F F. The length of these arms is



such that the pinion cannot turn until the slot L in the armature spindle comes round. The commutator is connected to the armature windings by means of four wires D, which form the continuation of a very flexible spiral *Sp* of four fine wires. *Ga* is a fork fixed on to the armature spindle, surrounding the extension of the pinion spindle, and preventing the armature from turning too far in relation to the commutator when the instrument is being moved.

When the meter is in action, the armature begins to turn. As soon as the slot L reaches the proper position, the arm F is released, and the pinion T makes a half revolution. This causes the arm *Ar*, and with it the commutator, to move $\frac{1}{20}$th of a turn forward. In the meanwhile, the armature continues to turn, being influenced by the current through the meter in the usual way, and when it has moved $\frac{1}{20}$th of a turn onwards, the second arm F is released and the arm *Ar* is allowed to make another $\frac{1}{20}$th revolution, and, so on; the sleeve connected with the counting mechanism turning the same amount as the armature, but yet being driven independently.

Dr. Hiecke states in his Paper that he has succeeded in producing a meter, in other respects identical with the Thomson meter, of such a sensibility that it would start at 1 per cent. of full load, while the mean inaccuracies of the readings at one-tenth, one-half and full load could be made less than 1 per cent. of the latter. The brushes can be made to bear firmly on the commutator, and neither brushes nor commutator need be made of noble metals.

LONDON COUNTY COUNCIL.

THE QUESTION OF COMPETITION.

At Tuesday's meeting, the Highways Committee of the Council submitted a report dealing with the twelve applications for electric lighting provisional orders presented by the Vestries of Bermondsey, Bethnal Green, Kensington and Plumstead; the Lewisham District Board; the County of London and Brush Provincial Co. (for Battersea and Fulham, County of London, east, and County of London, south-east); the Blackheath and Greenwich District Co.; the Charing Cross and Strand Corporation (for City of London); the Smithfield Markets Co. (for City of London, St. Luke's and Holborn); and the Metropolitan Electric Supply Co. (for City of London). The report stated that clauses as to the transfer of powers under these orders had been omitted in the applications made by the Vestries of Bermondsey and Kensington, but were inserted in the applications of Bethnal Green, Plumstead and Lewisham. The Committee recommended that the Board of Trade should be asked to strike out the provisions authorising the transfer of the undertaking. With regard to the price to be charged for current, the Committee recommend that the initial price should be 6d. per unit; and with reference to the system of supply, it would be advisable (except with the express sanction of the Board of Trade) that this should be by continuous current. The Committee further recommended that the Board of Trade should be asked to insert in each of the orders a special clause for the protection of the Council's interests as regards tramways already purchased or hereafter to be acquired or constructed by the Council, so as to provide that the electric light mains and works should not be placed in such position in the public thoroughfares as, in the event of the Council adopting some system of electric traction, would necessitate the removal of the mains. Earl Russell had undertaken to confer with the Board with a view to changing its attitude, if possible, on this matter. The Camberwell Order, 1896, contained a clause providing that at any time during the first 21 years after the granting of the order the local authority may purchase the undertaking upon payment of one and a-third times the capital outlay of the undertakers, plus the sum necessary to make the dividends up to an average of 5 per cent. from the commencement and after the twenty-first year upon the same terms, but without the condition as to the 5 per cent. dividend, or, as an alternative, on the payment of the "then value," plus an allowance for goodwill. The Highways Committee considered this clause should be inserted in orders granted to companies, and suggested the option of purchase may be exercised at the end of every period of *seven* instead of ten years after the expiration of the first statutory period of 42 years from the date fixed by the order. A very important question of principle had been raised with regard to several of the orders applied for, viz., whether, when an order had been granted to a company, and the company had carried out works in a district, the local authority should subsequently be granted an order which would enable it to establish competition with the company. The Committee considered it desirable that the Council should express a definite opinion as to what principle should be adopted on this point in dealing with the applications, and recommended—

"That the Board of Trade be informed that, having regard to the provision in the Electric Lighting Act, 1888, that the grant of authority to undertakers to supply electricity within any area 'shall not in any way hinder or restrict the granting of a provisional order to the local authority,' the Council is of opinion that the applications of local authorities for orders in respect of their districts, with regard to which orders have already been granted to companies, should be acceded to; that course having been taken by the Board last year, and approved by the vote of the House of Commons on 14th June, 1898, on the second reading of the Electric Lighting Provisional Orders (No. 12) Bill."

Another important question was sure to arise upon the applications which had been made by companies for orders in respect of areas for which the local authorities had already obtained them. This was a matter of even greater importance than that above referred to, as it involved the question of principle whether, when public money had been used for the establishment of the supply of electricity within a district, a company should be allowed to establish a competing supply. This phase of the matter did not seem to have been dealt with by the Act, as in the reverse case; and the Committee consider it one upon which the Council should come to some decision as to what course it would adopt. The policy of allowing competition between two companies in the same area had from the first been advocated by the Council and adopted by the Board of Trade in dealing with applications for orders; but the question of allowing a company or companies to compete with a local authority in its own area had not arisen in previous years. The Committee proposed to report further upon this matter at a later date, but thought that in the meantime the proposals of the companies should be opposed, as, if an understanding should be come to eventually, the Council's opposition could be withdrawn or modified.

The report deals in detail with the Bills before the Committee and recommended various amendments in accordance with the views set forth with respect to the Bermondsey, Bethnal Green, Plumstead, Kensington, Blackheath and Greenwich District (Extension) and City of London order. With regard to the other applications, the following recommendations were made:—"(*a*) That it be suggested to the Board of Trade that as the local authorities of Battersea, Fulham, Stoke Newington, Hackney, Poplar and Whitechapel have each been granted electric lighting orders for their respective districts, and the Vestry of Bethnal Green is applying this year for an order in respect of that parish, the application of the County of London and Brush Provincial Electric Lighting Co. for (*a*) the Battersea and Fulham, and (*b*) the County of London (East) Electric Lighting Orders should not be entertained; but that should the Board for any special reason decide to allow the company's orders to proceed, as

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regards all or any part of the areas referred to therein, the Council may have a further opportunity of submitting amendments.

"(*b*) That it be suggested to the Board of Trade that, having regard to the fact that the Vestry of Bermondsey and the Lewisham District Board are each applying this year for an order as regards their respective districts, and also to the fact that the greater part of the other areas included in the County of London (South-East) Order applied for by the County of London and Brush Provincial Electric Lighting Co., is already included in orders granted to other companies, and some of the local authorities of those areas are opposed to the granting of the order, the application of the company should not be entertained; but that should the Board for any special reason decide to allow the company's order to proceed as regards all or any part of the areas referred to therein, the Council may have a further opportunity of submitting amendments.

"(*c*) That it be suggested to the Board of Trade that the parish of St. Luke, Middlesex, and the Holborn district should be excluded from the area of supply under the City of London, St. Luke, Middlesex, and Holborn Electric Lighting Order applied for by the Smithfield Markets Electric Lighting Co., if granted; that the order so limited shall, if granted, be made to conform with the orders granted in respect of the City of London in 1890 and 1891, with an additional provision that a map of the area of supply under the order shall be furnished to the Council; but that, should the Board of Trade decide not to exclude those areas, the Council may have further opportunity of submitting amendments, having regard to the fact that the order, if granted in its present form, would not as regards those areas be in conformity with the existing orders applicable to areas outside the City of London."

Mr. Dobson thought that all local authorities should be free to make what arrangement they liked with companies. Mr. Westacott said the Council would leave the local authorities perfectly free. The report and recommendations were agreed to.

The Council granted a loan of £10,000 to the Newington Vestry for electric lighting purposes.

The Main Drainage Committee reported that Messrs. J. H. Pickup and Co. (Limited), whose tender was accepted last July for the supply and erection of the wiring, lamps and fittings required for the electric light installation at the Crossness outfall, had proposed an arrangement with their creditors, and their business had been placed in the hands of a receiver. A considerable amount of work had already been done under the contract; but, as it was important that the wiring, &c., should be finished in time for the completion of the work to be done under the contract for the engines and dynamos, they had authorised the engineer to retain the services of the foreman engaged by the late contractors, and to employ the necessary labour for proceeding with the work with as little delay as possible.

Mr. Parker has placed the following motion on the agenda:—

"That it be referred to the Rivers Committee to consider as to instructing the engineer and an expert to report upon the desirability of constructing water-wheels or the fixing of floating turbines at the various bridges, or the making of reservoirs, and generally upon the best method of utilising the tides on the river Thames for the purpose of motive power adaptable to the generation of electricity."

LEGAL INTELLIGENCE.

The Lord Mayor, Corporation, &c., of London, v. City of London Electric Lighting Co. (Limited).

On Wednesday Mr. Justice Kekewich, in the Chancery Division, heard an adjourned summons in this action. The matter came before the Court on three agreements relating to the supply of electric light to the City of London, and made between the Brush Electrical Engineering Co. (Limited) and the Commissioners of Sewers; the Laing, Wharton and Down Construction Syndicate (Limited) and the Commissioners of Sewers; and between the Brush Electrical Engineering Co. (Limited) and the Commissioners of Sewers. A number of questions were put to the Court as follows:—

1. Whether or not the Corporation of the City of London were entitled to have the public and private lighting of the City carried out by separate mains and separate generating plant both in the main thoroughfares and in the side streets, courts, lanes, &c.

2. Whether or not, for the purpose of public lighting, the Corporation are entitled to a continuous current of electricity, both in the main thoroughfares and in the side streets, &c.

3. Whether, under Clause 13 of the contracts, the engineer of the Corporation was entitled at any time to determine the position of all or any of the electric lamps, either in the main thoroughfares or in the side streets, courts, &c., and whether or not the contractors were forthwith bound to fix lamps in the determined positions.

4. Whether or not, under Clause 15 of the contracts, the Corporation were entitled, when once glow lamps had been fixed in the side streets, &c., to order all the glow lamps to be replaced by arc lamps, and whether or not the contractors were bound to carry out such alteration.

5. Whether or not, under Clauses 15 and 16 of the contracts, the only cost which the Corporation can be called upon to pay in respect of replacing the glow lamps by arc lamps in the side streets, &c., was the cost of removing the old lamps and fixing the new lamps, and whether or not in the event of the glow lamps being changed for arc lamps the contractors were bound at their own cost to supply the necessary plant for machinery and arc lamps for lighting the side streets, &c., by arc lamps.

6. Whether or not, provided the total consumption of electricity in side streets, &c., when lighted by arc lamps in pursuance of alterations made under Clause 15 of the agreements, does not exceed the total consumption of electricity provided for in the contracts when side streets, &c., were lighted by glow lamps, the contractors were entitled to any further payment for lighting and maintenance by arc lamps than they would be for lighting and maintenance by glow lamps.

7. Whether or not under the terms of the contracts the Corporation are bound to light side streets, &c., with electricity, and whether or not the engineer to the Corporation is not entitled under Clause 34 of the contracts to certify that the public lighting has been completed as soon as the electric lighting of the main thoroughfare has been completed.

8. Whether or not in the event of the lamps ordered to be erected by the Corporation not being either 100 watt lamps or 200 watt lamps, as set out in Clause 8 of the contracts, but 250 watt lamps or lamps of any other specified power, the price to be paid by the Corporation is proportional to the watts used upon the scale set out in Clause 8 of the contracts.

Mr. WARRINGTON, Q.C. (who appeared with Mr. Fletcher Moulton, Q.C., and Mr. A. J. Walter), for the plaintiffs, said that the question which his lordship had to determine were questions of construction, arising on three separate contracts which were *verbatim* the same, and made between the Commissioners of Sewers and the companies mentioned. The benefit of those contracts and the burden of them had, with the consent of the Corporation, become vested in the defendants, the City of London Electric Lighting Co. (Limited), and on the other hand, the interest of the Commissioners of Sewers under those contracts had become vested in the Corporation of the City of London, and, therefore, the parties which his lordship had now before him was the Corporation of the City of London on the one hand and the City of London Electric Lighting Co. on the other. The most important question his lordship had to determine was that set out in No. 1 of the above list. That question was of great importance, both to the Corporation and to the contractors, mainly for the reason that the contracts provided for the purchase by the Corporation of two undertakings, and the terms of purchase in the one case were different from the terms of purchase in the other, and, therefore, if the contractors were at liberty to mix the two systems up together, and to carry them on conjointly, there would be a great difficulty of exercising that option of purchase. The second question raised was also one of considerable importance. His lordship would see that the contracts provided for the lighting of the main thoroughfares by arc lamps and the lighting of the side streets by glow lamps. The Corporation had certain powers of alteration under the contracts, and the main question for his lordship on this part of the case was whether or not under their powers the Corporation could require the contractors to substitute arc lamps, either the same or of lesser amperage than those provided for by the contract, for the glow lamps in the side streets, and if they were entitled to direct that alteration, then on what terms as to payment, costs and expenses they were entitled to require that change. An extremely important question, which arose out of the second, was as to the rate at which the Corporation were to pay for the altered lights. It was proposed that if the Corporation could do so, that in lieu of glow lamps there should be substituted, in the side streets, arc lamps of 5 amperes. The arc lamps in the main streets were of 10 amperes. The question was at what rate the 5 ampere lamps were to be paid for. Those points his lordship would have to determine.

His LORDSHIP: They are quite distinct apparently.

Mr. WARRINGTON: Yes. There were two other questions which were, perhaps, of somewhat less importance. The first was as to whether the Corporation were entitled to require the contractors to continue a continuous current which had been supplied since the contracts had been entered into, or whether the contractors were entitled under the contract to substitute for that continuous current an alternating current, the difference being that the continuous current gave better results for street lighting where it was desired to get as much light below the lamp as possible. The other matters raised in the action were of minor importance. His submission was that the form of the agreement on the first question before his lordship showed that the parties were dealing both with a public system and a private system, and that the whole construction of the agreement was consistent with the view of the Corporation, and inconsistent with any other view.

Mr. CRIPPS, Q.C., having been heard on this point for defendants, his Lordship answered the first question in the negative.

His Lordship was then addressed by the learned counsel on the other questions, and answered question No. 2 in the negative, and questions 3, 4 and 5 in the affirmative. Question 6 was struck out. No. 7 was answered as to the first part in the affirmative, and as to the last part in the negative. No. 8 was answered in the negative.

Each party was ordered to pay their own costs.

"The Great Gold Medal (Gilded)."—The "Parisian Academy of Inventors" is still in evidence with its "great gold medal (gilded)," which it confers on miscellaneous inventors whose names appear in the Patent Office. A correspondent sends us a circular he has received from this quarter, in which it is stated that "this honourable title will be of no expense to you, but if you are desirous to receive the medal and diploma you would have to send us a Post money order of £2 sterling." This reminds us of the youthful student who, on hearing from a public examination board that he had been awarded a bronze medal, wrote to ask whether it would be struck in gold if he forwarded the necessary cost of that noble metal.

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TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London :—

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"PRIMARY BATTERIES: THEIR CONSTRUCTION AND USE."—By W. R. Cooper.

"PRACTICAL TELEPHONY."—By Dane Sinclair and F. C. Raphael.

"'THE ELECTRICIAN' WIREMAN'S POCKET-BOOK."

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The "Big Blue Book" for 1899 is NOW READY. The Directory Division has been corrected up to Feb. 8, 1899, and all the latest new names, changes of address, &c., will be found included. The Handbook Division has been much extended, many valuable tables having been added. The volume will contain, also, the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways, finally corrected to Feb. 9, 1899. The price of the Directory and Handbook remains the same—10s., post free 10s. 9d.; abroad, post free, 12s. (United States 13s. 6d.)

TENDERS INVITED.

As announced in an advertisement, the Magistrates and Council of *Edinburgh* invite tenders for the supply of condensing plant, with water-cooling tower, feed-water tanks and filters, for their Macdonald-road electric lighting station. Specifications, &c, can be obtained from the resident electrical engineer (Mr. F. A. Newington), Dewar-place, Edinburgh. Specifications and drawings may be seen at, but not obtained from, the office of Prof. Alex. B. W. Kennedy, 17, Victoria-street, Westminster, London, S.W. Tenders must be delivered at the office of the Town Clerk (Mr. Thomas Hunter, W.S.), not later than Monday, March 6.

The *Edinburgh* Town Council also invite tenders for installing the electric light at Tollcross Tramway Power Station. Specifications from the office of the resident electrical engineer (Mr. F. A. Newington), and tenders must be sent in to the Town Clerk (Mr. Thomas Hunter, W.S.), by Monday, March 6. See advertisement.

The Lighting committee of the *Canterbury* Corporation require tenders for the supply and erection of :—(*a*) Boiler-house plant, (*b*) engine-house plant, (*c*) extension of switchboard, (*d*) extensions to mains. Further particulars are given in advertisement, and specifications, &c., may be obtained at the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, Westminster, London, S.W., after Thursday, 23rd inst. Tenders must be addressed to the town clerk (Mr. Henry Fielding), by Tuesday, March 14.

The Electricity committee of the *Huddersfield* Corporation invite tenders for mechanical coking stokers. Specifications may be obtained from the borough electrical engineer (Mr. A. B. Mountain). An advertisement gives further information, and tenders must be sent in to the town clerk (Mr. F. C. Lloyd), Town Hall, Huddersfield, by Monday, the 27th inst.

The *Huddersfield* Electricity committee are also prepared to receive tenders for a complete switchboard. Specifications may be obtained from the borough electrical engineer (Mr. A. B. Mountain) and tenders must be sent in to the town clerk (Mr. F. C. Lloyd) not later than Monday, the 27th inst. See advertisement.

As announced in an advertisement, the *Dundee* Gas Commissioners invite tenders for the supply and erection of four Lancashire boilers, two 450 H.P. steam engines and dynamos and one 700 H.P. steam engine and dynamo. Specifications, &c., can be obtained from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope Crescent-road, Dundee, and tenders must be sent to the town clerk (Sir Thos. Thornton), City Chambers, Dundee, not later than March 15.

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The Board of Police of *Greenock* invite tenders for the supply and erection of boiler house plant, overhead travelling crane and engine house plant. An advertisement contains further particulars, and copies of specifications can be obtained from the burgh electrical engineer (Mr. S. E. Fedden), Municipal Buildings, Greenock. Tenders must be lodged at the office of the town clerk (Mr. G. MacCulloch), Municipal Buildings, Greenock, by March 3.

The *Brighton* Corporation want a centrifugal oil separator. Drawings, &c., may be obtained from the engineer (Mr. Arthur Wright), Corporation Electricity Works, North-road, Brighton. See advertisement.

The Corporation of *Dublin* require tenders for the supply of glow lamps for working at 200 volts, the number required being 8,000 of varying candle powers. Copies of the specification can be obtained on application to the city engineer, City Hall, Dublin, and can be seen at, but not obtained from, the office of Prof. A. B. W. Kennedy, 17, Victoria-street, Westminster, London. Tenders to Mr. Henry Campbell, town clerk, City Hall, Dublin, not later than 10 a.m. of Friday, 24th inst.

The *Harwich* Corporation invite offers for the transfer of their provisional order. Tenders by May 17 to town clerk (Mr. A. J. H. Ward).

The Electricity Supply committee of the city of *Gloucester* require tenders for the supply of jet condensers and air pumps, cast-iron condensing water pipes, and steam, exhaust and feed pipes, &c. Tenders to Mr. Geo. Sheffield Blakeway, Guildhall, Gloucester, by 28th inst.

The Electric committee of the *Belfast* Corporation invite tenders for the supply and erection of water-tube boilers, two 12½ kilowatt dynamos and switchboard. Tenders to Sir Samuel Black by 10 a.m. 23rd inst.

The *Edinburgh* Town Council invite tenders for the supply of steam, exhaust, feed and drain pipes, feed pumps and tanks for their Macdonald-road electricity station. Tenders to Mr. Thomas Hunter, W.S., City Chambers, Edinburgh, by 27th inst.

The *Shoreditch* (London) Vestry require tenders for stores for one year from March 26th, including electric cables and sundries, engineers' stores, ironmongery, tools, wiring and fitting materials, &c. Tenders to Dr. H. Mansfield Robinson, Town Hall, Old-street, E.C., before 3 p.m. 28th inst.

The Tramways committee of the *Manchester* Corporation invite tenders for the supply of sample electric tramcars. Tenders by Monday, 20th inst.

The *Islington* (London) Vestry invite tenders for the supply of electrical and other stores. Tenders to clerk, Upper-street, N., by 24th inst.

The *Oldham* Corporation invite tenders for two boilers. Tenders to the Water Office, Oldham, by 28th inst.

The *Burton-on-Trent* Town Council require tenders for the extension of the electric light station buildings. Tenders to Town Clerk by 25th inst.

The *Lewes* Corporation invite offers for the erection of electricity supply works. Tenders to town clerk by noon March 24.

The *Bury* (Lancs.) Council invite tenders for supplying and erecting three electric motors at the sewage disposal works, and for wiring the works. Tenders for motors by 21st and for wiring by 22nd inst.

Tenders are required for electric lighting plant at the *Eccleshall Bierlow* Workhouse. Tenders to the clerk, The Edge, Sheffield, by 27th inst.

Mr. Consul Howard (on Jan. 20) notified the British Foreign Office that he was directed by H.E. the Governor of the State of *Pernambuco* (Brazil) to give public notice that on March 18 next tenders would be received at the Department for Industry, Pernambuco, for the construction of an electric tramway along the beach from that city to the city of Olinda. The successful contractor will enjoy exemption from state taxation for 30 years. Tenderers must deposit in the State treasury Rs.1,000,000. This notice is dated at Pernambuco Jan. 16, which leaves little time for tenders, except from those firms having representatives on the spot.

The municipal authorities of *Piedrahita* (Avila), Spain, invite tenders for the electric lighting of the town for 15 years. Tenders by 9th March.

The *French* Post and Telegraph authorities require tenders for the supply of 10,000 metres of iron pipes, 65mm. diameter, for pneumatic lines. Tenders to le Sous-Secretariat d'Etat des Posts et des Telegraphes, 103, Rue de Grenelle, Paris, by 28th inst.

Tenders are invited until the 24th inst. by the Provincial Government authorities at *Mons* for the equipment of an electric lighting station at Fleurus. Tenders to le Gouvernement Provincial.

The *Prussian* State Railway authorities (Erfurt) invite tenders for 118,800 arc lamp carbons. Tenders to die Königliche Eisenbahn Direction, Bahnhofstrasse 23, Erfurt, by 28th inst.

TENDERS RECEIVED AND ACCEPTED.

The Metropolitan Asylums Board have received the following tenders for the execution of the various works in connection with the proposed electric light installation at the Northern Hospital, Winchmore-hill, N., set out in *The Electrician* of Jan. 13 :—

1.—Switchboards, Booster, and Connections.

Cox-Walters (*accepted*)	£463 10 0	Veritys Ltd.	£634 10 6
Fuller-Wenström Elec. Mfg. Co.	690 15 0	General Electric Co.	482 10 0

Consulting engineers' estimate, £600.

2.—Battery.

		*Annual maintenance
Hart Accumulator Co. (*accepted*)	£318 12	£15 4
Electrical Power Storage Co.	457 0	39 10
Lithanode Electric Storage Co.	458 9	21 0
T. Scott Anderson	450 0	55 0
Epstein Accumulator Co.	420 18	37 10
Tudor Accumulator Co.	414 0	28 0
Chloride Elec. Storage Synd.	410 0	25 0
Laing, Wharton and Down	380 0	16 10
D. P. Battery Co.	370 10	55 10
Pritchetts and Gold	Informal.	—

* 5 years. Consulting engineers' estimate, £400.

3.—Electric Mains.

Callender's Cable & Construction Co. (*accepted*)	£773 1 6	Western Electric Co.	£964 12 6
T. Scott Anderson	1,363 0 0	Johnson & Phillips Electric Cable Works	925 0 0
Laing, Wharton & Down	1,110 10 0	Brit. Insulated Wire Co.	903 13 8

Consulting engineers' estimate, £1,100.

4.—Steam Exhaust, Feed and Drain Pipes.

R. Taylor and Sons (*accepted*)	£840	Babcock and Wilcox (Limited)	£927
G. Wailes and Co.	945	R. W. Blackwell and Co.	732

Consulting engineers' estimate, £400.

5.—Wiring and Fittings.

G. Weston and Co. (*accepted*)	£2,875	Wells and Co.	£3,081 0 0
H. G. Ellis and Co.	4,800	T. Scott Anderson	2,935 0 0
Drake and Gorham	3,900	Benham and Sons	2,902 11 8
Laing, Wharton and Down	3,727	R. Whipp and Co.	2,750 0 0
G. F. Ratcliff and Co.	3 373		

Consulting engineers' estimate, £2,850.

The following tenders have been accepted by the Bury St. Edmunds Town Council :—

Davy and Co. (boiler house plant)	£1,495
John Fowler and Co. (engine house plant)	5,793
Callender Co. (mains)	2,994
Grimwood and Sons (buildings)	3,470

The Westinghouse Electric and Manufacturing Company recently obtained a contract for the equipment of 14 cars of the ordinary trolley type for use in the city of Cairo.

The Electric Lighting committee of the Edinburgh Town Council have let tenders for the iron and steel work for the Macdonald-road electric lighting station, amounting to over £10,000. The successful tenderers were Messrs. Redpath, Brown and Co., and Arrol's Bridge Co.

The Londonderry Corporation have accepted the tender of G. Braulik for the supply of 13mm. arc lamp carbons. The tender of Messrs. Irving, Rogers and Co. for the supply of opalescent globes has been accepted at 4s. 8d. each.

The Commercial Cable Co. have accepted the tender of Mr. S. Hill, of Cork, for the erection of a cable station at Waterville, Co. Kerry, at £4,349.

The Beckenham District Council have accepted the tender of the British Insulated Wire Co. for the supply of cables. Particulars of the tenders appeared in our issue of 3rd inst.

The Southport Corporation have accepted the tender of Messrs. Musgrave and Sons for the supply of condensers, steam piping, &c., for the new engine at the electricity station at £566. 1s. The tender of Messrs. Dorman and Smith for the supply of two switchboards has also been accepted.

APPOINTMENTS VACANT AND FILLED.

The Technical Instruction committee of the city of Manchester require a superintending engineer to supervise the arrangements of the engineering equipment of the new technical school in course of erection. Applications to the director and secretary (Mr. J. H. Reynolds), not later than Wednesday, 22nd inst. See advertisement.

The Hull Corporation require a traffic manager for their tramways. Salary £300 per annum. Applications to town clerk by 24th inst.

The Leyton Urban District Council are prepared to receive applications for the appointment of chief electrical engineer, Commencing salary £250 per annum, rising to £400. Applications have to be sent in by 20th inst.

The British Postmaster-General has been invited by the Secretary of State for the Colonies to recommend a duly qualified officer to fill the post of assistant superintendent of telegraphs at Ceylon, where the vacancy in the post of superintendent was caused by the resignation of Mr. E. O. Walker, whose place has been filled by the selection of Mr. Drogo Montagu. Salary and all further particulars are given in the "Post Office Circular."

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Mr. William Alan Fraser, chief assistant at the Edinburgh Electricity Supply Works, has been elected borough electrical engineer at Lancaster, in succession to Mr. C. M. Johnston, who was recently appointed borough electrical engineer at Shrewsbury. The salary is £200 per annum.

Mr. R. W. L. Phillips has been appointed chief assistant engineer at the Bristol Corporation electricity works at a salary of £200 per annum.

Mr. A. S. Black, of Derby, has been appointed mains superintendent at Southport, in the place of Mr. Tessier, resigned.

BUSINESS NOTICES.

Mr. J. C. Chapman, chartered patent agent, 70, Chancery-lane, London, W.C., notifies that he has taken into partnership Mr, H. Allen Pryor, who has been with the firm for the past 12 years. The firm now takes the name of J. C. Chapman and Co.

Messrs. G. F. G. Des Vignes and W. A. Cloud, electric yacht and motor car builders, &c., Strand-on-the-Green, Chiswick (trading as Des Vignes, Cloud and Co.), have dissolved partnership. Debts by Mr. Cloud, who continues.

BANKRUPTCIES, LIQUIDATIONS, &c.

Alfred Haywood, described as a company promoter, was examined at the London Bankruptcy Court last week. Debtor attributed his failure partly to inability to obtain commission due to him in connection with the sale of the Madeira electric light concession.

The adjourned public examination of Thomas King, electrician, of Maidstone, took place last week. The debtor was closely examined as to various transactions, but eventually the examination was concluded and the debtor allowed to pass.

The discharge in bankruptcy of W. R. Smith, electrical engineer, St. Andries, Hitherfield-road, Streatham, London, S.W., has been suspended for three years.

Thomas Ford (trading as Thos. Ford and Co.), electric fittings manufacturers, &c., The Retreat, Selly Park, and Emily-street, Highgate, Birmingham, has been adjudicated a bankrupt. The first meeting of creditors was held on Friday, at Birmingham. The statement of affairs showed liabilities £5,653. 18s. 10d., available assets £460. Debtor commenced business in 1870 as a chandelier manufacturer, with about £700. The business was successful, and in 1873 he built the Victoria Works, Emily-street, at a cost of £2,600. In 1884 the works were extended and improved with capital introduced by a partner, Mr. Lowe. The partnership was dissolved in 1887, Mr. Lowe receiving £4,000. This withdrawal proved disastrous. About this time debtor was doing a considerable foreign business, but lost considerably by bad debts. In 1891 he commenced the manufacture of electrical fittings. In 1896 he had to apply to money lenders for assistance, and since then had considerable difficulty in carrying on, owing to want of capital. Debtor attributes his insolvency to bad debts, law charges, heavy interest, &c. It was stated that debtor's friends were desirous of buying up the assets, and an informal meeting of creditors had agreed to accept £600.

Sale of Modern Plant and Tools.—Particulars will be found in an advertisement on another page of the sale by auction, on Tuesday and Wednesday next, Feb. 21 and 22, at 11 o'clock each day, of a collection of nearly new engineers' tools, which will be disposed of by Messrs. Fuller, Horsey, Sons and Cassell (of 11, Billiter-square, London, E.C.), on the premises, Bravington-road, Paddington, London, W. Included in this sale also is a small collection of modern engineers' tools, consisting of surfacing and cutting lathe, treddle lathes, drilling machine, horizontal planing machine, gas engine, &c. Copies of the catalogue can be obtained from the auctioneers, and from Mr. S. H. M. Killik, 3, Gracechurch-street, London, E C.

Plant for Sale.—Mr. A. J. Mather, Bowling Iron Works, Bradford, has for disposal a complete electric welding plant. See advertisement.

Sale of a Valuable Collection of Electrical Books and Publications.—Messrs. H. H. Hodgson and Co. will sell by auction at their rooms, 115, Chancery-lane, London, W.C., on Wednesday, Feb. 22, and the two following days, at one o'clock, a valuable library of electrical and engineering books and publications, some particulars of which are set out in an advertisement on another page. The sale is likely to prove an interesting one, and should bring together a large audience of technical book buyers. Catalogues can be obtained of the auctioneers.

"Practical Methods of Calculation."—Prof. John Perry, F.R.S., will commence a course of lectures to working men in the Lecture Theatre of the Museum of Practical Geology, Jermyn-street, London, W., on Monday, Feb. 20, and the lectures will be continued on Feb. 27 and March 6, 13, 20 and 27. Further interesting particulars will be found in an advertisement on another page.

Crompton Plant and Apparatus.—A well-illustrated circular of Crompton domestic apparatus, arc lamps, motors, &c., is just issued and can be obtained on application.

Stage Arc Lamps.—A useful list of arc lamps for stage and yacht projectors, optical lanterns, photographic and scientific work, &c., for direct or alternating circuits, is issued by Messrs. Beaumont and Co., of York.

Tubes and Fittings List, &c.—Messrs. John Spencer (Limited), of Wednesbury, have issued a new price list of a large variety of iron and steel tubes and fittings for all classes of work for which these goods are used. The list is in handy form and is fully illustrated.

"Taunton" Dynamos and Motors.—A well illustrated price list is to hand from the Newton Electrical Works (Limited), of Taunton, illustrating a number of "Taunton" dynamos and motors of various sizes. There are also shown types of electric haulage plant and plating or depositing machines, motor-starting switches, &c.

Catalogue.—We, last week, referred in detail to some of the manufactures of Messrs. Williamson and Joseph, of Northampton Works, Canonbury, and we have now to acknowledge the receipt of this firm's catalogue, which fully illustrates the special class of goods manufactured at the new works.

Siemens and Halske's Manufactures.—We have received from Messrs. Siemens and Halske (Berlin) a set of 51 sheets containing illustrations and textual matter dealing with a large variety of this company's manufactures, and covering examples of almost every variety of electrical plant and apparatus. The sheets comprise 51 insert supplements which have appeared in the German electrical journals during 1898, so that some of the sheets may be familiar to our readers. The group serves to show in a graphic manner the magnitude of the company's operations, and the variety of applications to which the Siemens and Halske plant and material is put. Electric plant for driving industrial machinery is a prominent feature.

Shades, Shade Carriers and Holder Covers.—Messrs. E. Duckenfield and Son, of Northampton, are introducing a new shade and cap for incandescent electric lamps, and a new device for attaching shades, globes, &c., to the holders of electric lamps. These covers and shades are made in colours to match the surroundings in body and frills. A demand will no doubt arise for the "Little Dainty" shade.

The "Engineering Magazine."—The contents of the February issue of this magazine include the "The Exploitation of Electric Tramways in Porto Rico," by A. M. Lluveras; "America and Germany as Export Competitors and Customers," by Louis J. Magee; "Depreciation of Plant and its Relation to General Expense," "The Tall Building under the Test of Fire," "Machine Shop Management in Europe and America," "The Development of Wood-Working Machinery," "Readings from Experience in Naval Engineering," "The American Isthmus and the Interocean Canal," "The Mineral Resources of the Island of Cuba," and "Fast Runs on the Northern Railway of France." The issue also contains the customary Review of the World's Technical Press. Copies of this number may be had at the office of *The Electrician*, 1, 2 and 3, Salisbury-court, Fleet-street, London, E.C.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Feb. 8 to Feb. 14, with the ports of destination:—

Argentina—Buenos Ayres, £713 (including £683 telegraph material). *Australasia*—Adelaide, £575; Auckland, £143; Brisbane, £23; Canterbury, £200; Melbourne, £472 (telegraph material); Perth, £2,724; Rockhampton, £39; Sydney, £1,168 (including £867 telegraph cable); Wellington, £88. *Belgium*—Antwerp, £490. *Brazil*—Rio Janeiro, £932 (including £867 telegraph material). *Canada*—Toronto, £8. *Ceylon*—Colombo, £76. *Chili*—Valparaiso, £20 (telegraph material). *China*—Shanghai, £14. *Colombia* (Republic of)—Santos, £25 (telegraph material). *Denmark*—Copenhagen, £297. *Egypt*—Alexandria, £162. *France*—Boulogne, £82. *Germany*—Hamburg, £140. *Holland*—Amsterdam, £340; Rotterdam, £12 (telegraph material). *India*—Calcutta, £308. *Japan*—Yokohama, £765. *Norway*—Christiania, £22. *South Africa*—Cape Town, £72; Durban, £692; East London, £78; Port Elizabeth, £345. *Spain*—Malaga, £25. *Straits Settlements*—Singapore, £312. *Sweden*—Stockholm, £110. Total £11,472, against £13,095 in the corresponding week last year (Feb. 9 to Feb. 15).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Acton.—The Council have received an offer from the London United Tramways, Ltd., to supply electric current for lighting and power purposes in the district. This offer will be considered in conjunction with a proposal to take current from the Metropolitan Co.

American Export Trade.—A Pittsburg firm of electric street car builders and equippers has recently received an order for the equipment of 50 street railway cars for Hanover, Germany. The order includes motors and controllers.

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Asylum Lighting.—The London Common Council are introducing the electric light at the City of London Lunatic Asylum, Stone, Dartford.

Barnsley.—The Worsbro' District Council has agreed to join the Barnsley Town Council in opposing the electric tramway proposals of the British Electric Traction Co., but if no definite progress be made by the Town Council towards the construction of tramways between Barnsley and Worsbro' within the next few months, the Worsbro' Council reserves to itself full liberty of action.

Bath.—The Council have received another proposal for the construction of electric tramways, but are recommended not to permit the construction of electric tramways except under the direct control of the Council.

Birmingham.—A report by the Public Works committee on the present position of the tramways question has been published and will be considered by the Council on March 7. The report advises the municipalisation of the tramways, but no recommendation is made as to the system of traction to be adopted.

Blackburn.—Satisfactory trials of a tramcar over the new electric tramway route took place last week.

Blackpool.—The General Purposes committee recommend that the borough electrical engineer (Mr. Robert C. Quin) be allowed to devote two days a month to consulting practice.

Bradford.—An inquiry has been held here into the application of the Council to borrow £20,000 for electric lighting extensions. There was no opposition.

The directors of the St. George's Hall Company have decided to adopt electric lighting.

Bristol.—In 1895, the Council were authorised to borrow £75,000 for extensions of the electricity works and buildings at Temple Back. These extensions have now been completed, and £3,148 expended on certain plant and buildings not provided for in the previous loan. It is necessary to put in still further plant, to meet next winter's demand, and also to provide for some minor extensions of the mains and the erection of new sub-stations. The Council have, therefore, decided to borrow a further £25,000 to be expended as follows: Additions to plant at central station, £8,860; additions to the external system, including mains and sub-stations, £4,450; customers' extensions, £8,542; additions not included in previous loan, £3,148; total, £25,000.

Canterbury.—Electric current for private lighting was available for the first time on the 8th inst.

Chester.—The Town Council on Wednesday authorised the extension of the electric light mains at an estimated cost of £2,300. The price of current will be reduced from 5d. to 4½d. per unit after March 25.

Chesterfield.—The Town Council have resolved to establish electricity supply works. Mr. W. Johnson, of Sheffield, has been asked if he is prepared, and on what terms, to advise the Council on a scheme and to act as consulting engineer, and the borough surveyor has been authorised to apply to Messrs. Siemens and Co. and the Westinghouse Company to give specifications and estimates for supplying and erecting plant.

Chichester.—The Council have empowered the Highways and Lighting committee to employ an expert to report generally upon one of the schemes for establishing electricity supply prepared by the surveyor.

Colwyn Bay.—The Council's consulting engineers have submitted a scheme for the electric lighting of the centre of the town estimated to cost £3,700.

Congo State Telegraphs.—The Budget of the Congo State for 1899 provides 520,000fr. for the telegraphs of the State.

Darwen.—It was announced at last week's meeting of the Council that the electric lighting works were making satisfactory progress, and that current would soon be available in the centre of the town for both public and private lighting.

Dewsbury.—Plans for extensions at the electric lighting works have been approved by the Corporation.

Dundee.—The harbour engineer is reporting upon the advisability of lighting the harbour electrically.

Electric Power Schemes.—A conference of about 40 district councils was held on Tuesday at Manchester, to consider the question of opposing the Lancashire Electric Power and the South Lancashire and Cheshire Electric Power bills. The Chairman of the Levenshulme Council (Mr. R. Burtles) moved that both bills be opposed. Mr. Goldbourne, of Turton, said there were districts to which the company might prove very useful by bringing to them the electric light, which otherwise they would not be able to get. He therefore counselled a milder course than the one indicated in the resolution, and moved: "That a committee be appointed to suggest amendments to the bill in the interest and for the protection of district councils, and to oppose the bill so far as may be necessary to carry out that object." He wanted the committee to amend, and not to oppose. The resolution was, however, carried by 32 votes against 15.

Egypt.—It is proposed to construct an electric tramway from Cairo to the Pyramids, and also to connect the latter city with Alexandria by means of an electric line as soon as possible.

Galashiels.—A proposal to establish electricity supply works in this town has been referred to the Works committee.

Garston (Lancs.).—The District Council have received a communication from the Board of Trade in reference to the proposal to transfer their provisional order to the British Insulated Wire Co. to the effect that, having regard to the circumstances under which the powers granted to the Liverpool District Electric Lighting Co. were revoked, any proposal the Council now made must receive the very special attention of the Board. The Special Purposes committee is to consider and report upon the position.

German East Africa.—Under the revised customs tariff all materials for tramways, railways and other means of transport, and accessories therefor, are admitted free into German East Africa, if intended for use in the colony.

Glasgow.—The Electricity committee have increased their offer for the purchase of the Kelvinside Electricity Co.'s undertaking to £30,000. The company offer to sell at £48,000.

Gosport.—The Council will shortly receive a report from the Electric Lighting committee upon the question of applying for a provisional order. Mr. Woodthorpe, a councillor, said the incandescent gas lighting adopted by the gas company was a complete failure and, in addition, the price of gas was very high.

Hove.—The Town Council, which is not remarkable for progressive tendencies, has resolved to adopt incandescent gas lighting. One member (Councillor Voysey) characterised the decision of the council as "an advance backwards." The neighbouring town of Brighton was, he said, illuminated electrically, and Worthing, Eastbourne and Hastings had also adopted electric lighting schemes, while Hove was "calmly and coolly talking of going back to gas." Nevertheless the retrograde report of the committee was adopted.

Huddersfield.—For the past year the balance of income over expenditure on the electric supply works was £2,437, and this sum is to be transferred to the depreciation and contingencies account to meet future expenditure. Ald. Calvert, in moving the Electricity committee's report, referred to the complaints made as to the high charges for current at Huddersfield, and said that of 15 towns of about the same size only four had lower charges, and three of these returned losses. The Huddersfield electrical undertaking had already been subsidised to the extent of between £5,000 and £6,000 out of the rates, and this ought to be considered before they reduced the charge for current. The committee believed that when their new plant was fixed and they were able to give a more satisfactory supply there would be more consumers, and the price would then be lowered. A proposal would be made to effect a reduction from July 1st next.

The Tramways committee reported that they had considered a report from the borough engineer on electric tramway construction and equipment, and recommended that the principle of the report be adopted, and also that immediate consideration be given to the advisability of converting the Lindley and Outlane section to electric traction. This was agreed to.

Ilfracombe.—Mr. W. H. Trentham has been appointed consulting electrical engineer to the Council.

Ingleton.—A public meeting was recently held for the purpose of discussing the lighting question, when the following resolution was unanimously adopted:—"That a company be formed, to be called the Ingleton Electric Lighting Co., with a capital of £2,500, in £1 shares, and that a working committee be formed to canvass the town and ascertain what share capital could be obtained."

Ipswich.—After consideration of the order being applied for by the local tramways company the Council are recommended to withhold consent and to authorise the Tramways committee to negotiate for the purchase of the lines. The company seek powers to construct tramways and equip the same electrically, and also to sell their undertaking to the Drake and Gorham Electric Power and Traction Co.

Kensington (London).—The Vestry have abandoned their application for a provisional order, and it has been decided to support by petition the bill of the Notting Hill Electric Lighting and the Kensington and Knightsbridge Electric Lighting Companies for the erection of a joint generating station.

Kingswood (Bristol).—A remarkable state of affairs has arisen in connection with the electric lighting arrangements of this district. The mortgagees entered into possession on Saturday last when the works were shut down. For some time past negotiations have been in progress for the purchase of the undertaking by the District Council, who conditionally offered £1,250. The electrical supply had been maintained in the hope of the Council taking over the property, but this expectation proving a vain one, matters came to a climax on Saturday, when possession was taken

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by the mortgagees of the generating station, and the engine fires were drawn. The lighting syndicate then issued the following notice:

"The Western Counties Electric Light and Power Syndicate (Limited) regret to have to announce that owing to the Kingswood Local Board having refused to carry out the agreement to purchase the installation which they had directed their clerk, by letter of Jan. 4, 1897, to enter into on their behalf, and which letter was ratified and confirmed by other letters from the clerk, and as the Local Board have intimated their decision to the mortgagees of the Syndicate, the consequence is that the mortgagees have entered into possession of the syndicate's property, with the result that from to-day no further light can be supplied.

"The syndicate consider it due to themselves to say that the delay in purchase has been caused through no fault of theirs, but in consequence of repeated requests by the Local Board for time to enable them to borrow the money in order to settle the purchase, which was at the price offered by the Board themselves, and was at about one-third of the original cost of the installation.

"The price having been fixed and the agreement to purchase having been entered into so long ago as January, 1897, the plant and light have naturally deteriorated, as the syndicate were expecting the purchase to be completed as soon as the Board had borrowed the money, and if it were known to the members of the Board that there was going to be delay or that they intended to repudiate their agreement, they should, in the interests of the locality, have made arrangements to save the inhabitants from inconvenience.

"It should be added that only one official complaint from the Board has ever been made to the syndicate as to deficiency of the power of the lamps, and upon that occasion the lamps were tested by the Board's surveyor and the syndicate's engineer and found in all cases to give more light than the syndicate had contracted to supply.

"It must be obvious that if the Board would only pay for 16 c.p. lamps the inhabitants could not expect lamps of greater lighting power.

"A writ has been issued against the Local Board for damage for breach of contract, and any responsibility for inconvenience, accident, damage, or loss to any inhabitant in consequence of the non-supply of light must rest upon the local authorities."

Leyton.—According to a report by the engineer (Mr. H. Collings Bishop) the capacity of the electricity station, when the present extensions are completed, will be 16,000 8 c.p. lights. There is already the equivalent of 14,692 lamps connected, the year's addition being 6,580. A scheme for the further extension of the buildings, machinery and plant is in preparation.

Light Railways.—The Colne Town Council is applying to the Light Railway Commissioners for an order to construct and work a network of light railways in the district.

The amended order of the Light Railway Commissioners for the construction of a light (electric) railway between Colwyn Bay and Llandudno is to be considered at a special meeting of the Colwyn Bay District Council.

An inquiry is to be held by the Light Railway Commissioners into the application to construct a light (electric) railway from Lye to Stourbridge, and also a line from High-street, Stourbridge, to Wollaston, to connect up the Kinver route.

The Light Railway Commissioners held an inquiry, on Wednesday, into the application of the Doncaster Corporation to construct electric tramways within and outside the borough. The Great Northern Railway Co. opposed, and the British Electric Traction Co., who are promoters of a rival scheme, were also represented. After hearing the evidence the commissioners intimated that they considered that the preamble had been proved, subject to the reservation with regard to the railway crossing being abandoned.

On Tuesday, at the Board of Trade offices, Sir Courtenay Boyle, assisted by Mr. F. J. Hopwood, Sir Thomas Blomfield and Lord Dudley heard the objections to the confirmation of the Order relating to the Liverpool and Prescot Light Railway. The light railway, which had been sanctioned by the Light Railway Commissioners, is 3½ miles long, extending from Prescot-road, West Derby, to Knowsley, and forms a junction there with the proposed extension of the St. Helens Corporation Tramways. After hearing objections, Sir Courtenay Boyle said the decision of the Board would be reserved.

The Light Railway Commissioners have intimated that they propose to recommend the Board of Trade to grant an order for the construction of a light (electric) railway between Leeds and Bradford. The inquiry into this application was heard some time ago, when objections were lodged by the Leeds and Bradford Corporations, either of which would readily construct the line, but cannot agree as to terms.

Lincoln.—A Local Government Board inquiry was held on Wednesday at Lincoln into the application of the Council to borrow an additional £19,000 for electric light extension purposes. The Deputy Town Clerk explained that sanction had already been obtained for the borrowing of £20,650 for the erection of electricity supply works. The plant put down, which had a capacity of 5,000 8 c.p. lights, was calculated to meet the requirements of the public demand likely to arise in the immediate future. The demand for the light had, however, reached an equivalent of 6,000 lamps within the area already cabled, and a further large increase within that area was certain to arise. The borough electrical engineer (Mr. C. S. Vesey Brown) gave technical details of the scheme to which there was no opposition.

London Underground Railways.—In the House of Commons yesterday, Mr. Ritchie, replying to Mr. R. G. Webster, said that the directors of the two underground railways in London had informed the Board of Trade in December last, that the necessary electrical plant and appliances for equipping a section of the lines for experimental electric work had been ordered, and he (Mr. Ritchie) trusted that this experiment might prove successful, and solve the question of efficient ventilation for these lines.

Maidstone.—Messrs. Kincaid, Waller and Manville have prepared an electric lighting and refuse destructor scheme for the Council. The scheme provides for the supply of current to an equivalent of 9,000 8 c.p. lamps and 24 arcs for public lighting. The total estimated cost is put at £36,349. The Maidstone order was obtained in 1893.

Margam (Glam.).—Plans and specifications of an electric lighting scheme were recently submitted to the District Council, and these were approved at a special meeting last week. The cost of the scheme is estimated at £6,500.

Morecambe—The Electric Lighting committee have reduced the price of current for lighting from 6d. to 5d. per unit, the reduction to take effect on 1st April.

Motor Cabs and Carriages.—Referring to remarks which have appeared in one of the London dailies on the subject of "new motors for London," Mr. W. C. Bersey, managing director of the London Electrical Cab Co., writes urging that no opinion should be expressed as to the virtues of the new motor until the vehicles equipped with it should have been worked and tried under the same conditions as the Electrical Cab Co.'s vehicles. Mr. Bersey adds:—

It may be of interest to your readers to know that since our cabs commenced running in August, 1897, they have, collectively, covered a distance of over 500,000 miles. No other motor carriage firm or company can show a record in any way approaching this, and until they can do so it is idle to make such comparisons. I note it is stated that the "new motors weigh 16 cwt., whereas an electric cab weighs two tons." The writer of the article has evidently been misinformed, as the weight of the London electrical cabs does not exceed 32 cwt. complete, and they are supplied with power sufficient to propel the cab 40 miles with each charge of the accumulators, at a speed of about nine miles per hour. It is perfectly easy, however, to construct a vehicle weighing only 16cwt., but such a vehicle would be absolutely useless for any business purpose. The weight of an ordinary horse brougham is about 12cwt., thus leaving only 4cwt. for the accumulators, motor, gearing and other mechanical parts, and in this case it would be impossible to obtain a run of more than seven or eight miles with each charge, or if a longer run is obtained (which means greater weight of accumulators) it must be at the expense of the strength and construction of the carriage and other mechanical parts, the result being that the vehicle would not stand the hard wear and tear of London work for a week.

Municipal Enterprise in Manchester.—At a meeting of the Manchester Association of Engineers the Lord Mayor of Manchester (Mr. W. H. Vaudry), replying to the toast of "Municipal Institutions," said that in Manchester they expected in 1901 to have an electric tramcar system, which would be superior to any system in the country. Other corporations were undertaking the same kind of work, but Manchester was more favourably situated than most of them, because of the fact that the leases ran out in 1901, and for 40 or 50 miles of tramcar system in Manchester they would have nothing to pay. He believed that the Corporation would be able to so conduct the system that it would prove an extremely profitable undertaking, and afford great relief to the rates of the city. Manchester had also dealt with the question of electric lighting. Liverpool had to pay a sum of, he believed, £200,000 for the goodwill of electric lighting works, but in Manchester they took up the Board of Trade order, and had no goodwill to pay for.

Municipal Trading.—The North Staffordshire Chamber of Commerce have decided to petition Parliament asking for the appointment of a Royal Commission to define the extent to which municipal trading in electric and gas fittings, &c., should be sanctioned by Parliament, and that in the meantime bills for the extension of municipal trading should be suspended until the commission reported.

Neyland (Glam.).—The Parish Council are considering a scheme for the electric lighting of the district, at an estimated cost of £1,000, the annual up-keep being put at about £90. 1,000 c.p. arcs are to be used.

New Works.—Operations have commenced with the erection of extensive works at Cledford Bridge, Middlewich, for the Electrolytic (Parent) Co., Limited.

Paisley.—The Electric Light committee have before them a scheme prepared by the borough electrical engineer (Mr. F. Teague) for the extension of the electric lighting plant. The proposed extensions are estimated to cost £8,750.

Plumstead (London).—After visiting the stations at Leyton, Shoreditch, St. Pancras and Brighton the Electric Supply Com-

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mittee have presented a report in which they make the following recommendations:—(*a*) That the Brighton installation be taken as the type for adoption at Plumstead; (*b*) That the installation be worked independently of a dust destructor, but, if a destructor be erected, any effective supply of steam produced be debited to the electricity department at an agreed price; (*c*) That the initial outlay be increased to £50,000; (*d*) That the Marsh site be adopted for the generating station. These recommendations have been adopted by the Vestry.

Plymouth.—The Town Council have had before them Mr. J. H. Rider's report on the electric lighting of the new markets. Mr. Rider's estimate of the cost of fitting up each section is about £100, or £300 for the whole of the market. The shops within the market would require two 16 c.p. incandescents in each single shop, and four in each double shop, a total of 46. The various market offices would require probably 30 lamps, the cost of which would be £30 to fix. The report so far as it relates to the lighting of the markets, as distinguished from the shops and offices has been adopted and tenders are to be invited for the work. Mr. Rider has also been requested to prepare plan and estimate for the electric lighting of the council chamber.

The Council have authorised the Tramways' committee to have estimates prepared of the cost of electrically equipping the Compton section of the tramways.

Portsmouth.—The Town Council will adopt the overhead trolley system on the local tramways as soon as they come into their possession.

Private Bill Legislation.—The General Power Distributing Co.'s Bill, which was passed through the House of Lords last session, and was suspended in the Commons, was read a first time in the Commons on Monday. Mr. Stuart Wortley has given notice of his intention to move in the House of Commons the rejection of the bill for supplying electricity in bulk in Sheffield and district. It is recognised that the decision of the House in connection with the General Power Co.'s bill will affect, one way or the other, the large number of bills seeking similar powers which are now awaiting parliamentary sanction.

Railway Station Lighting.—Carlisle station was lighted electrically for the first time on Thursday evening last. The platform and approaches are lighted by 67 arcs, each of 800 c.p., and there are between 500 and 600 incandescent lamps in the offices, refreshment-rooms, &c.

Reigate.—The Town Council have concluded their negotiations for the purchase of a site for an electricity generating station.

Rothesay.—The Harbour Trust and Town Council have adopted a scheme for the electric lighting of the harbour, esplanade, &c., estimated to cost £1,800. It is not at present intended to give a supply of current for private purposes. The lighting will probably be in operation in August.

St. Pancras (London).—The Vestry have sanctioned an expenditure of £634 for laying mains to supply consumers and arc lamps in Cumberland Market, and the Electricity committee have been authorised to obtain tenders for the wiring of the labour bureau.

St. Paul's Cathedral.—Once again the question of lighting St. Paul's Cathedral by electricity is being discussed, and it is announced that the authorities have now obtained the money required for the installation—about £5,000. If this is the only difficulty the wiring can be proceeded with, but we understand that there is a division of opinion as to the suitability of the building for electric light, and especially as to the disposition of the lights.

South African Customs Union.—A customs tariff, which came into operation on Jan. 3 last in the territories forming the South African customs union (Cape of Good Hope, Orange Free State, Natal, Basutoland and the Bechuanaland Protectorate), provides for the admission free of duty of materials and instruments for use in connection with the construction and working of telegraph and telephone mains, and tramway construction requisites, including permanent way.

Southport.—It is announced that the Council will be able to reduce the rates by ½d. in the pound out of the profits of the electricity department for the past year. The question of reducing the price of current is under consideration.

Stirling.—At a meeting of the police commissioners of the burgh last week the minutes of the Lighting committee were presented, recommending the acceptance of certain tenders for electric lighting plant, and that application should be made for sanction to borrow £30,000 for purposes of the scheme. The recommendations were adopted.

Stockton-on-Tees.—A Local Government Board inquiry will be held here on the 24th inst. into the application of the Town Council to borrow money for electric lighting purposes.

Swansea.—It is now proposed to apply for only £54,648 on loan for electric lighting purposes.

Taunton.—The accounts of the electricity department for the year ended Dec. 31 show a profit of £794. 11s. 9d. The salary of the borough electrical engineer (Mr. J. B. Thornhill) has been increased to £200 per annum. The charges for current are to be revised. In future the price will be 6d. per unit for the first hour's maximum demand and 4d. afterwards.

Trade Unionism.—Some strong comments on the methods of latter-day trades unionism were made by Sir W. H. Bailey at the meeting of the Manchester Association of Engineers last week, and these comments were endorsed in the remarks of Mr. S. R. Platt (Mather and Platt). Sir W. H. Bailey said that the despotic ruling in the labour world was crippling British industry. In America, where engineers were receiving 60s. per week, there was no limit to the use of the best inventions nor of the best intellect of man, whereas in this country engineers received 36s. per week, and placed every possible obstacle in the way of improved and increased output. Inventors who devise machinery that quadrupled the power of man saw their genius frustrated by the trade unionists, who stepped in and said that a man must do only "one-third of a day's labour for a full day's pay." Mr. S. R. Platt contended that this country possessed the foremost engineering talent in the world, but it was badly hampered by the trade unionists of the country. He feared that imperialism and municipalism were enemies to the engineering industry, as both representative bodies were prepared to give way to any demand that might be made by any little tinkering society calling itself a trades union. They allowed their employes to work the hours and receive the wages that the trade unionists demanded, and in that way became competitors of the private trader.

Train Lighting.—It is announced that three of the trains of the North Staffordshire Railway Co. were fitted up for the electric light during the past year, and two more are being so fitted.

Twickenham.—The District Council have resolved to apply for a provisional order. Edmundson's Electricity Corporation is also applying for an order for the district.

Underground Electric Railways.—At the half-yearly meeting of the Great Northern Railway Co. the Chairman (the Right Hon. W. L. Jackson, M.P.) said that the Directors had come to the conclusion that the only remedy to relieve suburban traffic was by the means of light underground trains worked by electricity, and a Bill dealing with the project was being promoted by people who had large interests in the Great Northern. A separate company would be formed.

U.S. Rubber Trust.—We recently announced that rumours were afloat that an extensive india rubber trust was to be formed in this country. It is now announced that a similar trust is about to be established in the United States under the title of the Mechanical Rubber Co., with a capital of $30,000,000. The combine includes the chief rubber manufacturing companies of the States.

Walsall.—There were 139 customers of the electricity department of the Corporation on the 31st ult. A loss of £279. 3s. 11d. is shown on last year's trading.

West Bromwich.—Mr. R. C. Quin has been appointed consulting electrical engineer to the Corporation.

Will.—The will of the late Dr. E. F. A. Obach, of 113, Victoria-road, Old Charlton, and Messrs. Siemens Bros. and Co., Woolwich, has been proved by Mr. Carl Obach, the brother and sole executor, the value of the estate being £12,192. 17s. 11d. After making various bequests, testator bequeaths to the Siemens Engineering Society his scientific technical library, upon condition that it shall be continued as the Obach library, and that a catalogue shall be sent to every member, and to the Berlin Botanical Museum his special library on india-rubber and gutta-percha, together with the samples of plants, patterns, &c. The residue of his property he leaves to his wife.

Woking.—The Woking Electric Supply Co. has been invited to state the terms upon which it would be willing to sell its undertaking to the Council.

Wolverhampton.—An inquiry was held here on Wednesday into the application of the Council to borrow £29,740 for electric lighting purposes. The town clerk explained that the loan was for carrying out extensions of the generating plant and mains. It was proposed to extend the mains along Tettenhall-road and into the Horseley Fields district. There would be two separate generating systems (alternating and continuous current) and the new scheme would facilitate the adoption of electric traction should the Corporation become the owners of the tramways in the borough. The new system would also effect a reduction in the cost of generation and distribution. Technical particulars of the scheme were given by the borough electrical engineer (Mr. C. E. Shawfield). There was no opposition.

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Electro Harmonic Society.—A "Ladies' Night" concert will be given at the St. James' Hall Restaurant, Regent-street, London, on Friday evening, Feb. 24, at eight o'clock.

Benefit Concert.—A well-known figure at the concerts of the Electro-Harmonic Society is Mons. J. Greebe, for 26 years a member of the Royal Italian Opera band. Mr. T. E. Gatehouse, to whose talent and popularity so much of the success of the Electro-Harmonic concerts is due, is organising a benefit concert for M. Greebe at the Myddleton Hall, Upper-street, Islington, London, N., on Tuesday evening, Feb. 28, at eight o'clock. Many of our readers have found pleasure in listening to Mr. Greebe's performances at St. James's Hall, and will, we are sure, be glad to know that tickets, 3s., 2s. and 1s. each, can be obtained from Mr. T. E. Gatehouse, 60, Gresham-road, Brixton, London, S.W., or from M. Greebe, 49, Melgund-road, Highbury, London, N.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application an asterisk is affixed.*

January 27, 1899.

1,865. A. ORLING and C. G. G. BRAUNERHJELM. London. Method of, and apparatus for, controlling the operating gears of rudders. signals and the like, by means of heat, light, or electrical waves, (Date applied for under Patents, &c., Act, 1883, Section 103, Oct. 26, 1898, being date of application in Sweden.)

1,866. A. ORLING and C. G. G. BRAUNERHJELM. London. An improved receiver for waves of light, heat, or electricity. (Date applied for under Patents, &c., Act, 1883, Section 103, Oct. 27, 1898, being date of application in Sweden.)

1,867. A. ORLING and C. G. G. BRAUNERHJELM. London. Improvements in apparatus for regulating the sensitivity of receivers for waves of light heat or electricity. (Date, &c., as in No. 1866.)

1,869. A. ORLING and C. G. G. BRAUNERHJELM. London. Improved electrical condenser and apparatus for producing powerful electric waves. (Date applied for under Patents, &c., Act, 1883, Section 103, Nov. 25, 1898, being date of application in Sweden.)

January 27, 1899.

1,895. R. M. MURRAY. Glasgow. Improved electric switch.

1,902. V. G. LIRONI. Manchester. Improvements in the manufacture of secondary battery plates.

1,920. J. WEBSTER. London. Improvements in electric arc lamps for stage and the like purposes.

1,941. H. HIRST and J. MURPHY. Improvements in incandescence electric lamp pendants or brackets.

1,960. J. G. LORRAIN. London. Improvements in electric railways of the sectional conductor type. (F. C. Esmond, United States.)

January 28, 1899.

1,978. V. G. LIRONI and O. MOON. Manchester. Improvements in electric glow lamp sockets or holders.

2,028. E. FRISCHAUER and A. O. SIMMONIER. London. An improved manufacture of carbons for electric arc lamps.

January 30, 1899.

2,044. J. HUTTON. Scarborough. A method of varying the electromotive force of, and consequently the current in, a circuit carrying an alternating current of electricity.

2,068. F. C. MELHADO. London. An improvement in conveying electric current to portable fittings for lighting or to motors and other electrical purposes.

2,074. C. ESCHWEI. London. An improved electric arc lamp.

2,104. J. HUNTER. Liverpool. Improvements in electrically-illuminated signs or advertisements.

January 31, 1899.

2,118. A. MUSKER. Liverpool. Improvements in or connected with the manufacture of electrical cable or conductor conduits.

2,130. B. THOMAS. Manchester. Improvements in safety devices for electro-magnetic circuits.

2,131. R. ACOCK. New Leeds. An improved means or apparatus for reducing or extinguishing the electric arc formed on breaking electrical circuits.

2,144. T. HEFFERNAN. London. Improvements in and relating to primary batteries.

2,165. L. FEIDLER and E. JÄCKEL. London. An improved cover for electrical cells.

2,166. L. FEIDLER and E. JÄCKEL. London. An elastic support for electrodes.

2,170. A. R. LEASK. London. Electric heating apparatus.

2,171. A. R. LEASK. London. Improvements in electric heaters.

2,174. SIEMENS BROS. AND CO. (LIMITED), and A. SIEMENS. London. An improvement in commutator brushes for electrical machines.*

2,175. SIEMENS BROS. AND CO. (LIMITED). London. Appliance for automatically regulating the frictional pressure on the rails of the driving wheels of electrically-propelled vehicles. (Siemens and Halske Aktien-Gesellschaft, Germany.)*

2,176. SIEMENS BROS. AND CO. (LIMITED). London. Safety appliances in connection with overhead or exposed conductors of electrical railways and tramways. (Siemens and Halske Aktien-Gesellschaft, Germany.)

2,177. SIEMENS BROS. AND CO. (LIMITED). London. Method of supplying electrical energy to motor vehicles from two overhead conductors. (Siemens and Halske Aktien-Gesellschaft, Germany.)

2,218. M. SCHMIDT. London. Improvements in electrical cut-outs.*

SPECIFICATIONS PUBLISHED.

NOTE.—**All Specifications can now be obtained at the uniform price of 8d. each.**

1897.

29,505. LODGE. Magnetic telegraphy and telephony.

1898.

835. ATKINSON. Single-phase and multiphase alternate current motors.

1,002. VOYSEY and WILSON. Electricity measuring instruments.

1,011. BOTT. Holders or sockets for electric incandescent lamps.

1,046. QUIN. Method and electro-magnetic cut-out for automatically disconnecting charged conductors in the event of breakage or short circuit, applicable to overhead systems of electric traction and the like.

1,564. WHIDBOURNE. Electric striking mechanism for clocks and the like.

2,423. MULLARD. Manufacture of filaments for incandescent electric lamps.

3,365. SINCLAIR and AITKEN. Telephone systems.

4,747. SIEMENS BROS. AND CO. (LIMITED) (Siemens and Halske Aktien-Gesellschaft). Means for counter-balancing the frictional resistance in alternating current motor meters.

5,034. BASTIAN. Electrolytic electrical meters.

5,065. BELFIELD. (Davis and Conrad). Arc lamps.

5,590. SKÖLD. Microphones.

5,705. PIEPER. Manufacture and production of electrodes for secondary batteries.

6,022. LAFARGUE and DROUET. Primary, voltaic or galvanic batteries.

6,025. SYKES. Draw and junction boxes for electric mains.

9,712. LODGE. Telephones and circuit arrangements and relays therefor.

18,557. CAPEWELL. Motor trucks for electric and other railways.

18,847. FULD. Electric batteries.

19,940. THE BRITISH THOMSON-HOUSTON CO. (LIMITED) (Hewlett). Circuit-breakers for three-wire electricity distribution systems.

20,532. BLACKWELL. Electrically-propelled vehicles.

22,079. THE BRITISH THOMSON-HOUSTON CO. (LIMITED) (Rohrer). Carbon brushes for dynamo-electric machines or motors.

22,130. HAYS (Heilmann). Electric railways and tramways on a section conductor system.

22,686. PITT. (The Elektrizitäts Aktien-Gesellschaft vormals Schuckert and Co.) Magnetic brakes.

22,959. GOLBY (de Constant). Telegraphic apparatus.

23,430. THOMPSON (von Zweigbergk). Electric controller mechanism primarily adapted for railway motors.

COMPANIES' MEETINGS AND REPORTS.

Westminster Electric Supply Corporation (Limited).

The ordinary general meeting of the shareholders of this Company was held on Wednesday at the offices, Eccleston-place, Belgravia, under the presidency of the Right Hon. Lord SUFFIELD, K.C.B.

The SECRETARY (Mr. Frank Iago) read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN then said: I have now to move the adoption of the report and accounts, and in doing so I am sure that it is not necessary for me to detain you by a long speech after the voluminous report you have already received. In fact, there is very little, if anything, to say beyond that which you have already had placed before you in the report; but if any proprietor wishes for information on any point whatever we shall be very happy on this side of the table to give all the information in our power. I think that you will consider it satisfactory that we have been enabled to maintain our position during the past year. You will notice that the applications for supply still continue, and during the year the equivalent of nearly 50,000 lamps of 8 c.p. were connected, being an increase of 8,000 over the advance of the previous year. I have no doubt that this must be satisfactory to all the proprietors, because it shows that we have held our own in a way that is, perhaps, astonishing; and it bears out the remark which I believe I made at our last general meeting that we had no reason to expect a decrease in the demand for supply. The late rise in the price of coal, combined with the coal strike, has alone made a difference to us in this one year of about £3,000—I believe more than that; and although I hope you will regard the dividend which we are about to declare as not unsatisfactory (that is to say, I do not know that the proprietors could have expected a larger distribution), yet if it had not been for certain difficulties, of which one was the coal strike, we should no

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doubt have been able to declare a higher dividend. That, however, was an accident which we could not possibly avoid. Like the other lighting companies, we have also found that the absence of fogs during the winter season has affected our revenue to a considerable extent, while the reduction from 6d. to 4d. per unit, after 4,000 units have been used for lighting in any one year, and to 3d. per unit for motor purposes, has also affected the Corporation in the same manner. I do not think I will detain you any further, but, as I said before, if any shareholder has any question to ask, we shall be very happy to answer. There are one or two points which I daresay you will require information upon, and, if so, we shall be glad to give it.

Mr. BOULNOIS, M.P., seconded the motion.

Mr. MAKINS said he thought that all the expenses seemed to be higher than they were last year.

Mr. S. JEFFRIES inquired whether any fresh capital was to be raised during the present year?

Mr. E. PYE SMITH REED asked the Chairman to give the shareholders any information he could with regard to the acquisition of the new site, and what it portended.

The CHAIRMAN: With regard to the increased expenses, I should have thought that it was hardly necessary for me to answer the question. The report and accounts will show the vast increase in our business; and it is, of course, impossible to conduct an enormous business, such as this is now, without a very large expenditure in the way of staff, and, indeed, all round. The Board of Directors over which I have the honour of presiding is and always has been most careful in regard to the question of expenses, and we look into every detail of the business once a week or fortnight; and I can assure you that we are conducting the Company as economically as we find it possible to do. It must be remembered that this is a very large business now, and that it increases weekly and monthly, and you must also expect the expenses to increase. With regard to the future, I can honestly say that the future prospects of this Company are very satisfactory. You see by the report that we have an enormous number of additional lamps on circuit as compared with the number last year. I see nothing whatever as regards the future to prevent the continued success of the Company, which, I am thankful to say, has the right to be considered throughout the area which we serve as generally very popular. We have enjoyed an extraordinary immunity from difficulties. I hear no complaints whatever with respect to our lighting, and the complaints would naturally be brought to us. There must be some accidents, but they arise principally through faulty installations. On enquiry we find that in 90 out of 100 cases the fault is not with regard to the supply, but is in connection with the installation, which has in some cases been put up indifferently. The future of the Company is, therefore, extremely bright. With reference to the raising of fresh capital, there is no need at present for any new capital. You know what our further powers are to raise additional capital if required, but we have no immediate necessity for further capital—beyond the £50,000 of debentures, of course. Mr. Reed put a question which I shall call upon Mr. Boulnois to answer, because he is connected with that matter.

Mr. BOULNOIS: As a representative of this Board at the Central Electric Supply Co. (one of the three who have been sent there from the Westminster) I will reply to Mr. Reed's question as to the position which we hold with respect to the Central Electric. Finding that we were unable to discover any suitable site for an extension of premises—which had, I may say, become absolutely necessary in consequence of our increased business in the area we supply (that is, in Westminster and adjoining parts)—we joined with the St. James's Company in a joint station outside our district of supply, in St. John's Wood. We had acquired a very eligible freehold site, consisting of about 2½ acres, close to the new station of the Great Central Railway in St. John's Wood. That site had been acquired and paid for; but, unfortunately for us, the Great Central Company cast longing eyes on it, and went to Parliament last year, scheduling the site in a bill. Of course, the unfortunate electric lighting companies had to give way to a great railway, and the site has been taken from us. We are now in Parliament for a site adjoining, which we consider quite as good, and we hope to be able to obtain it under the compulsory purchase clause. The area of the site which we had originally was rather more than 2½ acres, and the amount standing in our books as half the cost of that is £23,306. It may be thought that £46,000 is a large sum to pay for rather more than 2½ acres of land, but when you remember that it is adjoining a great railway and also a canal, both of which are almost essential for our purposes, it will not, I think, be considered too extravagant a sum. The new site which we hope to be able to get under the Bill we have lodged in Parliament is rather larger than that which we have been obliged to abandon, and I think that ultimately, when we have acquired that site, as I hope we shall, it will be found of great benefit to this Company, as well as to the St. James's.

Mr. MAKINS said he trusted that the Company got a profit out of the great railway company who took the site referred to out of their hands.

Mr. BOULNOIS: That remains to be seen. We shall have to go to arbitration, and you may depend upon it that we shall make the most out of our property.

The CHAIRMAN put the resolution in the usual way, and, having declared it carried unanimously, said: I have now to move—

"*That the payment of a dividend of 1½ per cent. per annum, less income tax, for the past half-year, making 12 per cent. for the year ended Dec. 31 last, carrying forward a balance of £1,000, be agreed to.*"

Mr. R. W. WALLACE, Q.C., seconded, and the motion was carried unanimously.

Mr. Hayes Fisher, M.P., and Sir Douglas Galton, K.C.B., F.R.S., were then unanimously re-elected directors of the Company.

A cordial vote of thanks to the Chairman and Directors for their conduct of the Company's undertaking brought the proceedings to a close.

Blackpool and Fleetwood Tramroad Company.

A meeting of this Company was held last week at Manchester, Mr. GEORGE RICHARDSON presiding. In moving the adoption of the report (an abstract of which appears below), the CHAIRMAN congratulated the shareholders on the results of their enterprise so far. The report was all the more satisfactory in that it only represented five and a-half months' working. So far as the traffic was concerned, he was glad to be able to state that it had been for these dead months most satisfactory, and greater than the Directors had ventured to anticipate. He admitted that the Company made a mistake at the outset in not having sufficient capital to go on with. They had not thought they would be required to provide accommodation for the public on so large a scale. Consequently they had now decided to increase the capital and provide increased accommodation in various ways to enable the Company to deal with the enormous traffic in a satisfactory manner. There had been a large number of sales of land for building purposes along the line, and an increase of buildings would give the Company a working traffic quite independent of the excursion traffic. Their working expenses came to about 42 per cent. They started with the idea of losing £100 a week during the winter, but they were not losing £100 a month. The damage caused by storm had been repaired at a cost of about £40. In a very short time the Company would be able to work with 27 cars, against the eight that ran last season.

The report was adopted, and a dividend at the rate of 8 per cent. per annum was declared. £1,500 was voted to the Directors for their services up to the end of last December, and £800 per annum in future.

The CHAIRMAN, in acknowledging this resolution, said he did not think the shareholders would ever regret having invested their money in the Blackpool and Fleetwood Tramroad Company.

A vote of thanks to the Directors and staff terminated the proceedings.

Following is the report of the directors for the half-year to Dec. 31:—

The directors congratulate the shareholders on the successful results of the working of the undertaking, especially having regard to the insufficiency of the rolling stock. This insufficiency, owing to the remarkable popularity of the line, it was impossible to foresee; but steps have been taken to largely augment the rolling stock and thus cope with the apparently increasing and crowded traffic. The number of passengers carried from July 14, 1898, the date when the tramroad was opened, to Dec. 31, was 734,293, and the gross receipts £14,476. 2s. 10d., and the net profit £8,584. 4s. 3d. After providing for interest on debentures, the disposable balance is £8,006. 9s. 3d., and the directors recommend a dividend at the rate of £8 per cent. per annum, free of tax, payable Feb. 24, leaving £3,206. 9s. 3d. to be carried forward.

Liverpool Overhead Railway Co. (Limited).

The half-yearly meeting of this Company was held at Liverpool on Tuesday, under the presidency of Sir W. B. Forwood. In moving the adoption of the report the Chairman said the directors were pleased to be able to show such a gratifying statement of accounts. The gross profits of the half-year had been £40,655, against £37,558 in the corresponding half of the previous year. The expenditure was £24,717 against £4,240; but it was only fair to point out that last year they had a charge of £1,500 for the tramways. Therefore, properly speaking, the expenses had gone up £1,977, for which they had earned increased receipts of £3,097. The net revenue was £15,938, making, with the balance (£5,868) brought forward, £19,986 of net revenue with which they had to deal. The debenture interest was £3,400, leaving £16,856. The preference interest would require £3,000, and the directors recommended a dividend for the past half-year at the rate of 4 per cent. per annum, against 3½ per cent. in the corresponding half of last year, leaving £4,586 to carry forward. They had at present a formidable competition at the Dingle Station, but the Directors believed the growth of traffic along the dock line would fully compensate them for any loss they might sustain there, and he thought they saw there loss to-day at its worst, for not only had the electric tramways all the attractiveness of novelty, but they had practically obstructed the approach to the Dingle Station. It was an extraordinary thing that the more facilities were given to traffic the more it would increase. The traffic on their line had increased in the short space of six years from 3,500,000 to 10,000,000 per annum, which he thought was abundant justification for expressing the hope that any loss of traffic sustained at the Dingle would be more than made up in the general growth of traffic along the dock line. The expenditure in connection with the lighting of the line and carriages had gone up. They had spent £1,200 during the half-year in new storage batteries, the old ones being replaced at a total cost of £2,500. These batteries had a very short life, only three or four years. They had now at the credit of the renewal fund £12,400. Hitherto they had paid for renewals out of revenue, and he hoped they might be able to keep the fund intact for a little longer. They were gradually accumulating a contingent fund, which now amounted to £700. He referred to the arrangement with the Waterloo and Seaforth and Great Crosby District Councils for the working of the tramway which these bodies had obtained powers to construct extending to two and a half miles from the Seaforth station to Cook's-road, Crosby. The local authorities would lay the road and rails, and the Company would provide electrical equipment and maintain the rails. They had agreed to pay the district councils 8½ per cent. interest per annum for 20 years on the cost incurred in laying the rails. That covered their interest and sinking fund on the estimated cost; and at the end of that period, when the sinking fund was wiped off, the annual payment would be reduced to 4 per cent. for the remaining six years of the lease. The total expenditure the Company would have to incur in providing the

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necessary equipment was estimated at £25,813. They would adopt the most economical mode of working the tramway, and it might be they would have to put down a new generating station. The report and accounts were adopted, the Company's bill in Parliament approved, and a vote of thanks to the Chairman and Directors terminated the proceedings.

Kensington and Knightsbridge Electric Lighting Co.

The directors have just issued their report for the year 1898. The number of houses and shops connected with the system has increased from 1,620 on Dec. 31, 1897, to 1,851 on Dec. 31, 1898, and the number of lamps, calculated on the usual basis of 8 c.p., has increased from 137,953 to 156,158.

Additional capital required by the Company during the year has been raised by the issue of £12,785 Four per Cent. Debenture stock, producing £13,807. 16s. and by the issue of 1,187 Second Preference shares, producing £7,122. The directors have strengthened the renewal account by transferring to it £5,117. 15s. 11d., making the total £25,615. 9s. 9d. After providing for this amount, and paying dividends on the Six per Cent. First Preference shares to June 30, 1898, on the Five per Cent. Second Preference shares to Sept. 30, 1898, and an interim dividend at the rate of 10 per cent. per annum on the Ordinary shares for the first half of the year, the balance standing to credit of nett revenue for the year is £6,300. 10s. 11d. Of this sum £1,450 has been appropriated to payment of the First Preference dividend to the end of year, and £400 has to be set aside to meet the portion of the dividend on the Second Preference shares accrued to the same date, leaving £4,450. 10s. 11d., out of which it is proposed to pay a dividend on the Ordinary shares at the rate of 10 per cent. for past half-year, making 10 per cent. for the year. This will leave a balance of £825. 10s. 11d. to go forward.

After the general meeting on Feb. 22 there will be an extraordinary meeting confirming the resolution passed on the 1st inst. relative to the bill now being promoted by this company in conjunction with the Notting Hill Electric Lighting Co.

Northampton Electric Light and Power Co. (Limited).

The report of the directors of this Company for the year 1898 states that the extension of the company's operations has been considerable. The demand for current for lighting and motive power has grown from 11,084 to 13,061 equiv. 8 c.p. lamps fixed. Large additions have been made in houses already supplied, but the company's mains are only now reaching private residences in any large number. The value of the electric current for motive power is becoming more generally recognised, and there is also an increasing demand in churches and chapels. From January 1, 1899, the price of current is reduced from 8d. and 4d. to 6½d. and 3½d. per unit. Places of worship are charged at 4½d. and motors at 3d. Discount at 5 per cent is allowed in each case.

A large increase has taken place in the power plant at the works. A new 240 H.P. engine has been erected, with dynamo and accessories, making seven sets in all. This addition was made in view of the necessity for providing a sufficient reserve and for meeting contingencies, and is expected to serve for the whole of the current year. An abnormal expenditure has taken place during the past year, which accordingly has been weighted with an increase of interest on borrowed money, but it is hoped that benefit may accrue in the immediate future. Additional mains have been laid (about 1¼ miles in all) making a total of about 3¾ miles. An advance in the price of coal, the need for insuring under the Workmen's Compensation Act, and an increase in rates have constituted, in the aggregate, a heavy tax. Against this may be set off the expected saving from the introduction of apparatus of various kinds designed to effect economies in steam, coal, oil, &c.

The Directors have secured a valuable addition to the freehold property of the company, for extensions of engine and boiler houses, and giving important frontages to the company's premises.

It is proposed to deal with the balance of £747. 18s. 2d. shown by the net revenue account by paying a year's dividend on all shares for the year ending 31st. Dec., viz.:—6 per cent. Preference shares (£232), 5 per cent. Preference shares (£145), and on Ordinary shares at the rate of 2 per cent. (£256. 10s. 3d.), carrying forward £114. 7s. 11d. As further capital is needed for paying off the temporary loan account, for completing the new purchase of land, and for extension of mains, it is proposed to issue 10,000 additional Ordinary B shares which shall rank as part of the "second issue," and also a limited number of Debentures as occasion may arise.

India Rubber, Gutta Percha, and Telegraph Works Co. (Limited).

The report of the directors of this Company for the year ended Dec. 31 states that, after provision for doubtful debts, a net profit for the past year of £62,222. 2s. 2d. is shown. Adding £13,173. 1s. 1d. brought forward, and deducting £12,500 interim dividend paid in July, there remains a disposal balance of £62,895. 3s. 3d. The directors recommend the distribution of a dividend of 15s. a share, free of income tax, amounting to £37,500, making, with the interim dividend paid in July, a total payment of 10 per cent. for the year, and leaving £25,395. 3s. 3d. to be carried forward.

The company's general business has been more profitable during the past year than in 1897, the selling prices of goods having been advanced to meet the increase in the cost of the raw materials. The cable vessels have been moderately employed.

The high efficiency of the Silvertown and Persan factories has been maintained by constant renewals and by the replacing of plant and machinery where improved methods of manufacture have so required. The employment of electricity for the transmission of power is being extended at the works.

NEW COMPANIES, STATUTORY RETURNS, &c.

GARSTON AND DISTRICT ELECTRIC SUPPLY CO. (LIMITED).—This company was registered on Feb. 11 with a capital of £25,000, in £1 shares, to apply for, obtain, and carry out the terms of provisional orders and licences under the Electric Lighting Acts (1882 and 1888), and to carry on the business of an electric light company, and of electricians, electrical and mechanical engineers, suppliers of electricity, and manufacturers of and dealers in electrical apparatus. The first subscribers are:—George H. Nisbett (engineer) and Jacob Atherton (merchant), each with 5,000 shares; A. Tracey, S. P. Doudney (engineer), F. W. Le Tall (engineer), E. Tracey (secretary), and D. Bates (with one share each). The first directors are:—Jacob Atherton and George H. Nisbett.

MEDICAL ELECTRO-THERMIC GENERATOR CO. (LIMITED).—This company was registered on Jan. 28 with a capital of £20,000, in £1 shares, to acquire the business of the Medical Electro-Thermic Generator Co. (Limited) and to acquire the rights of and to sell and use the Greville Electro-Thermic air baths.

MICA BOILER COVERING CO. (LIMITED).—This company was registered on Feb 6, with a capital of £75,000, in £1 shares, of which 37,500 are Preference, to enter into agreements with the Mica Boiler Covering Co. (Limited) and Mr. Henry C. Michell, and to manufacture, sell and deal in mica, mica waste, flake mica, Michell's mica boiler covering, wood jacketing, asbestos and other mineral fibre, steam pipes and electrical insulating or other electrical materials. The first Directors are: P. A. Makins, L. S. Robertson, W. M. Mordey, C. R. Tritton, N. Kingsmill and D. S. Michell.

LONDON ELECTRIC OMNIBUS CO. (LIMITED).—The annual return to Jan. 28 gives the capital as £250,000, in £1 shares (of which 80,000 are Deferred); 79,200 Deferred and 22,059 Ordinary shares have been taken up, and all the former and 1,000 of the latter are considered as paid. £1 per share has been called on 21,059 Ordinary shares, resulting in the receipt of £34,556. 12s. 6d.; £14,176. 18s. has been paid on 27,348 shares forfeited, 1,600 Ordinary and 800 Deferred shares have also been forfeited, and £697. 5s. 6d. is in arrears.

LONDON ELECTRICAL CAB CO. (LIMITED).—The annual return to Dec. 13 has been filed. The capital is £150,000, in £1 shares, of which 101,187 have been taken up; 24,811 have been issued as fully paid, and the full amount has been called on the others.

SALISBURY ELECTRIC LIGHT AND SUPPLY CO. (LIMITED).—The annual return to Jan. 3 has been filed. The capital is £20,000, in £1 shares, of which 3,807 have been taken up; 2,500 are considered as paid, and the full amount has been called on the others.

URBAN ELECTRIC SUPPLY CO. (LIMITED).—The statutory return to Nov. 12 has been filed. The nominal capital is £100,000, in £5 shares. Seven shares have been taken up, but no calls have been made.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 2, 1899). Price of silver $27\frac{7}{16}$d. per oz. (Feb. 16). Consols (2¾ per cent.) 111¼—111⅝ for money, $111\frac{5}{16}$—$111\frac{7}{16}$ for account; 2½ per cent. 103⅞—104⅛ (Feb. 16). Stock Exchange Settling Days: Consols, March 1; Stocks and Shares Continuation Days, Feb. 22 and March 8; Ticket Days, Feb. 23 and March 9; Pay Days, Feb. 26 and March 10; Mining Share Carry over Days, Feb. 21 and March 7.

H. ARON ELEKTRICITATS ZAHLERFABRIK (G.m.b.H.), BERLIN.—This company has been formed with a capital of 500,000 marks (£25,000) for acquiring the works of Dr. H. Aron at Berlin and Schweidnitz.

BRISTOL TRAMWAYS AND CARRIAGE CO. (LIMITED).—A meeting of this company was held on Wednesday. The Chairman (Mr. W. Butler) said the tramways receipts showed an increase of £4,143. The number of passengers carried showed a very large increase. The total gross revenue of the company was £78,258, the expenditure £55,806. The dividend for the half-year was at the rate of 7 per cent. per annum, free of tax, leaving £5,741 to be carried to reserve and renewal funds. They had practically finished some of their new lines and extensions. From what he could see of the progress of the work, he thought they might fairly rely upon being able to run electric cars on these lines in July next; but with regard to the remainder of the horse lines, they would have to await the completion of the central power station, as they could only work a certain amount of additional line from the St. George power station. As to the power station at Counterslip, their contractor was at work upon the foundations and new harbour wall, and immediately these were completed they would proceed with the building. The electrical plant was on order. The great extension of their system necessitated the provision of a depôt and car-building works. It was too much to expect that the whole of the line would be relaid and the machinery installed and the depôts erected during the present year, but at that time next year he

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hoped they would be very close to a completion of the whole conversion. The Directors were pleased with the progress made, especially having regard to the delays which had occurred in getting plans passed by the Sanitary Committee of the Corporation. He thought that committee might have helped them by giving their decisions more promptly in certain matters, or, rather, might have abided by their decisions when once given. This indecision had necessitated their preparing altogether new sets of plans, causing considerable waste of time, and, but for the decision of the Directors not to be drawn into a serious fight in the law courts with the Corporation, there would, doubtless, have been still further delay. The company, in connection with the re-laying of the lines and the provision of posts and overhead work, had undoubtedly yielded the benefit of a strong legal position in order to meet the wishes of the Sanitary Committee, and in doing so the company had been entailed in an additional capital expenditure of some thousands of pounds. He feared, however, that the company had got very little credit for this attitude, and he complained of a want of reciprocal good feeling on the part of the committee. The only point as to construction of lines which he had not touched upon was that with regard to the St. George and Hanham Light Railway. This order was confirmed by the Board of Trade on Nov. 28 last, when Sir Francis Marindin went over the line and made a variety of suggestions as to the location of double and single lines, which he considered would improve the line in the interests of the travelling public as well as the frontagers. They were now delayed in consequence of the Sanitary Committee not being ready to give their immediate approval to the alterations sugested by Sir F. Marindin. Here again, however, they were met by the unreasonable opposition of some members of the Sanitary Committee. It has been decided to increase the capital of the company to £750,000 by the creation of 25,000 new shares of £10 each.

CENTRAL LONDON RAILWAY.—At a meeting of the shareholders of this company, Sir Henry Oakley, who presided, said that the whole of the works from end to end of the line were progressing satisfactorily. Some portion of the work was extremely difficult, not altogether from the engineering point of view, but from the fact that the immense traffic in certain parts of London interfered with the contractors' operations. Due credit was given to the Corporation of London for the facilities offered for proceeding with the work under difficult surrounding conditions. The connection to the City and South London Railway at a point near the Bank of England had been completed, and with the extensions of the City and South London Railway to Islington on the north, and joining also with the Great Northern and City at or near Finsbury Circus. he traffic from all these lines would be freely exchanged with the Central London Railway at that company's Bank station. Most of the stations were approaching completion. They had four out of six out of their engines delivered. Large supplies of electric apparatus of all descriptions, from motors downwards, were also either delivered or waiting delivery, so that there was no probability of any delay when the excavation work was completed. They had hoped that the construction operations would have been completed, enabling them to open the line in June next, when their present Parliamentary powers expired, but this was not now likely to happen, and he would consequently ask them to approve a bill seeking for an extension of time for one year. He concluded his remarks by expressing the regret of the Directors and all concerned in the company at the lamented death of Sir John Fowler. The report and accounts were adopted, and the approval of the meeting was given to the bill before Parliament asking for extended time for the completion of the company's undertaking.

COMPANY REFORM.—This subject is now prominently before the public, and justifies us in referring to a series of articles appearing in the *Statist*. Among a series of suggestions made for protecting the public, and for affording investors the opportunity of inquiring into the statements made in prospectuses, is one that the closing of the lists of subscriptions should be deferred for at least one week after the prospectus is publicly advertised. Such a proposal should be heartily supported by the press and the public. The successful flotation of many wild-cat schemes, electrical and otherwise, has been possible only from the fact that no time has been allowed for inquiries into the statements made by vendors and others who "are taking a profit."

COVENTRY ELECTRIC TRAMWAYS COMPANY.—The annual meeting of this company was held at Bank-buildings, London, last week, under the presidency of Capt. Pavy. The Chairman stated that the earnings for the year to Dec. 4 last amounted to £10,283, against £9,924 for the preceding year. On the old capital this would have sufficed to pay 21 per cent. on the Ordinary shares, after paying 4 per cent. on the Debentures and 6 per cent. on the Preference shares. The new lines were rapidly nearing completion, and it was hoped that the full 10½ miles would be in operation shortly. The accounts submitted showed a sum of £2,673 available for dividend on the shares. Of the total capital of £112,000 only 9,600 shares of £10 each had been issued, and of these shares 8,000 were fully paid up, representing £80,000, and 1,600 were half paid up, representing £8,000, making a total of £88,000 paid up, leaving a balance of £8,000 to be paid on the completion of the works. The Directors proposed to pay a dividend at the rate of 4 per cent. on the amounts paid up from dates of payment. This amounted to £2,182, and left a balance of £390 to be carried forward.

DUBLIN UNITED TRAMWAYS CO. (LIMITED).—A meeting of this company was held at Dublin on Tuesday. The chairman (Dr. Wm. Carte, J.P.) congratulated the shareholders on the satisfactory results of the past six months' working. Owing to the transition state of the company from horse to electric traction it was not possible to give fuller working details. But on the Clontarf line the receipts last half-year were £12,114, against £7,216 for the corresponding half-year of 1896, when the line was worked altogether by horses, an increase of more than 53 per cent. in favour of the electric working, whilst the number of passengers carried increased from 1,124,801 to 2,273,883, or over 100 per cent. The working expenses amounted only to £4,234, or equal to 3·83d. per car mile. There had, however, to be added a proportion of general charges, rents, rates and taxes, licences, accident insurance, &c. (after taking credit for a proportion of sundry receipts), amounting to £455, making the total expenditure £4,779, equal to 39·45 per cent. of the receipts, or 4·25d. per car mile, the figure for horse traction over the rest of the system during the same period being 7·84d. per car mile, or 75·43 per cent. of the receipts. Track repairs are excluded from consideration in both cases, as none were necessary on the Clontarf line during the past half-year. Considerable progress was made in the electrical equipment of the company's system; 26½ miles of conduit out of 32 were laid, and the overhead work was so progressing that when the central power station on the Ringsend road was completed, which they hoped would be by the end of the current half-year, they looked forward to working the remainder of the present horse lines electrically. The electrical through service of cars from Donnybrook to Phœnix Park had been working since Jan. 23, with very satisfactory results, showing an increase of 37 per cent. in receipts and 56 per cent. in passengers. These results were obtained by 20 electric cars in service against 24 horse cars and with reduced fares. No accident has occurred, and as this service passed through the most crowded and important part of the city it bore testimony to the capacity and care of the motormen, most of whom have been in the company's employment as horse car drivers. The Order in Council authorising the company to construct additional lines in the city and townships had been issued, and immediately the reconstruction of the existing lines now in progress had been completed the construction of these additional lines would be proceeding with.

DUDLEY AND WOLVERHAMPTON TRAMWAYS CO. (LIMITED).—Application is to be made to the Board of Trade for their approval of the transfer of the undertaking of the company to the British Electric Traction Co. (Limited), the consideration being £18,300.

EDISON AND SWAN UNITED ELECTRIC LIGHT CO. (LIMITED).—The Directors of this company have resolved that a payment on account of the dividend of the current year be made at the rate of 6 per cent. per annum (less tax) on the "A" shares, in respect of the half-year to Dec. 31 last. This equals 1s. 9$\frac{3}{5}$d. per share on the partly paid £5 shares (£3 paid), and 2s. 9$\frac{3}{5}$d. per share on the fully paid £5 shares (less tax). The dividend warrants will be issued on 24th inst.

GENERAL ELECTRIC CO. (U.S.A.)—This company has declared a dividend of $19 on the Preferred stock, payable March 8, which completes the payment of all back dividends on this stock.

GESELLSCHAFT FUR ELEKTRISCHE UNTERNEHMUNGEN (BERLIN).—The net profit of this company for 1898 was 4,290,000 marks (£214,500), and a dividend of 10 per cent. has been declared, against 8½ in 1897.

GREAT NORTHERN RAILWAY COMPANY (OF IRELAND).—In their half-yearly report the directors state that they have entered into a contract for the construction of a portion of the Sutton and Howth electric tramway, and the works are in progress. Contracts have also been made for the building and electrical equipment of the power house at Sutton.

GREAT NORTHERN TELEGRAPH CO. (LIMITED).—Coupons falling due on the 1st prox. on this company's 1883 debentures (series B) should be presented to Messrs. C. J. Hambro and Son, 70, Old Broad street, E.C.

HAMPSTEAD ELECTRIC SUPPLY CO. (LIMITED).—The *Financial Times* says:—A firm of stock and share brokers and dealers whose name is not familiar to us, "have the opportunity of being able to offer you a limited number of both Preference and Ordinary shares in an electric lighting company of substantial standing and of very great promise for the future." The concern referred to is the Hampstead Electric Supply Company, which was registered as recently as July, 1898. It would be interesting to know if this touting of their shares is being done with the cognisance of the Directors, and, if so, whether it meets with their approval.

JAMAICA ELECTRIC LIGHT AND POWER CO.—The undertaking of this company has been acquired by the Electrical Co. of America, a Philadelphian concern, with a capital of 25 million dollars.

NATIONAL ELECTRIC SUPPLY CO. (LIMITED).—The annual general meeting was held at Preston last week. The chairman (Mr. J. Booth) said the past year had been a busy one and the progress made was satisfactory. They had obtained a new provisional order enabling them to extend their mains into the district outside the borough, and they had already carried them as far as Broughton, with a result which had fully justified their enterprise. This year they proposed to carry them through Fulwood and Cadley, where they had the promise of a large number of consumers. They had also erected new machinery at the generating station, and had placed orders for new engines and boilers having a capacity of 700 H.P. The gross profit for the year showed an increase of about £1,200. They commenced in 1897 with a credit balance of £500, while last year they had only £12, and they had also had to provide about £300 more for debenture, interest, &c. They directors, therefore, felt that it was a much wiser course to strengthen the position of the Company by putting the remaining £400 as an additional amount for depreciation, and to recommend the same dividend as last year. Thanks to their chief engineer (Mr. Tonge) and his efficient staff, the figures showed the Company to be the most economically worked company of its size in the kingdom. They had offered additional inducement in price to new consumers, and there were now few companies providing such a steady, reliable service on such reasonable terms. The following dividends were declared:—On the Preference shares a dividend of 4 per cent. per annum; on the Ordinary shares a dividend of 2s. 6d. per share for the half-year ended Dec. 31, making 5s. per share for the year.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING CO. (LIMITED).—The ordinary general meeting of this company was held on Tuesday. The chairman (Mr. J. D. Milburn) said it was now necessary to lay down new plant, as they contemplated having a continuous as well as an alternating system of supply. If the directors could see their way to reduce the price of

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current they would do so. The company's contract with the North-Eastern Railway Co. would expire in June, and he was glad to say that, after continued negotiations, they had succeeded in closing with them for the supply of the whole of their requirements in Newcastle for electric or arc lighting, or energy for power. As this contract would be for the next five or seven years, it would partly necessitate the laying down of extra plant, and the directors, in view of this and the possibilities of the tramways and other matters, were contemplating this extra outlay. They must be prepared, also, to meet a demand for power for electric trams, and be ready to supply it at a price which would defy competition either from outside or under Corporation management. He expressed himself favourable to the overhead system of electric cars. A dividend of 5 per cent. for the half-year (making 8½ per cent. for the year) was declared.

SOUTHPORT TRAMWAYS CO. (LIMITED).—A meeting of this company was held on Monday. Mr. E. Garcke, who presided, said that the company was supported by the British Electric Traction Co., who were likewise interested in the Birkdale and Southport Tramways Co. They were in a position, therefore, to bring about the working of the two systems upon uniform methods.

STOCK EXCHANGE NOTICE.—The Stock Exchange Committee has ordered the further issue of 75,151 £10 Fully-paid shares (Nos. 130,001 to 205,151) of the *Brazilian Submarine Telegraph Co. (Limited)* to be quoted in the official list. The Committee have been asked to allow the further issue of 5,749 Five per Cent. Perpetual Preference Shares of £10 each, and £50,000 Four per Cent. Perpetual Debenture Stock of the *City and South London Railway Co.* to be quoted in the official list.

WOLVERHAMPTON TRAMWAYS CO. (LIMITED) —The general meeting of this company was held on Tuesday. The Chairman (Mr. Emile Garcke), said that the Corporation had given notice to purchase last autumn, and unless they could agree upon a price the matter would be referred to arbitration, and that portion would be sold to them at the figure the arbitrator might assess. Negotiations had been pending with the Corporation with a view of fixing the figure by agreement. In view of further negotiations with the Corporation he did not wish to say anything that might be taken by them as being discourteous or uncomplimentary, but so far as his experience had gone the Corporation had not dealt with the matter in a very nice spirit. Five-eighths were inside the Corporation area. The Corporation had given notice of their intention to purchase only that portion within their area because they had no power over the other. But it was perfectly clear that they hoped to obtain the lines outside the borough at practically less than scrap value. He believed the idea of the Corporation was that the company would be unable to work the lines outside the borough, and that the company would have to come to them cap in hand, and ask them to take these lines off their hands at a price less than the price for those within the borough. The Directors were thus placed in a great difficulty, and they made arrangements with the British Electric Traction Co. with a view to the British Company taking over the whole concern, and an agreement was approved at a former meeting, at which that company undertook to take over their undertaking at a price which was satisfactory. Unfortunately, the British Company could not arrange with the Wolverhampton Corporation, and had had to pay the penalty of not carrying out what was a purely provisional agreement. A bill would, however, be promoted in Parliament to enable the company to alter the gauge of certain of their tramways, and it was proposed to the shareholders that they should sanction a provisional agreement with the British Electric Traction Co. to take over the outside portion of the lines at the same price per mile of tramway as the company may receive from the Corporation for the portion within the area. The British Company would promote a bill at their own expense, and if it did not go through, it would be no worse for the Wolverhampton Company. The proposals of the Directors were approved.

YORKSHIRE HOUSE-TO-HOUSE ELECTRICITY CO. (LIMITED.)—A meeting of the shareholders of this company was held at Leeds on Friday when the resolution recently passed to wind up the company voluntarily was approved. The members also voted £210 out of the funds of the company to Mr. Robert Hammond, consulting electrical engineer, as an acknowledgment of his services in connection with the formation of the company. The Chairman (Mr. Grosvenor Talbot) has been appointed liquidator of the company.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	AGGREGATE. Amount.	AGGREGATE. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Feb. 11	3,689	+ 170	...	...	...
Blackpool Corporation...	„ 9	113	+ 2	45	17,051	+ 2,483
Blackpool and Fleetwood Co.	„ 11	143	...	6	881	...
*Bristol Trams & Carriage	„ 10	2,357	+ 61	6	14,656	+ 530
City & South London Ry.	„ 12	1,119	+ 61	7	7,807	+ 293
Dover Corporation	„ 11	141	+ 36	45	8,051	...
Dublin United(Southern)	„ 10	596	+ 233	6	3,501	+ 1,072
Liverpool Overhead Rly.	„ 12	1,223	− 157	7	9,047	− 463
*Sheffield Tramways.....	„ 12	1,191	+ 225	6	7,213	+ 1,380
*South Staffs. Trams.....	„ 10	554	− 26	6	3,450	− 88

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Feb. 8.		Price Wednesday, Feb. 15.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Week Ending Feb. 15. Highest.	Lowest
			TELEGRAPHS					£ s. d.			
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	101	104	101	104	3 16 11	January and July	—	..
25,000	10	—	Amazon Telegraph	3	4	3	4	—	—	—	—
£125,000	100	5%	Do. 5 per Cent. Debentures xd	87	92	87	91	5 6 5	—	—	—
£505,560	Stock	24/0	Anglo-American xd	68	70	67	69	5 0 0	Feb., May, Aug., Nov.	..	..
£3,047,220	Stock	80/0	Do. Preferred xd	120	121	119	120	5 0 0	„ „	120	119
£3,047,220	Stock	18/0	Do. Deferred	16½	17	15½	15⅝	5 14 3	—	15⅞	15⅝
205,151	10	3/0	Brazilian Submarine	15⅝	16⅛	16	16½	4 4 10	Mar., June, Oct., Dec.	16½	15 17/16
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	110	114	110	114	4 7 9	June and December	..	..
10,000,000	$100	$2¾	Commercial Cable Capital Stock	180	190	180	190	4 4 3	Jan., Apr., July, Oct.	..	..
£1,332,523	Stock	4%	* Do. 4 per Cent. Debenture Stock	104	106	105	107	3 15 2	„ „	105⅞	105⅝
16,000	10	8/0	Cuba Submarine Ordinary (Deferred)	8½	9½	9⅛	10½	6 13 4	February and August	9⅛	9½
6,000	10	10/0	Do. Preference 10 per Cent.	17	18	17½	18½	5 8 1	„ „	—	..
12,931	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October ..	..	—
8,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	„ „	..	—
£30,000	50	4½%	Do. 4½ per Cent. Debentures	104⅞	107⅞	104⅞	107⅞	4 4 1	January and July	..	..
65,710	20	3/0	Direct United States Cable	12½	13	12½	13⅜	5 2 0	Jan., Apr., July, Oct.	12⅝	12½
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	102	105	102	105	4 5 9	„ „	..	..
£4,000,000	Stock	5%	Eastern Ordinary	177	182	179	184	3 16 4	Jan., Apr., July, Oct.	181	178
£1,295,000	Stock	3½%	Do. 3½ per Cent. Pref. Stock	103	106	104	107	3 5 7	„ „	106	105⅝
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	125	129	126	130	3 2 0	May and November	127	—
£89,900	100	5%	* Do. 5 per Cent. Debentures, 1899	99	102	99	102	4 18 0	February & August	..	..
£500,000	Stock	—	Do. Provisional Certificates (all paid)	103	106	103	103	..	..	..	..
250,000	10	2/6	Eastern Extension	17¾	18½	17⅞	18¼	3 16 9	Jan., Apr., July, Oct.	18½	17⅞
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	124	128	125	129	3 2 1	February & August	..	..
£16,200	100	5%	* Do. 5 p. c.(Austln.Gov.Sub.)Deb.190((reg.)	99	103	99	103	4 17 1	January and July	..	..
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	..	—
£35,100	100	5%	*Eastern and S. African 5 p.c.Mor.Deb.,190((reg.)	99	103	99	103	4 17 1	„ „	..	—
£46,500	100	5%	Do, (Bearer)	100	103	100	103	4 17 1	„ „	..	—
£300,000	100	4%	* Do. 4% Mortgage Debentures,1909	102	105	102	105	3 17 8	February & August	..	—
£200,000	25	4%	Do. 4% Mauritius Sub. Debs. (red.)	104⅞	107⅞	104⅞	107⅞	3 15 2	May and November	..	—
180,227	10	1/9	Globe Telegraph and Trust	12⅝	13½	13⅜	13½	3 17 4	Jan., Apr., July, Oct.	13⅛	12⅝
180,042	10	6%	Do. 6 per Cent. Preference	16½	17½	17	17⅝	3 8 7	„ „	17⅝	17½
150,000	10	5/0	Great Northern of Copenhagen	29	30	29½	3 1/2	3 5 7	January, April, July	2 1/2	—
£150,000	100	5%	* Do 5 per Cent. Debs., 1883 Issue Series "B"	101	104	101	104	4 17 7	March & September	—	—
£97,800	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort.Deb.(red)	99	102	99	101	4 8 6	June and December	..	—
17,000	25	12/6	Indo-European	58	61	58	61	4 2 0	May and November	..	—
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904	109	112	109	112	5 7 7	March & September	..	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs.(red)	104	107	105	108	3 14 5	June and December	—	—
11,889	8	4/0	Reuter's	6½	7½	6½	7½	5 6 8	April and October	6⅞	—
3,881	£100 Cert.	6%	Submarine Cables Trust	138	143	138	143	4 4 11	„ „	101⅛	—
15,609	10	—	West African Telegraph	—	—	..	..	..	—	—	—
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	100	103	101	103	4 18 6	March & September	—	—
80,008	2½	—	West Coast of America	½	1	½	1	..	—	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	103	106	103	106	3 15 9	June and December	—	—
88,821	10	1/6	West India and Panama	1½	1⅝	1⅝	1⅞	—	May and November	1⅝	—
34,563	10	6/0	Do. 6 per Cent. 1st Preference	10½	10⅝	10½	10⅝	5 11 7	„ „	10 5/8	—
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	8½	9½	8½	9½	6 6 4	„ „	..	—
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	104	107	4 13 6	January and July	..	—
64,269	15	5/0	Western and Brazilian Ordinary	12½	12⅝	12⅞	13	4 11 3	May and November	..	—
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	8	8½	8½	8⅝	4 5 8	„ „	..	—
33,129	7½	1/3	Do. Deferred Ordinary	4	4½	4	4½	—	„ „	..	—
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	105	108	106	109	3 13 9	June and December	108	105½
1,168,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 190:	—	—	—	—	6 7 10	Feb., May, Aug., Nov.	—	—
£158,100	100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	98	103	98	103	5 16 6	March & September	..	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Feb. 8.		Price Wednesday, Feb. 15.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 15.	
								£ s. d.		Highest	Lowest
			TELEPHONES.								
£4,000	£5	4/0	Chili Telephone (fully paid)	2⅜	3½	2⅜	3½	6 8 1	August	–	–
224,850	10/0	1½d.	Consolidated Telephone Const. & Manufacturing	1/16	3/16	1/16	3/16	6 7 0	July	–	–
28,000	5	4/0	Monte Video Telephone 6 per Cent. Preference	..	–	–		–	October	–	–
490,000	5	3/0	National	5⅜	6	5⅞	6⅛	4 18 0	February & August	6 1/16	5⅞
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	14	16	14	16	3 15 0	" "	16	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	13	15	14	16	3 15 0	" "	..	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	5⅝	5⅞	5⅝	5⅞	4 5 1	" "	5⅞	5 1/16
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	99	101	100	102	3 9 0	June and December	101	100
171,504	1	0/4	Oriental	⅜	½	⅜	½	6 13 4	April and October	–	–
58,000	5	6/0	United River Plate	4½	5½	4½	5½	5 14 3	July	–	–
£151,788	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	104	107	104	107	4 13 11	June and December	–	–
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	–	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (10s pd.)	⅜	⅝	⅜	⅝	..		–	–
6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	12½	13½	12½	13½	–		–	–
6,000	10	6/6	Do. 4½ per Cent. Cumulative Pref. ..xd	10⅝	11½	10⅝	11½	4 4 0		10 1/16	..
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	11	12	11	12	2 18 4	February & August	–	–
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6½	6	6½	3 9 3	" "	–	–
£34,000	5	2/6	Chelsea Electricity Supply Ordinary	9	10	9	10	3 0 0	March	..	..
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	114	116	114	116	3 18 1	June and December	..	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red)	103	105	103	105	4 15 3	–	..	–
50,000	10	5/0	City of London Elec. Lighting Ord. 40,001 to 90,000	23	24	19	20	6 5 0	February & August	2 1/16	19
10,000	10	1/9	Do. Ordinary 90,001 to 100,000	23	24	18	21	..	–	20	18⅞
40,000	10	6%	Do. 6% Cumulative Pref.	15½	16½	15½	16½	3 13 9	January and July	–	–
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	125	130	124	129	3 17 10	June and December	125	..
30,000	10	–	County of London & Brush Prov. Ord. (1 to 30,000)	12½	13½	12	18	–	–	1 3/8	12½
10,000	10	..	Do. (30,001 to 40,000)	12	13	12	13	..	–	..	12½
20,000	10	6/0	Do. 6% Cumulative Preference	14½	15½	14½	15½	4 0 0	March & September	14 1/8	14⅜
15,660	5	2/6	House-to-House Electric Lighting Supply Ord.	9	10	9	10	2 0 0	–	–	–
12,000	5	3/6	Do. 7 per Cent. Preference	9½	10½	9½	10½	3 6 8	March & September	–	–
15,000	5	10%	Kensington and Knightsbridge Ord.	13	14	13	14	3 18 7	–	–	–
10,000	5	6%	Do. 6% 1st Pref.	7⅞	8½	7½	8½	3 12 9	January and July	–	–
110,000	3	–	London Electric Supply Ordinary	3⅝	4	3⅝	4	–	–	–	–
48,050	5	–	Do. Preference	6½	7	6½	7	–	–	6½	..
£100,000	Stock	..	Do. 4% 1st Mort. Deb.	103	105	104	104	3 15 6	Mch., June, Sept., Dec.	..	–
62,500	10	5/0	Metropolitan Electric Supply Ordinary	18½	19½	17⅞	18½	3 4 10	April and October	18½	18
22,500	10	–	Do. (£7 paid)	12	13	14	15	..	–	–	–
£120,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	118	121	118	121	3 14 7	June and December	119½	..
6,452	10	6/0	Notting Hill Electric Ordinary	17½	18½	17½	18½	3 4 10	March	–	–
10,000	5	–	Oxford Electric Ordinary	6⅞	7½	6⅞	7½	–	–	–	..
275,000	1	–	Rand Electric	1	1⅛	1	1⅛	–	–	–	–
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb	83	93	83	93	5 8 1	–	–	–
150,000	$100	$2	Royal Electric Company of Montreal Shares	160	180	160	180	4 9 5	–	–	–
130,900	100	4½%	* Do. 4½% 1st Mort. Debs.	107	109	107	109	4 3 9	April and October	–	–
31,980	5	9/6	St. James and Pall Mall Electric Ordinary	16½	17½	16	17	4 11 5	February & August	18 1/16	16⅝
20,000	5	3/6	Do. 7 per Cent. Preference xd	9	10	9	10	3 10 0	" "	9½	..
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.)	..	..	..	..	..	June and December	..	–
65,000	5	..	South London Electric Supply Ordinary (£3 paid)	3⅜	3⅝	3½	3⅝	..	–	..	..
79,900	5	5/0	Westminster Electric Supply Ordinary	15½	16½	15	16	4 1 3	March & September	15½	15½
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	2	1/2½	Brush Electrical Engineering	1⅞	2⅛	1⅞	2⅛	2 16 5	–	1⅞	..
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	–	..	..
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	111	115	111	115	3 19 0	February & August	..	..
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101	104	101	104	4 6 7	June and December	101	..
£20,000	5	5/0	Callender's Cable Construction	10½	1 ⅛	12½	13½	5 0 0	" "	1⅛	11½
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	110	113	113	116	3 17 11	November and May	..	–
300,000	1	9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	–	1⅛	1 1/16
50,000	1	–	Chadburn's Ship Telegraph Ordinary	1⅛	1⅜	1⅛	1⅜	–	–	..	–
50,000	1	7½d	Do. 6 per Cent. Cumulative Pref.	1	1⅛	1	1⅛	4 16 0	–	–	–
32,098	3	1/6	Crompton and Co. (Nos. 1 to 32,098)	2¾	3¼	2¾	3¼	4 12 4	–	3⅛	–
£82,850	100	5%	* Do. 5% First Mort. Deb. (red.)	93	101	98	101	4 19 8	January and July	–	..
99,261	5	2/1½	Edison and Swan United ("A" Shares) (£3 paid)	2½	3	2½	2⅞	6 11 9	February & August	..	..
17,189	5	3/1½	Do. (£5 paid)	4	5	4	5	6 0 0	" "	..	–
£194,023	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	97	99	97	99	4 1 0	June and December	98½	–
17,400	5	5%	Edmundson's Electric Corporation Ord (fully pd)	5	5½	5½	5⅝	4 6 11	Half-yearly	5⅛	–
112,100	2	1/2½	Electric Construction Co. (Limited)	2½	2⅞	2⅛	2⅜	4 12 0	January & July	–	–
25 000	2	2/9⅛	Do. 7 per Cent. Cumulative Pref.	3	3½	3	3⅛	4 0	July	–	–
£140,300	Stock	4%	Do. 4% First Mortgage Deb. (red.)	103	105	103	105	3 16 2	January and July	104½	–
91,196	1	–	Elmore's Patent Copper Depositing	⅜	⅝	½	¾	..	–	⅝	–
12,500	10	8/0	Henley's Telegraph Works Ordinary	25	26	25	26	5 0 0	February & August	25	..
3,000	10	7/0	Do. 7 per Cent. Preference	18½	19½	18½	19½	3 11 10	" "	19½	..
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	111	116	111	116	3 19 1	" "	–	..
50,000	10	5/0	India Rubber, Gutta Percha, &c., Works	21	23	23	24	4 3 4	" "	23⅜	24½
300,000	100	4%	Do. 4% First Mortgage Debentures (red.)	102	106	102	103	3 15 6	March & September	–	..
£7,350	12	12/0	Telegraph Construction and Maintenance	37	41	38	42	4 5 9	March and July	41½	39⅜
£12,400	5	..	Do. Manufacturing Ordinary	8½	9	8⅞	9½	–	–	9 1/16	..
13,410	5	..	Do. 5% Cum. Pref.	5⅜	6⅛	5⅜	6⅛	4 0 0	–	–	–
£20,000	5	4/0	Williams and Robinson Ordinary	8½	8⅞	8½	8⅞	4 11 5	April and October	–	–
£30,000	5	3/0	Do. 6% Cumulative Preference	7	7½	7	7⅛	4 0 0	" "	–	–
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	106	109	108	108	3 18 8	May and November	–	–
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	..	Blackpool and Fleetwood Tramways	20	21	21½	22½	..	–	–	–
25,000	10	6%	Bristol Tramways and Carriage	22	22½	23⅜	24½	2 10 0	–	24½	23
25,000	10	6%	Do. (£7. 10s. paid)	19	19½	20½	21	2 2 10	–	21	20
£90,410	Stock	4%	Do. 4% Debenture	120	121	120	121	3 6 2	–	–	–
80,000	10	..	British Electric Traction Ordinary	17	18	17	18	..	–	..	..
10,000	10	6/0	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm. pd.) xd	13½	14	13½	13⅞	4 7 3	–	..	..
£100,000	Stock	6/2·3	Do. 5% Perp. Deb.	120	122	121	123	4 1 10	–	112½	121⅜
40,000	5	..	Buenos Ayres & Belgrano 6% Cum. Pref. (£3 paid)	3½	3⅝	–		..	..	3⅜	3⅛
27,500	5	..	Do. do. do. (fully paid)	4	4⅛	–		..	..	4 1/16	..
£260,000	Stock	5%	Do. do. 5% Deb.	107	110	..		4 11 4	..	108	–
£35,250	10	3/0	Central London Ordinary	9½	10½	9⅞	10½	2 18 6	June and December	10⅛	9⅛
178,303	10	1/9⅜	Do. (£8 paid)	7⅜	8½	7⅞	8⅛	2 13 2	" "	8 1/16	–
£530,000	Stock	2%	City and South London Railway Con. Ordy.	71	73	72	74	2 17 6	January and July	73⅛	72
22,500	10	..	Do. Ordinary (£5 paid)	4⅜	5⅛	4⅛	5⅛	..	..	5⅛	5 1/16
9,251	10	5%	Do. 5% Perpetual Preference xd	14½	15½	14⅛	15⅛	3 5 7	January and July	–	–
£137,701	Stock	4%	Do. 4% Perpetual Debenture	133	135	133	135	2 19 7	May and November	..	–
20,000	10	6%	Imperial Tramways Ordinary (old £6 shares	20½	21	22⅜	23½	2 11 10	March & September	23½	23⅛
* 10,000	10	6%	Do. 6% Preference	15½	16	15½	16	3 15 0	" "	..	–
£70,000	Stock	4½%	Do. 4½% Debenture	118	119	118⅜	119½	3 15 4	.. ..	119½	118½
97,500	10	3/-	Liverpool Overhead Railway Ordinary	10½	10⅝	10⅛	10⅜	3 3 5	February & August	–	–
10,000	10	5%	Do. 5% Preference	14⅜	15⅛	14⅜	15⅛	3 5 7	" "	–	–
125 000	Stock	4%	Do. 4% Debenture	103	108	103	103	3 14 1	January and July	–	–
20,000	5	3/3½	New General Traction 6% Cumulative Pref	4½	5½	4½	5½	5 14 3	–	–	–
£540,000	Stock	3%	Waterloo and City Ordinary xd	109	112	109	112	2 13 7	June and December	112	111½

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

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CONTENTS OF THE CURRENT NUMBER.

Notes 595
Meetings of Scientific Societies 598
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe 599
Contractors' E'ectric Locomotives for the Waterloo-Baker-street Railway. Illustrated 600
E'ectrical Utilisation of Niagara Falls. Illustrated. Continued 601
Magnetic Leakage in the Alternating Current Transformer. By A. Russell, M.A. Continued 603
Nernst's Electric Light.—*Discussion* 604
Electricity Works Accounts ... 606
Superficial Criticisms and Surface Contacts 608
James Hookey 609
Induction Motor Diagrams. By C. C. Hawkins, M.A. Illus. Continued... 610
Carbons for Electric Lighting and Other Purposes. By F. Jehl. Illustrated. Continued 612
Electri Traction by Surface Contacts. By Miles Walker. Concluded..... 614
Electric Inter-communication in Railway Trains. By W E. Langdon. Illus. Concluded 617
Legal Intelligence 620
Trade Notes and Notices 621
Companies' Meetings and Reports 627
New Companies, &c. 630
City Notes 630
Companies' Share List 632

NOTES.

Whatever may be thought of the telegraphists' grievances, which found free expression in Parliament on Monday last, nobody can credit Mr. Hanbury with either tact or knowledge in discussing them. So far as can be gathered, the one great cause of exasperation is that the telegraphists' interests are largely sacrificed to those of the postal servants—the letter sorters more especially. Mr. Hanbury's speech is virtually, though unintentionally, an admission that the allegation is well founded. Not merely did he flatter the sorters—who have got all they wanted, and far more than they ever expected—but he went out of his way to disparage the telegraphists where disparagement is peculiarly offensive and unjust. According to Mr. Hanbury, telegraphy is "only a superior kind of typewriting," and he was pleased to observe that in his belief "sorting required more skill than did the ordinary telegraph work." No wonder that the telegraph service groans under the control of men who know nothing about them or their work. And Mr. Hanbury's ignorance is the more inexcusable, seeing that there is a flat contradiction ready to his hand in the attempt to carry out certain of the Tweedmouth Commission's recommendations. That telegraphists can learn sorting, not even Mr. Hanbury will deny; but that sorters cannot learn telegraphy is demonstrated by the failure of the extraordinary efforts that have been made in London to teach them. The reason is obvious enough, and reflects no discredit on the sorters; but it proves that telegraphy *is* a skilled calling, and for Mr. Hanbury to deny it will only make the telegraphists more determined than ever to assert their superiority over the more favoured class.

In reply to a question asked in the House of Commons on the same day, by Mr. Provand (member for Blackfriars, Glasgow), Mr. Hanbury stated that the Government intend to introduce a Bill based on the recommendations of the Select Committee on Telephones, which sat last year. It will be remembered that the Committee recommended that, "when in an existing area in which there is an exchange, the local authority demands a competing service, the Post Office ought either to start an efficient telephone system itself, or grant a licence to do so," and considered the former alternative the better one. This would, therefore, still leave a doubt whether the granting of municipal licences was intended, but from information received from Manchester this appears to be so. The Corporation of Manchester having been unsuccessful in obtaining a license for its *protégé*, the New Mutual Telephone Company, inserted clauses in an omnibus bill for the present Parliamentary session, to grant powers for the establishment of a municipal telephone exchange. These clauses were withdrawn, however, on an intimation being received from the Postmaster-General that, in the event of the report of the Select Committee being approved by Her Majesty's Government, a Bill would be introduced to give effect to its recommendations. The Postmaster-General added that this Bill would *inter alia* authorise him to grant provisional orders enabling a local authority to lay down and work telephones in its own district, or the districts of other authorities within the exchange area. It will be interesting to see whether the granting or refusal of a licence will rest entirely on the discretion of the Postmaster-General, or, on the other hand, he will only be entitled to refuse on certain grounds.

Sound, practical common sense pervades the report of the representatives of the Chelsea Vestry, appointed to inquire into the alleged nuisance arising from the electricity supply works. As will be seen in our abstract of the report on a later page, these gentlemen have been unable to find even partial ground for complaint. Having regard to the fact that the company is under statutory obligation to supply current,

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it is held that it is specially protected against injunction for alleged nuisance; moreover, there appears to have been a remarkable diversity of opinion among residents in the vicinity of the works as to there being any nuisance at all, or, if existing, as to what precisely it was like. Trumped up rumours and allegations of nuisance from electricity works do more harm to the neighbourhood than to the works, a fact which ratepayers and property owners would do well to remember in their own interests.

A FORTNIGHT ago we announced that the London County Council had been advised that it already is in possession of powers for working its tramways electrically. We are glad to observe that these powers are not to lie fallow, and that the Council has begun in earnest to inquire as to the best system to adopt. At the last meeting of the Council Prof. A. B. W. KENNEDY was engaged to give advice "for a fee of 500 guineas, with an additional 100 guineas for travelling expenses, in order that, before reporting upon the matter, he may make full investigation as to the systems in use in different places." This last part, by the way, is rather like paying a physician's college fees before taking his physic.

INTER-COMMUNICATION in railway trains is doubtless a necessity, and the electrical system of effecting it is admittedly the best; but the methods by which it may be carried out are so simple, and have resolved themselves into such mere questions of detail, that the subject appears hardly interesting enough to occupy the attention of the Institution of Electrical Engineers for a whole evening. That it should, for instance, have been deemed worthy of serious discussion whether or no a chain was the best means of affording electrical connection between two railway coaches, was ridiculous; the meeting finally saw the humour of it when Mr. WINTER, after condemning the employment of rail returns, dilated on the excellent conductance of tarred chains. The Paper has been useful in one way, however; it has shown us that the long delay in the general adoption of electrical intercommunication in trains has been to a large extent due to the amateurish nature of the methods tried on some of the leading railways.

TRANSMISSION of electrical power for manifold uses, from water power situated at a great distance from the place where it is used, although so great a boon to mankind, is not without its constant worries for the electrical engineer. In a recent issue of the *Electrical World* of New York the anxiety caused by the number of transformations of Niagara power is alluded to; and, indeed, when we contemplate the long chain of mechanism and apparatus the energy must pass through before it arrives at the energy-utilising device, surprise that interruptions are not more frequent takes the place of dismay at their occurrence.

TAKE, for example, the transfer of power from Niagara Falls to the premises of a customer in Buffalo. The mechanical power is first controlled by the hydraulic governors; then comes the fuse-shunted circuit breaker protecting the step-up transformers at the power station; next, similar protecting devices at the step-down sub-station; after that, high-pressure fuses protecting the primary windings of the step-down transformers; then aluminium fuses on the secondary windings. Following these come fuses on the polyphase circuit, and circuit-breakers on the continuous current circuit of the rotatory converter; then circuit-breakers in the feeders; and finally the fuses in the consumer's premises. At each and all of the nine points enumerated the express purpose of the apparatus is to interrupt the circuit; as contrasted with the generating, transforming and transmitting plant proper, wherein accidental—*i.e.*, unintended—interruptions may take place through breakdown.

IN Mr. ANDREWS' report to the Electric Light Management Committee of the Hastings Corporation, referred to in another column, we observe a feature that will be regarded by contractors with mixed feelings, if generally adopted by engineers advising owners of municipal electric supply undertakings. Mr. ANDREWS, having made up his mind what type of engines and dynamos are most suitable for certain necessary extensions, boldly mentioned these by name in his report, and tenders were asked for these makes only. Most engineers, in similar circumstances, would have invited tenders by advertisement from any and every builder of dynamos and engines; though often it is decided beforehand which machines will be chosen. When the conditions are such that every tender can be treated on its own merits, every manufacturer is distinctly entitled to a chance of obtaining the contract, especially in the case of works to be built with public money; but when, as at Hastings, a particular article is to be bought for particular reasons, it may seem superfluous, and it would certainly cause much unprofitable labour, to invite a number of estimates which are known beforehand to be needless.

PARTICULARS will be found in our City Notes of the prospectus just issued of the Nernst Electric Light (Limited). Out of a total capital of £320,000, no less than £270,000 is to be paid, in cash and shares, for "the right to apply for patent rights in the countries comprised in the continents [and islands] of Australasia, Africa, Asia, South and Central America," patents having been applied for in certain countries on these continents. Though the title of the new company would not appear to indicate the fact, none of the British, European, or North American rights are to be acquired—a vital fact which is disclosed only on the third page of the prospectus.

THE pleasant but somewhat irrelevant information is tendered that the three companies who own these latter rights "are generally recognised to be three of the leading undertakings in the electrical world"—though how this can affect the present flotation passes our comprehension. There is also a list of cities within the new company's sphere, including such places as Pekin, Shanghai, Smyrna—where, we understand, dynamos are confused with dynamite, and both are taboo. Having regard to the fact that NERNST light has made only one public appearance in this country, and then only in a lecture room, we can quite appreciate the statement that "The working capital of £50,000 provided by this issue is considered by the Directors to be ample for present needs, as

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the operations of the Company should not entail large capital outlay." Ample?—we had rather said excessive! But the question is whether the "operations" will be "ample" enough to pay a dividend on £320,000. We strongly advise intending subscribers to read carefully through page 8 of the prospectus.

Cable Interruptions.	Date of Interruption.
Dakar—Bathurst	Feb. 9, 1899
Paramaribo—Cayenne	Feb. 10, 1899

The Society of Arts.—In consequence of Mr. Philip Dawson's indisposition, the reading of his Paper on "Electric Traction" last Wednesday was postponed.

Erratum.—In the note on the Long-Schattner prepayment meter, appearing in our last issue, instead of the last word "short-circuited," read "in circuit."

Royal Society.—The following were among the Papers down for reading yesterday:—"Some Experiments bearing on the Theory of Voltaic Action," by Mr. J. Brown, and "The Efficiency of Man, or Economic Coefficients of the Human Machine," by Dr. Marcet, F.R.S., and Mr. R. B. Floris.

Wireless Telegraphy to Sicily.—Experiments are about to be made with Marconi's system of wireless telegraphy across the Straits of Messina, between Reggio and Messina, and the *Elektrotechnischer Anzeiger* hears that if these are successful they will lead to a regular wireless telegraph service being established between the two points.

Conduit Explosion.—Another explosion, very similar to the one we chronicled last week, but, according to an eye and ear witness, "of much smaller dimensions," occurred at Belfast on Thursday last week, at about 3 p.m. Some 15 yards of pavement were disturbed, but there was no damage to person and practically none to private property.

The "James Forrest" Lecture.—The Institution of Civil Engineers announces that the seventh "James Forrest" lecture will be delivered by Prof. J. A. Ewing on Thursday, April 20th, at 8 p.m., the subject being "Magnetism." The lecture will be repeated at four o'clock on the following day, for the benefit of members and their friends.

An X-Ray Yarn.—*Electricity* of New York states that an up to-date Californian poultry raiser is using the X-rays in the following novel manner:—All his hens are examined under the rays, and those which are not found to be "built for laying eggs" are immediately shipped to market, while the remainder are retained for the egg department.

Lectures on the Design of Polyphase Machinery.—In view of the extensive use of polyphase machinery abroad, and the demand for it which is steadily increasing at home, it is interesting to note that a special course of instruction upon the commercial design of this class of plant will be given at Finsbury Technical College. The course, commencing March 7th, and extending over six evenings, will be given by Mr. A. C. Eborall, assisted by Mr. W. B. Woodhouse.

Electromagnetic Power Couplings.—The mill of the Cliff Paper Co., of Niagara Falls, has for some time past been driven by electric power. It is found, says the *Electrical World*, of New York, that electric transmission gives an elasticity and comparative smoothness of working sufficiently superior to mechanical connection between the paper-making machines and the driving turbines to make electric transmission advisable even for the shortest distance. In other words, the electric circuit acts as an elastic coupling and thus screens the paper machinery from irregularities of driving.

A New French Submarine Cable.—The Compagnie Française des Câbles Télégraphiques have ordered from the Société Industrielle des Téléphones, who made the recent Brest–New York cable, a cable 250 miles long to connect Vela de Coro with Maracaibo (Venezuela). Although this order is but a small one, it is giving great satisfaction in France, the *Industrie Electrique* pointing out that the Company has now made over 12,000 miles of submarine cable, and that, thanks to its efforts, France now takes part in an important industry which has been until recently exclusively an English one.

An Electric Railway to Chamonix.—According to the *Industrie Electrique*, the Paris, Lyons, and Mediterranean Railway Company is about to construct an electric railway from Saint-Gervais-les-Bains to Chamonix, at the foot of Mont Blanc. It will be a metre-gauge line, intended both for passengers and goods. The current will be collected from a side rail, and a rack and pinion will be employed where the gradient is steep. The River Arve will furnish the necessary energy, partly from the station already existing at Chedde, and partly from three other power-houses which are to be built. The line is about 12½ miles long, and crosses the Arve several times.

American Telephone Scheme.—It is reported from the other side of the Atlantic that a scheme for telephone connection on a broad scale has been devised in which four Bell companies—the Bell Telephone Co. of Canada, the American Telephone and Telegraph Co., the Michigan Telephone Co. and the Wisconsin Telephone Co.—will take part. A continuous telephone system will be organised from Quebec and Montreal up the St. Lawrence, touching Toronto, Buffalo, Cleveland, Detroit, Port Huron and other places to Duluth, on Lake Superior; in fact, every city and town of importance situated on the chain of Great Lakes and the St. Lawrence river will be in telephonic communication.

The Telegraphists' School of Science.—At the St. Martin's Town Hall, London, on Monday evening, the Duke of Norfolk presented the medals and certificates gained by students of the Telegraphists' School of Science of the Central Telegraph Office during the past year. Mr. A. Brooker, chief instructor of the school, who presided, stated that the classes would from henceforth be held in more spacious premises at the Northampton Institute, Clerkenwell, instead of at the Central Telegraph Office. After the distribution the Duke of Norfolk presented Mr. W. Slingo, who founded the school, and was for 21 years principal, with a service of plate, subscribed for by the male students, as a mark of esteem on the occasion of his retirement. The formal proceedings were followed by a students' *soirée*.

The Collection of Current by a Tramcar.—At the meeting of the Civil and Mechanical Engineers' Society, on Thursday last, the 16th inst., Mr. Holroyd Smith, gave a lecture on "Some Methods of Collecting the Current in Electric Tramways." He prefaced his remarks by a brief statement of principles. In dealing with the methods of collecting current, reference had to be made to the various systems of electric traction, and a brief *résumé* of the history from 1832 to the present day was given. By means of numerous diagrams the lecturer showed the constuction and details of nearly every known collector for underground work, with closed or open conduits, and for overhead with tubes, wires, &c., describing the brush, the bar, the shuttle, and the trolley; and compared the relative advantages of rolling and sliding contact, stating his preference for the latter. He considered that the electrical world was largely indebted to Sprague, of America, who he believed to have been the first to introduce the trolley bar collecting the current from the underside of an overhead wire.

Institution of Electrical Engineers.—At the last meeting of the Institution, it was announced that in consequence of the resolution passed on the subject of wiring rules at the meeting on February 10, the Council has re-appointed the Committee that framed the Institution rules, with certain instructions in order that the wish conveyed to the Council in that resolution might be duly carried out. The Chairman (Dr. Silvanus P. Thompson) also informed the meeting that, after years of consideration, the Council has adopted a seal and form of diploma, thus conforming to Article 10 of the new Articles of Association. The diplomas will forthwith be printed and, in due course, will be available to those members and associate members who apply for them. The diplomas will be printed on a special kind of Japanese paper, and no charge will be made to those entitled to apply for them. The Council have also decided to have a number of diplomas struck off on vellum, necessarily at some considerable extra expense, and for these a charge of one guinea is to be made; any profits arising out of this will be devoted to the building fund.——The secretary informs us that the Council has also appointed a

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committee "to inquire into the future of electrical engineering in the domain of telephony in these kingdoms."

American Cable Schemes.—Col. Maxfield, of the Signal Corps, is organising a cable detachment in connection with the laying of submarine lines in the Philippine Islands. The War Department has authorised the manufacture of 200 miles of cable, to be laid between the different islands of the Philippine group. The cable, with special machinery, which is also in the course of manufacture, will weigh between 700 and 800 tons. It is expected that this will leave New York very shortly, and proceed to Manila through the Suez Canal. The Signal Corps has a short cable of eight miles now in operation in Manila Bay. The land lines in the Philippines are, says the *Western Electrician*, nearly 2,000 miles long, and are mainly on the islands of Luzon, Masbate, Cebu and Leyte.——The bill introduced by Mr. Lodge, in the United States Senate last month, provides for a submarine cable between the United States and Hawaii, the Philippines, Japan, China and Australia. The postmaster-general is authorised to contract with the Pacific Cable Co., of New York, for the payment of $125,000 a year for 20 years, for transmission of official messages from San Francisco to Honolulu, the line to be laid by December 31, 1900. Before December 31, 1902, the company shall construct a line from Honolulu to Manila, with an additional sum of $125,000, to be paid annually by the government. Within four years the company shall lay connecting lines to Japan, for which $25,000 a year for 20 years shall be paid. The rates fixed between San Francisco and Honolulu are 35c. a word, and to the more distant points $1 a word.

A Vacuum Telephone Transmitter.—A new form of telephone transmitter has been devised by Mr. Paul de Kilduchevsky, from which it would appear a future is in store if the results of the preliminary trials are borne out in the commercial form of instrument, and if there is no important deterioration with age. The principle on which the instrument is based is the enclosure of the microphonic contact in a small glass vacuum tube (or in a tube of inert gas), this tube being attached bodily to the transmitter diaphragm. As in the case of the filament of an incandescent lamp, the exclusion of air enables larger currents to be used than would otherwise be the case without the combustion of the carbon, and the advantages (especially for long-distance work) of a transmitter, through which large currents can be sent without clogging the instrument, are well known to all telephone men. The inventor has found that the pencil form of contact and the "granular button" give equally good results, but he prefers the latter, as its construction is simpler and cheaper. Either form is contained in a glass tube, 1in. diameter and 4in. long. Six or seven accumulators in series have, we are told, been used, giving variations of current from 0 to 9 amperes in the microphone circuit, without impairing the articulation. Tests have been recently made by Mr. A. R. Bennet, in which two of the most efficient transmitters in ordinary use were compared with the Kilduchevsky under identical conditions. First the conditions for ordinary short-distance work were imitated, and it was found that, while with 2, 3, and 4 dry cells all behaved equally well on increasing the number of cells to 6 the new transmitter gave louder results. Next the artificial cable resistance was increased to about 350 ohms, with a capacity of about 35 microfarads, and it was found that the intensity of the ordinary transmitters was considerably reduced, leaving the Kilduchevsky markedly the best. The dry cells being next replaced by three E.P.S. accumulators, and the artificial cable circuit increased to about 500 ohms and 50 microfarads, the speaking continued quite good enough for ordinary conversation. On replacing the double-pole receiver by one of Mr. Kilduchevsky's, in which the magnetism was reinforced by an extra set of coils and a local battery of six dry cells, the loudness of transmission was again increased. We understand that larger currents were not employed for fear of damaging the artificial cable by the higher voltages that would have been induced in the secondary of the induction coil.

The Individual Behaviour of Accumulator Plates.—*L'Industrie Electrique* of Jan. 25th contains an article by M. M. Schoop "On a Practical Method of Determining the Components of the Capacity of an Electric Accumulator." His method consists of an examination of the behaviour of each of the electrodes individually by the employment of an auxiliary electrode. By this means, for instance, he is easily able to see whether the positive or negative plates are first exhausted. In most of the cells he has examined, it is the positive plates; in a Tudor cell of the 1891 type, however, the reverse is the case, and in two German cells he finds the capacity of the negative electrode nearly twice that of the positive. The use of an auxiliary electrode for such investigations is not new, but M. Schoop has paid particular attention to the construction of this electrode in order to avoid all possible sources of error in the experiments. It consists of a preferably cylindrical porous pot into which mercury is first poured to a depth of 10mm., and over this is put a layer of $HgSO_4$, the tube being then filled with dilute sulphuric acid of 1·17 density. A gelatinous electrolyte may be used by adding to the sulphuric acid one-third its volume of silicate of potassium. A platinum wire, fused in a glass tube to prevent contact with the electrolyte, passes through the celluloid cover of the porous pot and dips into the mercury. When not in use the porous pot should be kept in a solution of sulphuric acid to prevent the gelatinous electrolyte from drying up. Comparisons of the difference of potential and electromotive force between this electrode and each of the two poles of the cell give useful results. In most of the better-known cells, especially those with grid positives, it is the peroxide electrode that requires replacing first; but it is noticed that the capacity of the spongey lead electrode also diminishes gradually, the volume of the active material diminishes, and the cracks are produced. The only cell known to the author in which the contrary occurs is that of Khotinsky; in this cell the active material swells instead of shrinking. The author attributes this to the addition of certain substances to the active material. Curves are given of tests made on a Gottfried (Hagen) cell. From readings of the electromotive force and potential difference between the terminals and the auxiliary electrode, the enormous increase in resistance at the negative plate near the beginning of the discharge is apparent, and also the fact that this resistance is greater the greater the current. With smaller currents, however, this dip in the curve appears to take place at an earlier period than with larger currents. These variations, says the author, show an intimate connection between the internal resistance and the facility of diffusion of the acid, which is a function of the quality of the active material.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) **FRIDAY, February 24th.**

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Papers to be read: (1) "The Joule-Thomson Thermal Effect," by E. F. J. Love; (2) "A Study of an Apparatus for the Determination of the Rate of Diffusion of Solids Dissolved in Liquids," by Albert Griffiths; (3) "Note on the Source of Energy in Diffusive Convection," by Albert Griffiths.

ROYAL INSTITUTION.

9 p.m. Evening Discourse, "Coherers," by Prof. O. J. Lodge, F.R.S.

SATURDAY, February 25th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture III.—"The Mechanical Properties of Bodies," by the Right Hon. Lord Rayleigh, F.R.S.

WEDNESDAY, March 1st.

INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Students' Meeting in the Library. Paper to be read: "Direct and Alternate Current Distribution," by H. H. Williams.

GLASGOW PHILOSOPHICAL SOCIETY.

8 p.m. Lecture on "Electric Discharges in Vacuo and the Röntgen Rays," by A. A. Campbell Swinton.

THURSDAY, March 2nd.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read: "Wireless Telegraphy," by G. Marconi.

FRIDAY, March 3rd.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Meeting at the Westminster Palace Hotel, when a Paper on "Carbon Consuming Batteries and their Possibilities," by W. R. Cooper, will be read.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

A Simple Magnetometer.—For rapidly measuring the modifications of magnetisation produced by percussion, heating, and other physical causes, A. Guillet has devised a magnetometer, consisting of a metallic square, suspended by a thin wire, and carrying below it a hollow metallic cylinder. Both the plane of the square and the axis of the cylinder are vertical, and a current is conducted through the wire, the two sides of the square, the cylinder, and out by two very fine silver wires, which do not impede the freedom of the suspended system. First the pole strength of the bar is measured by the magneto-electric deflection it produces when its pole is inserted in the cylinder from below. The formulæ are surprisingly simple, and the deflection is accurately proportional to the pole strength. Next, the position of the pole within the magnet is determined by gradually pushing it into the square until the latter shows a maximum deflection. At that point the pole itself is in the plane of the square, and its position is found. Knowing the pole strength and the magnetic length of the bar, the magnetic moment is known. Rapid operations are possible, and the sensitiveness of the instrument may be varied by shortening or lengthening the suspending wire. The same apparatus may be used as a ballistic galvanometer or an electrodynamometer.

[Guillet, *Comptes Rendus*, Jan. 2, 1899.]

Magnetic Fluxes in Electrical Instruments.—In all electrical measuring instruments in which the deflecting or controlling forces are electromagnetic, the magnetic fluxes and fields are of great importance, and yet there seem to be no tables published which give even rough measurements of these. In order to fill this gap, A. Campbell has recently carried out a series of experiments upon the more familiar types of instruments. In the direct-current instruments, the flux was measured by the ordinary search-coil method, while in alternate-current instruments a high resistance was inserted in the search-coil circuit, and was wound in contact with a thermopile. B, the number of induction tubes per square cm., was found to vary from 0·008 in a Kelvin astatic mirror galvanometer to 14,200 in an Ayrton and Perry magnifying spring voltmeter. Some of the intermediate values were 65 in a Kelvin ampere balance, 870 in a Weston voltmeter, and 3,000 in a Bell telephone. The author also investigated the energy spent in power meters, especially of the motor type. He found that in these the driving-flux density is of the order 100, and the brake, B, is 500 to 1,000. The power spent is 3·2 in the Hookham alternate-current meter, and 10·4 in the Schallenberger meter. In all the motor meters the greater part of the power taken is spent in heating conductors (either by eddy-currents or otherwise). If a small fraction of this wasted energy could be employed to overcome with certainty the friction at the lowest loads, a great advantage would be gained thereby.

[Campbell, *Phil. Mag.*, January, 1899.]

Electrolytic Iron.—Iron produced by electrolysis is far from being a pure metal. It contains 100 to 150 times its volume of hydrogen, and Lockyer has shown that it contains certain traces of 10 other metals and uncertain traces of 11 more. But a very important impurity is carbon. It occurs in quantities varying from 0·08 to 0·03 per cent. in all kinds of electrolytic iron hitherto produced. How much carbon goes to the cathode with the iron during electrolysis depends upon the form in which the carbon occurs in the iron or steel. L. Houllevigue has made some valuable tests with a specimen of pure steel from the Assailly steel works, which contained 0·4 per cent. of carbon, It was electrolysed in a bath of iron and ammonium chlorides. The result was different according to the treatment of the steel before electrolysis. One piece was tempered at 680°C., while another was slowly cooled from a temperature of 900°C. The former, therefore, contained carbon dissolved in the iron, but not combined with it, while the latter contained carbon combined with iron (perlite). The latter after electrolysis yielded iron containing about 0·08 per cent. of carbon, while the former yielded iron containing practically no carbon at all. It seems, therefore, that there exists some compound molecule of iron and carbon capable of acting as a cation, as does cyanogen among other radicles.

[Houllevigue, *Journ. de Phys.*, Dec., 1898.]

Electrolytes in a Magnetic Field.—While admitting that the resistivity of electrolytes does not vary in a magnetic field, H, Bagard maintains that the resistance of any given liquid conductor is modified by the presence of such a field, and he describes the manner in which such a variation may be brought clearly into evidence. The liquid conductor is a ring of $CuSO_4$ solution contained in a circular glass tube of rectangular cross section. This ring is placed between the poles of an electromagnet so that the lines of force are parallel to the axis of the ring. The latter is interrupted for a short length, and tubes containing more liquid and leading to the current terminals are welded on side by side. On establishing a field of some 5,000 units, the galvanometer indicates an abrupt change of resistance amounting to about 1 per cent. in case of a ring 4·4 c.m. wide and about 1 sq. cm. in sectional area, and when the current is in such a sense that the magnetic lines of force would tend to narrow the circle. It is rather more than that when the force is such as would tend, by Ampère's rule, to widen the circle. The author accounts for this phenomenon by supposing that the magnetic field has a definite effect upon the flux of the current in the liquid, as has already been admitted theoretically.

[Bagard, *Comptes Rendus*, Jan. 9, 1899.]

Radiophony.—A. Sella describes a method of transmitting sound by means of ultra-violet light. The circuit of a powerful influence machine, without condensers, is closed by a telephone and a short air gap. When the machine is working the rapid succession of sparks produces a sound in the telephone. If a beam of ultra-violet light impinges upon the negative-terminal of the gap the sound in the telephone is much altered. If the impact of the ultra-violet light undergoes a periodical variation the sound in the telephone will show an alteration of the same period, and if these periodical variations are short enough combination tones are produced corresponding to the periodical disturbances of the ultra-violet light. On this principle the author has constructed his radiophone. The ultra-violet beam is periodically deflected by means of a phonautograph mirror, and the beam is finally received upon the flat cathode at the distant station. Greater clearness is obtained by putting the spark gap in circuit with the secondary of an induction coil, and the telephone itself in the primary. Another device, also based upon the use of ultra-violet light, is described by M. Dussaud. But he makes the beam impinge upon a fluorescent screen which in turn modifies the resistance of a battery of selenium cells. Both inventors use the arc for producing the ultra-violet beam.

[Sella, *Nuov. Cim.*, Oct., 1898, and Dussaud, *Comp. Rend.*, Jan. 16, 1899.

Zeeman Effect on a Large Scale.—In attempting to furnish further material to decide the still pending controversy as to the nature of cathode rays, A. Broca has produced phenomena analogous to Zeeman's phenomena on a visible scale in vacuum tubes. As the author points out, if Crookes' assumption is correct, and the cathode rays are electrons projected from the cathode, then they must come under Lorentz's theory, and must in a magnetic field have two stable trajectories—one in the direction of the lines of force, and the other a screw line traced on a cylinder or a cone, with its axis normal to the lines of force, the cone applying to the case where the magnetic field is not uniform. The spiral lines have already been shown to exist by Braun and others, but Broca finds that when the magnetic field acquires a certain intensity the rays along the lines of force become visible, and often both kinds of rays are seen in the same tube. The arc light shows similar phenomena, modified by the higher pressure. In fact, the motions of the ions in the Bunsen flame and in the vacuum tube are essentially the same, and another link is traced between light and electromagnetic phenomena, which confirms the emission theory of cathode rays, and enables us to watch the Zeeman effect without the aid of the spectroscope.

[Broca, *Journ. de Phys.*, December, 1898.]

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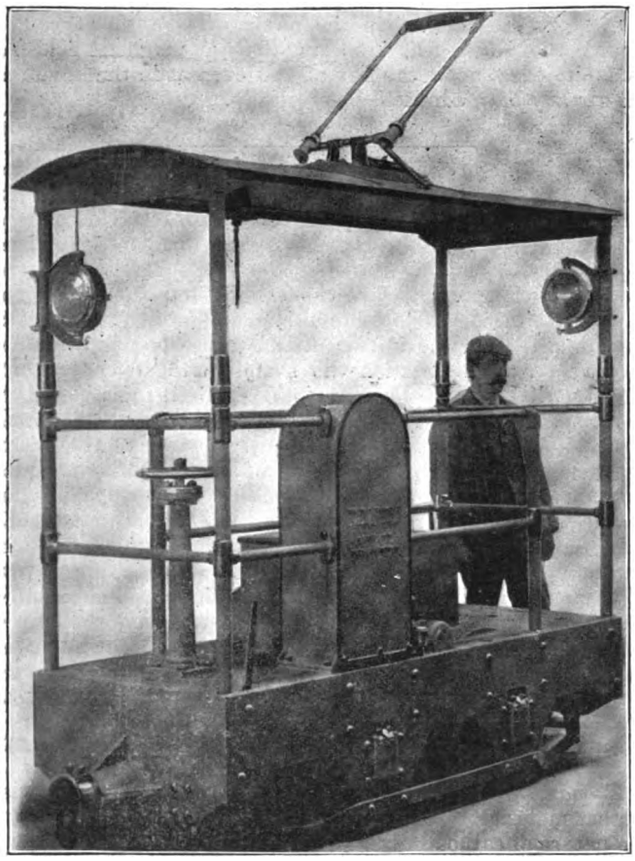
Condenser Losses.—E. B. Rosa and A. W. Smith describe a resonance method of measuring the energy dissipated in condensers. How important it is to know the amount of energy that is likely to be absorbed by a condenser of any particular construction, under given working conditions, is illustrated by the fact that some condensers rise in temperature as much as 30°C., and, if they are of the paraffined paper type, the paper would, on a warm summer's day, be floating in melted paraffin. The authors measure the energy absorbed by means of a wattmeter, which, together with a shunt resistance, forms one branch of an alternate current circuit, the other branch containing the condenser and a coil of large inductance, but without an iron core. The coil insures the absence of upper harmonics. Measurements carried out on some commercial beeswax and rosin condensers yielded unexpected results. There was a well-marked maximum of energy loss at 39°C., or a temperature at which the composition begun to soften. As the temperature rose the loss decreased, but even then it was some time before the condensers gave way or any considerable leakage current set in. The loss itself was surprisingly large, ranging, as it did, from 22 watts at 36°C. to 30 watts at 39°C. The capacity of the condensers was $\frac{1}{3}$ microfarad, and the percentage loss about 9.

[Rosa and Smith, *Phys. Review*, Jan., 1899.]

CONTRACTORS' ELECTRIC LOCOMOTIVES FOR THE WATERLOO-BAKER STREET RAILWAY.

The work of tunnelling for the deep level underground electric railway between Waterloo and Baker-street is proceeding at a rapid pace. An interesting feature of the contracting work during the construction of this line will be the use of a special type of electric locomotive on the temporary railway over which the material will be hauled to the shaft recently sunk below the Thames, at Charing Cross. Six locomotives for this work are being made by Messrs. Thomas Parker (Limited), of Wolverhampton. One of these locomotives, now completed, is shown in the accompanying illustration from a photograph; while details of construction of the locomotives are shown to scale in another of the illustrations. The locomotives have been designed by Messrs. Thomas Parker (Limited) to meet stringent conditions laid down in Messrs. Burstall and Monkhouse's specification, which provides, among other things, that the maximum width over all must not exceed 3ft. All the working parts are covered, being, at the same time, easy of access. The motor is enclosed in a cast iron case, with a lid to give access to the commutator, and there is a glass window over the commutator to allow of ready inspection. The motor case serves as a seat for the motor-man. The switch-box is built into the railing round the locomotive platform, an arrangement which permits of the conductors being carried through the tubes forming the frame. Current is collected from an overhead trolley wire by means of a trolley roller, and the head room over the car to the trolley wire is naturally considerably below usual trolley practice. This arrangement for collecting the current allows of a greater latitude in putting up a temporary trolley wire as regards centreing, while, at the same time, permitting the locomotive to pass through comparatively low passages. Where the head room is extremely small the canopy can be removed in order to bring the locomotive through. From the trolley collector the current passes to the switch and controller box, and then to a single-series motor, the armature of which is wound with Messrs. Parker's Eickemeyer winding. The return current, as usual, is taken through the track rails, which, by the way, are at 18in. gauge. The current is supplied at 200 volts, and at this pressure each locomotive develops from 15 B.H.P. to 20 B.H.P., and will



20 H.P. Contractors' Electric Locomotive for the Waterloo-Baker Street Railway. Built by Messrs. Thomas Parker, Ltd.

25 H.P. Contractors' Electric Locomotive for Tropical Surface Work. Built by Messrs. Thomas Parker, Ltd.

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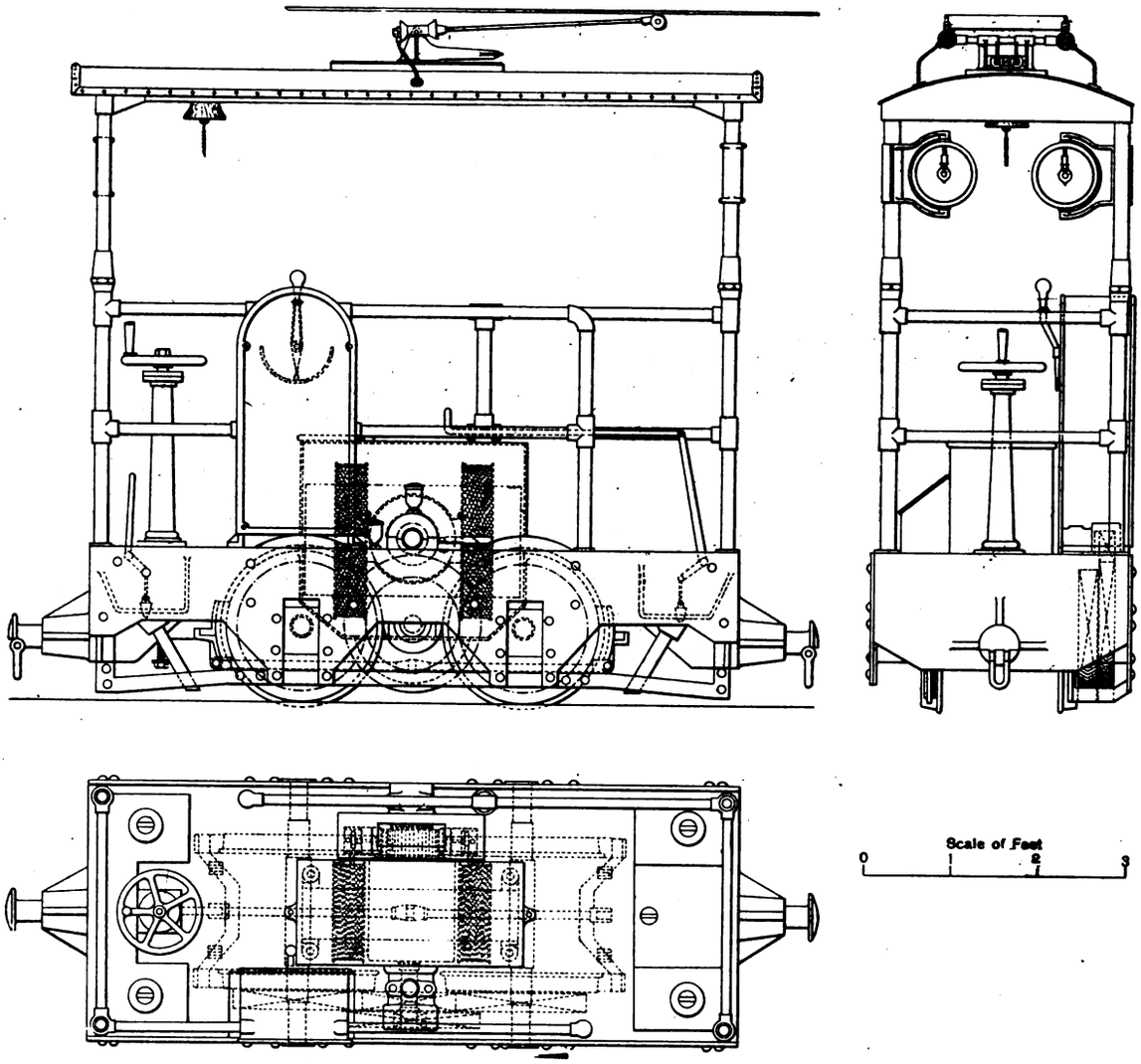
run at a speed of 10 miles an hour on the level. The motor is geared by double helical gearing to both the locomotive axles, thus giving the maximum possible adhesion to the rails and allowing of heavy hauls up steep gradients, if necessary. The starting and reversing motions are controlled by one handle which breaks a reversing switch fixed at the top of the switch-box, and geared to a resistance switch with platinoid coils inside the box. There are two electric headlights, arranged to swivel, one side of the lamp being of clear glass and the other of red. The arrangement of the locomotive, as will be seen from the illustrations, permits of its being worked in either direction without necessitating changing the position of the driver, who has a clear view in all directions. From his seat on the motor box he can work the switch, the sand-box lever and the brake, which acts on all four wheels.

ELECTRICAL UTILISATION OF NIAGARA FALLS.

(*Continued from page 567.*)

The general scheme of grouping the machines in banks of five each group indicated and controlled on a separate switch-board has been followed. Each machine is fitted with an instrument panel and in front of it a lever stand, standing separate from the others and practically identical with those of the original installation. The instrument panel contains simply two indicating ammeters, voltmeters and wattmeters, one for each phase. Above these six instruments is a small synchroniser. This is simply a voltmeter connected to the secondary of an instrument transformer. Each synchroniser in series with its secondary winding is simply connected across two 'buses common to all, each instrument having a key like



20 H.P. Contractors' Electric Locomotive for the Waterloo-Baker Street Railway. Built by Messrs. Thomas Parker, Ltd.

Warning of the approach of the locomotive is given by a small bell suspended from the canopy.

It may be of interest to our readers to learn that Messrs. Thomas Parker (Limited) have for some time past manufactured contractors' electric locomotives for railway work. Another of our illustrations shows a type of electric locomotive somewhat different from that for the underground railway between Baker-street and Waterloo. This has been supplied for railway work in South Africa during the last two or three years. It is rather more powerful than the Waterloo and Baker-street type, working up to 25 B.H.P.; and, as will be seen, it is more completely enclosed, so as to offer protection against the sun. The general arrangement of the motor and gearing, however, is the same as in the latter type.

that of a lamp socket. Below the six Niagara-type instruments on each panel is one Weston direct-current ammeter indicating the exciting current. The lever stand is surmounted by the ordinary hand wheel controlling the field rheostat and bears also four handles operating air valves directing compressed air to four pneumatically operated switching devices. One of these is a circuit breaker in the field circuit, its chief peculiarity being that it connects across the terminals supplying the field, just before opening the circuit—a non-inductive resistance of one ohm. The resistance of the field winding itself being an ohm and a-half, and that in series with it perhaps three ohms, the inductive rise of pressure cannot much exceed that generated by the exciters, or 220 volts. Another of the valves controls a throw-over switch in the field circuit, whereby it may be fed from one or the other of the

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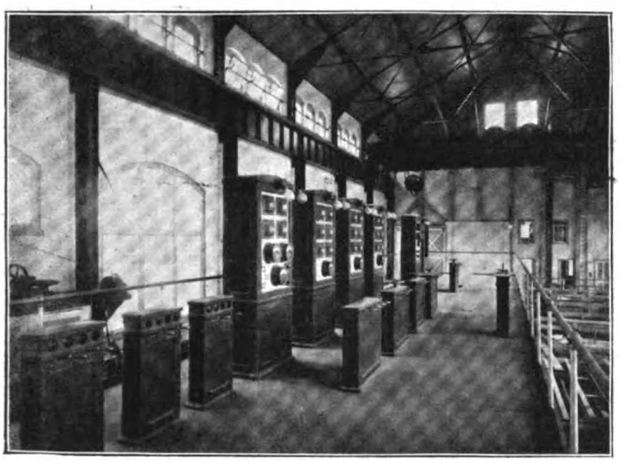
two pairs of exciting 'buses. The other two valves control respectively two four-pole single-throw switches in the main dynamo circuits, two poles for each phase, the two switches connecting respectively with two sets of four-pole 'bus bars. These switches are intended to break the maximum load which the machines will give on emergency, and will do so, although, of course, they are normally opened only after their respective machines have had their load removed. These main switches have primary or low-resistance contacts of the ordinary knife, and laminated-spring clip style and secondary breaks—shunted around the main contacts through a resistance of 1,200 ohms per pole—consisting of eight split tubular receptacles and plugs of non-arcing metal. These are so connected up that all eight are in series on each pole, giving 16 breaks in series in each phase, the maximum opening being about 1in. per break and in a horizontal direction.

A modification not contemplated in the original plan, but which has been added to all eight machines, is the provision of emergency shut-down stands, one on each of the two switchboards. These shut the machines down, not by opening the main circuits, but by opening the fields by means of the field circuit breakers, which can not only be unlatched by the air cylinders and valves mentioned above, but also by a trigger and magnetic trip with a shunt coil operated from these shut-down stands. The latter consist essentially of two rows each

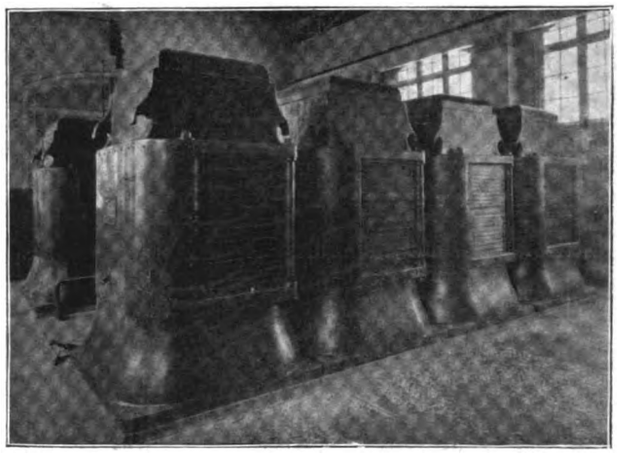


View of No. 2 Switchboard Gallery.

of five plug switches, each machine being represented by a switch in each row. Besides these is a double-pole double-throw knife switch which, closed in either position, throws current on to the circuit-breaker trip coils of all machines plugged in the corresponding way. Under normal conditions all the machines connected to one set of 'buses will be plugged in one row, and those connected with the other 'buses in the other row. In case there is serious trouble with the circuits branching from either set of 'buses, all that will be necessary to shut off the power from them will be a movement of the switch, which will open all the circuit breakers of the machines feeding that set of 'buses, and simultaneously set the governors in action and close the gates of the corresponding turbines.

In the original installation exciting current was derived from any one or more of three sources: A steam engine driven dynamo in the Niagara Falls Waterworks, or from either one or both of two 200-kilowatt rotary converters, deriving their power from the alternators which they excite, the pressure of the exciting circuits being 220 volts. In order to avoid dependence on an outside source of current, should the whole installation shut down for any emergency, and to give an exciting pressure less dependent on the machine voltage and speed, turbine-driven exciters have been installed with the new apparatus. There are four Westinghouse four-pole exciters resembling others of the same make in most particulars except that their shafts stand upright, the armature being overhung on the upper end of the shaft. The machines are fitted with two exciter panels and instrument stands, one on each switchboard, with a voltmeter and ammeter each, and pneumatic throw-over switches and circuit breakers. Each machine is direct coupled to a single radial inward-flow turbine. The speed of the exciters will be governed by hand through a pair of buttons, a magnetically-operated valve and an hydraulic ram attached to the gate.

The new machines are connected with their boards through vitrified ducts laid under the cement floor, instead of through small subways. A similar change has been adopted throughout the property of the company, the lines to the structures of the various tenants being now drawn into conduits, instead of being run through tunnels, as was originally intended under the proposals of Prof. Forbes. The latter also contemplated the use on all the local lines of 20,000 volts generated direct in the machines, instead of which the comparatively low machine voltage adopted is taken directly to the tenants' transformers. The feeders are tapped off from the 'bus-bars through pneumatic switches—which resemble the main machine switches—with lever stands on the galleries. Eight feeder lever stands have been constructed on the new switchboard beside the lever and instrument stands for the cross-connecting switches between the four 'buses on the two boards. The feeders run out through the subway to the transformer house, where those carrying power for Buffalo and other distant



A Bank of 935-kilowatt Transformers, Four of which Carry the Load of One 5,000-h.p. Generator.

cities enter the step-up transformers, the others being jointed here with the lead-covered cables drawn into the ducts of the conduits.

The transformer house now contains 10 air-insulated, air-cooled, 935-kilowatt transformers, the largest ever built, stepping the voltage up to 11,000. The high-tension coils are arranged in two parts in multiple, which may be thrown over to series, giving 22,000 volts. The present ohmic drop to Buffalo with all six wires in is only about 5 per cent. The transformers also change the phase relation, giving three phases for the line.

The total load on the station now runs up to about 15,000 kilowatts, the daily load curve being remarkably smooth, whatever variations there are in it being due to the Buffalo load. The local load, consisting mainly of furnaces and electrolytic plants, is ideal in its regularity, the local load curve for December 28, 1898, for example, varying between 11,700 kilowatts as a maximum and 11,500 as a minimum. For the same day the Buffalo load varied between a maximum of 8,140 and a minimum of 500 kilowatts, with an average of 1,668. The power factor of the whole load averages about 95 per cent. The load is rapidly growing.

In conclusion, we must refer our readers to a complete account of the Niagara Falls plant in the *Electrical World*, of New York, January 7th, to which we are indebted for the illustrations and descriptive matter embodied in this article.

(To be continued.)

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MAGNETIC LEAKAGE IN THE ALTERNATING CURRENT TRANSFORMER.

BY ALEXANDER RUSSELL, M.A.

(Continued from page 569.)

The Effect of the Shape of the Wave of the Applied E.M.F.—If we neglect the resistance of the primary coil, it can easily be shown that the maximum induction produced in the iron core is proportional to the area of the applied wave of E.M.F. and to the frequency. Looking back at the diagram of a transformer (Fig. 1), a little consideration will show that the maximum induction produced in the iron is exactly proportional to the area of the wave of E.M.F. that has the effective value BC. In commercial transformers we can assume that the induction varies as the area of the wave of the applied E.M.F. If v_m be the mean height of this wave, and $\bar{v}$ be the height of its centre of gravity, then

$$V_1^2 = 2v_m\bar{v}.* \quad . \quad . \quad . \quad . \quad . \quad . \quad (16)$$

For a given V_1, therefore, $\bar{v}$ is inversely proportional to v_m, and therefore inversely proportional to the area of the wave. Hence the maximum induction produced in the core is inversely proportional to the height of the centre of gravity of the applied wave of E.M.F. Curves with a high centre of gravity, generally called pointed or peaky curves, produce less induction in the core than curves whose centre of gravity is lower (rounded curves).

If we know the core losses in a transformer for a wave of any shape and the height of the centre of gravity of that wave, then we can predict to a certain extent how the transformer will act when subjected to waves of E.M.F., the heights of whose centres of gravity are known. We can predict, for example, the efficiency at any load; but we cannot predict the secondary voltage, as this depends on the leakage angle of lag which depends on the shape of the wave. We may say very roughly that the angle due to leakage varies as the height of the centre of the gravity. The law connecting this angle with the height of the centre of gravity is a purely mathematical one, and it would be interesting to know what it is. Kapp, Fleming and Roessler each introduce the idea of the form factor f, Dr. Fleming defining it by the equation

$$f = \frac{V_1}{v_m}.$$

We see by (16) that it also equals $\frac{2\bar{v}}{V_1}$ and $\sqrt{\frac{2\bar{v}}{v_m}}$.

It is, perhaps, unnecessary to introduce a new name, as there is no doubt that the number of new names being introduced into electrical theory frightens off young engineers who are quite capable of understanding the ideas involved. As every one knows what a centre of gravity is, it has not been thought necessary to introduce a new definition. Unfortunately, a great many names have been given to the centre of gravity as, for example, centre of mass (d'Alembert), centroid (Clifford), centre of inertia, centre of mean position, &c., and microscropic distinctions have been made between some of them, but there seems no good reason for changing from the *centrum gravitatis* of Newton when writing for engineers.

Testing Transformers on the Low Tension Side.—The advantages of not having to read ammeters and wattmeters on the high-tension side when testing transformers at central stations are obvious. The following method, which was shown to me five years ago by my old pupil, Mr. A. F. Berry, the inventor of the Berry transformer, has these advantages. The station high-tension voltmeter indicates the volts on the high-tension side, the volts and amperes on the low-tension side are read by an ordinary voltmeter and ammeter, the efficiency is then given by the formula,

$$\eta = \frac{V_2 W_2}{E_2 W_2 + V_2 W_0}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

where η is the efficiency for the load W_2 and E_2 is the secondary voltage on open circuit. W_0 is, of course, first determined by measuring with a wattmeter the magnetising watts required on the low-tension side to convert it into a step up transformer. This is a useful practical method, and for testing transformers with small magnetic leakage can be trusted up to full load. If transformers have considerable leakage then (17) gives the efficiencies too small at full load, in this case, by means of equation (8) above, we get,

$$\frac{1}{\eta} = \frac{E_2}{V_2}\cos\alpha + \frac{W_0}{W_2}, \quad . \quad . \quad . \quad . \quad . \quad (18)$$

and by (11) $\cos\alpha$ is very nearly equal to $\frac{V_2 + (S + n^2 R) A_2}{E_2}$, hence Berry's method can be extended to leaky transformers. A study of (18) is instructive, as it shows that if we have two transformers which have each the same W_0, and the same drop at full load then the leaky one is preferable from the user's point of view as it has the higher efficiency.

*Dr. Roessler's Tests on the Action of a Transformer with Differently Shaped E.M.F. Waves.**—The transformer Dr. Roessler experimented on was a small one of the closed iron circuit type with a capacity of about half a-kilowatt. The iron plates used in the core were half a-millimetre thick and were well insulated, and their weight was 8·168 kilos (18·01lbs.). The number of turns in the primary was 132 and in the secondary 265.

The primary and secondary resistances were 0·179 and 0·775 ohm when cold and 0·214 and 0·948 ohm when hot respectively, the hot resistances being taken after five hours running at full-load. As only a Cardew voltmeter whch took 35 watts at 120 volts was used, the open circuit volts were not measured directly. Dr. Roessler gives 117·5 as the open circuit voltage and this value has been adhered to in all the calculations. The true volts may, however, have been +0·2 volt higher.

This transformer was tested first with a 5·5 kilowatt four-pole machine by Ganz and Co. in which the magnets rotated and then with a small 0·5 kilowatt machine by Wechsler and Co. with four magnets on each side of a ring armature having four coils. The height of the centre of gravity of the E.M.F. wave of the Ganz machine is 1·48 times greater than the height of the centre of gravity of the rounded E.M.F. wave produced by the Wechsler alternator. With an effective voltage of sixty the height of the centre of gravity of the pointed wave was 50·8 and of the rounded wave 35·7. The induction density in the core of the transformer ought, therefore, to be 1·48 times greater in the latter case than in the former. Again by Steinmetz's law the hysteresis loss varies as the 1·6th power of the maximum induction density, and hence it will be 1·772 times greater with the Wechsler machine.

The eddy current loss in the core does not depend on the height of the centre of gravity of the applied E.M.F. wave but merely depends on the effective volts and hence it will be the same with the two machines. Let its value be x. The open circuit loss when connected to the Ganz machine was observed to be 34·5 and deducting the copper loss in the primary 0·2 $(1·46)^2$, *i.e.*, 0·4 nearly, we get 34·1 watts as the core loss. Similarly we get the core loss with the rounded waves to be 51·9.

We, therefore, have

$$51·9 - x = 1·772\,(34·1 - x)$$

$$\therefore\ x = 11 \text{ watts.}$$

The eddy current loss from this calculation appears to be 11 watts, and hence we easily find that the hysteresis loss in the iron is 2·27 watts per lb. with the rounded waves and 1·28 watts per lb. with the peaked waves.

Again, to find the maximum induction in the core in the two cases, the following simple method was practically adopted by Dr. Roessler.

With the usual notation we have

$$e = Ri_1 + n_1\frac{d(SB)}{dt}$$

where S is the section of the iron core and B the mean flux density of the induction embraced by the primary coil.

* See *The Electrician*, Vol. XXXV., p. 115; "Graphical Methods of Finding Mean Square Values," by A. Russell.

* "Das Verhalten von Transformatoren unter dem Einflusse von Wechselströmen verschiedenen periodischen Verlaufs." Read to the Verband Deutscher Electrotechniker, Munich, July 6, 1895.

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If T be the period of an alternation we have

$$\int_0^{\frac{T}{2}} e\,dt - R\int_0^{\frac{T}{2}} i_1\,dt = 2n_1 S B_{max}.$$

B_{max} denoting the maximum flux density. Now $\int_0^{\frac{T}{2}} e\,dt$ is the area of the E.M.F. wave and $\int_0^{\frac{T}{2}} i_1\,dt$ is the area of the current wave taken between two consecutive points where e vanishes. As the current area below the axis has to be subtracted from the current area above the axis $\int_0^{\frac{T}{2}} i_1\,dt$ is less than the area of the current wave. For the Wechsler machine we can see from Dr. Roessler's diagrams that $R\int_0^{\frac{T}{2}} i_1 dt$ is less than the 200th part of $\int_0^{\frac{T}{2}} e\,dt$. We can, therefore, in general write

$$\int_0^{\frac{T}{2}} e\,dt = 2n_1 S B_{max}.$$

This is easily written in the form

$$B_{max} = \frac{V_1^2 \times 10^8}{8 f n_1 S \bar{v}}. \quad . \quad . \quad . \quad . \quad . \quad (19)$$

where f is the frequency.

In the given experiment $f = 40{\cdot}57$, $n_1 = 182$, $S = 20{\cdot}19$, $V_1 = 60$ and $\bar{v} = 50{\cdot}8$ with the Ganz machine and 35·7 with the Wechsler. Hence, using (19), we find that B_{max} with the pointed curves was 8,200 and with the rounded curves 11,700. At these inductions the loss in watts per pound at a frequency of 41 in very good transformer iron is about one-half of what was found above.

In the following tables, Dr. Roessler's figures are altered by simple proportion so as to make the primary voltage 60 in each experiment. The primary angles of lag given in the fifth column are got by finding out what angle has its cosine equal to the true primary watts divided by the apparent primary watts.

Experiment with Ganz Machine (pointed curves).—Frequency 41. Maximum induction density in iron core 8,200. V_1 = primary volts, A_1 = primary amperes, W_1 = primary watts, ϕ_1 = primary angle of lag, V_2 = secondary volts, A_2 = secondary amperes, $W_2 = V_2 A_2$ and η = the efficiency $= \frac{W_2}{W_1}$.

No. of experiment.	V_1	A_1	W_1	ϕ_1	V_2	A_2	W_2	η
1	60	1·462	34·5	66·9		0	0	0
2	60	1·809	71·6	48·7	117·5	0·302	35·4	0·494
3	60	2·144	99·4	39·5	117·0	0·511	59·7	0·607
4	60	2·982	156·9	28·8	116·7	1·004	117·2	0·747
5	60	3·761	205·3	24·5	115·0	1·444	164·2	0·800
6	60	4·512	252·9	20·9	114·3	1·823	207·7	0·822
7	60	5·554	317·9	17·4	114·0	2·356	267·3	0·841
8	60	6·787	390·9	16·5	112·5	2·951	334·7	0·856
9	60	7·575	433·7	17·3	111·3	3·382	374·7	0·864
10	60	8·825	509·9	15·6	110·3	4·039	440·3	0·864
11	60		576·9		108·7	4·588	498·0	0·863

By formula (2) the ratio of the effective turns $n = \frac{E_2}{V_1 - RA_0 \cos\phi_0} = 1{\cdot}96$

Calculation of Angle of Lag due to Leakage. The angles α in the first row in the following table are calculated from the formula

$$\sin\alpha = \frac{A_1 \sin\phi_1 - A_0 \sin\phi_0}{n A_2}. \quad . \quad . \quad . \quad . \quad (5)$$

In the second row the formula

$$\tan\alpha = \frac{A_1 \sin\phi_1 - A_0 \sin\phi_0}{A_1 \cos\phi_1 - A_0 \cos\phi_0} \quad . \quad . \quad . \quad . \quad (7)$$

is used, and in the third row the probable values of α are given.

No. of experiment.	2	3	4	5	6	7	8	9	10	11
α by (5)	1·0	1·0	2·6	4·4	4·2	3·9	5·7	7·8	7·5	...
α by (7)	1·0	1·0	2·6	4·3	4·1	3·8	5·6	7·3	7·4	...
Probable α	0·7	1·1	2·1	3·1	4·0	5·0	6·5	7·2	8·7	10

If we try and find α by the cosine formula,

$$\cos\alpha = \frac{A_1 \cos\phi_1 - A_0 \cos\phi_0}{n A_2} \quad . \quad . \quad . \quad . \quad (6)$$

then in each cos α comes out greater than unity, showing that there is probably a small error in the determination of W_0 (perhaps, 1 per cent. too small). The leakage may be expressed by saying that the lag due to leakage when connected to the Ganz machine is 2·1 degrees per ampere of secondary current.

(To be concluded).

NERNST'S ELECTRIC LIGHT.

The following is an abstract, condensed from the *Journal* of the Society of Arts, of the discussion that took place on Feb. 8, in connection with Mr. James Swinburne's Paper :—

Prof. AYRTON said that the knowledge that an insulator could be made to conduct electricity by heating it was much older than the recent experiments of Sir W. Roberts-Austen, for some 23 years ago a Paper appeared in the *Transactions* of the Royal Society on the extraordinary diminution of resistance in a solid electrolyte by heating. In Japan, plates of zinc and copper were put on each side of a glass plate, which was heated, and the electromotive force passing, as indicated by a high-resistance voltmeter, after short circuiting the cell, appeared almost as rapidly as if the plates had been immersed in dilute sulphuric acid. It had also been known ever since carbon filament lamps had been on the market that there were certain difficulties connected with them, and many experiments had been made, and patents taken out, with the object of using refractory earths, but, apparently, no one before Professor Nernst had thought of the simple expedient of heating a very good insulator with a match or spirit lamp, applying a current of suitable potential, and thus obtaining a brilliant light such as they had now seen for the first time This result was clearly of enormous commercial importance, and would be an entirely new departure in glow-lamp electric lighting. It was also extremely interesting from the purely scientific side. Some five or six years ago he asked an assistant of his to look up the literature on the subject of the Welsbach burner, and see if any report had been made on the question whether the effect of the burner depended solely on the high temperature. He gave him a reference to a German paper in which experiments were quoted, which seemed to show that the high temperature was not the sole factor. Later on he discussed the matter with a very distinguished English chemist, who agreed in the view that it was not solely a question of temperature, and a year or two afterwards he again discussed it with Prof. Elihu Thomson in America, who took exactly the same view. Many people thought that the material of which the mantle was made had the power of absorbing oxygen from the air or the gas, much as spongy black absorbed hydrogen and oxygen, and so caused these gases to burn under considerable molecular pressure. It was not merely that the Bunsen flame raised the material to a high temperature, but that the gas and air were compressed together in the pores of the material, so that the gas was burnt under pressure, and so you got a much higher temperature than you otherwise would. In the glow lamp, as they were not dealing with gas, it did not seem that the materials could play any such part. There seemed to be something in that idea because it was necessary for the mantle to be a certain exact composition ; you could not take thoria or zirconia at random. In fact it was the addition of 0·4 per cent. of ceria which converted the Welsbach burner from a ghastly failure commercially into a wonderful success. He should like to know whether the mantle was not at a much higher temperature than the flame which surrounded it, and whether a particular combination of materials did not reach a much higher temperature than another combination immersed in the same flame. One great advantage about the Nernst lamp was that it did not seem to require a thin glass bell and a vacuum. He should like to know the reason of the difference in the colour of the light of the Welsbach and the Nernst lamps—was it a difference in material or in temperature? He understood from his colleague, Dr. Armstrong, who visited Prof. Nernst some time ago, that it was essential t use an alternating current, as with a direct current the incandescent ro soon ceased to make good contact with one of the platinum terminals.

Mr. HIRAM MAXIM said he had always understood that the light in the Welsbach burner did not depend entirely upon the temperature. There were many things in nature which gave light without any heat at all ; such were glow-worms and fireflies. His opinion was that any substance would give a light proportionate to the temperature ; that platinum or iridium, or iron, if the iron was not burnt, would all give the same light at the same temperature, provided none of the material volatilised. In all probability the light emitted did not increase as the temperature directly, but as some power of the temperature. In the Welsbach burner the light was not white, and that, he thought, indicated that some change was going on which made the apparent light higher than that due merely

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to the temperature. If carbon were heated to the same temperature it would not give the same light.

Mr. R. S. ERSKINE said it would be an enormous advantage to central supply stations when these lamps came on the market. There was a great difficulty in getting satisfactory 200 volt lamps, though he did not know that they were much worse than the 100 volts. The fact was the public were now educated up to a much higher standard of light. They were not content with an 8 c.p. lamp that gave eight candles, but wanted it overrun so as to give 10 or 12 candles, and the 200 volt lamps would not stand this; the old 100 volts stood it to a certain extent, but soon got inefficient. It looked as if the Nernst lamps would give the public what they wanted at a reasonable price.

Mr. W. M. MORDEY thanked Mr. Swinburne for speaking the truth about the 200 volt lamps. The companies should supply not electricity, but light; and instead of persuading customers to buy lamps of any particular kind, they should make an inclusive charge, and supply them with lamps themselves. He congratulated the Society on this Paper, which he thought would mark a new epoch in electric lighting; it was the first page in a new volume, recording an invention which would rank with that of the Swan lamp, since which there had been nothing brought forward so pregnant with results. They must also congratulate Prof. Nernst on his invention, and take care that he had the credit of it, and was not robbed by a number of people, who would be immeditely writing to *The Times* to say that they did the same thing in their back kitchen 20 years ago. That was what always took place in the case of a new invention. Prof. Langley, in America, dealt with the radiation from fireflies and glow-worms in a Paper a few years ago, and gave a diagram showing the total radiation, and what proportion was luminous; the result proving that the glow-worm had solved the problem which Tesla, Hertz, and many others had been working at, of making nearly the whole of the rays luminous. If they could only get a glow-worm to come and read a Paper explaining how it was done, Dr. Nernst's lamp would have no future before it. He agreed with Mr. Swinburne that the possibilities of the carbon filament were about exhausted; there had been very little improvement for a long time, and it was a remarkable thing that just when the carbon filament was failing to meet their requirements this new invention should be made, which seemed to meet the case. It was like the discovery of guttapercha at the critical period, which got electric cable-makers out of their difficulties. But, though the new lamp was evidently a very robust child, it was still a child, and it would at any rate take a little time to displace existing lamps.

Dr. FLEMING asked if there was any deterioration in the quality of these lamps after a time, such as occurred with carbon filaments and Welsbach mantles; because this would be very important in considering the commercial value of the invention. If the lamp only required 1 watt or 1½ at starting, and, after a few hours' work, 4 or 5, it would be a serious disqualification. It was well known that most of these radiants did deteriorate after a time; with the lime-light, for instance, after a few minutes, the radiant quality of the lime diminished, although it was played upon by an oxy-hydrogen flame at a constant temperature; and turning the lime round would markedly increase the amount of light on the screen.

Major FLOOD-PAGE said that those connected with carbon lamps, as he was, were as much interested as anyone in this new departure. They had a higher interest than that of any particular lamp, and that was in the advance of electricity.

Mr. H. COLEFAX said several applications for patents had already been put in, which appeared to claim the benefit of this discovery, but he did not think they would prove successful. He should be glad if Mr. Swinburne could tell them what it was which limited the life of the filament, because when he saw Professor Nernst, he did not think he had then arrived at any explanation. When he first saw the invention, the limit then was 200 hours, the first experiments only having attained 40 hours.

Mr. CAMPBELL SWINTON said Prof. Ayrton was not strictly accurate in saying that this was the first attempt to use a heated electrolyte. Some twenty years ago, Jablochkoff showed a lamp in London consisting of a strip of kaolin, along the top of which he put what he called a match, which consisted, he believed, of carbon mixed with treacle; this conducted the electricity until it heated the kaolin, and that then formed the conductor. He would not go into the question of how far that was an anticipation of the present invention; he only wished to correct the impression that nothing of the kind had been tried. With regard to the lighting power of incandescent gas mantles, he had made many experiments on them with cathode rays, by which you could heat them to a very high temperature without the use of gas in the ordinary sense, and he found there was no appreciable difference in the amount of light given by a mantle of pure thoria, and one with the addition of a small percentage of ceria.

Mr. SYDNEY MORSE said he was interested in this question on the commercial side, and especially as connected with the competition of municipal authorities, who were now commencing to manufacture and sell electric fittings, which he feared would seriously interfere with the progress of invention. They had heard that invention in conjunction with carbon filaments was exhausted; but this opened up a new industry, which he hoped would be taken up and improved by English engineers and inventors, for they could not suppose that everything had yet been done.

Mr. J. G. LORRAINE asked what amount of heat was emitted by this lamp, compared with an ordinary incandescent one.

Mr. A. H. DYKES asked what was the power required for these lamps. A difficulty in connection with street lighting was, when arc lamps were too large, ordinary incandescent lamps were not a great success. This lamp appeared to have many advantages for such purposes, and particularly the volume of light-giving material being so much larger than a carbon filament, it would have much greater penetrative power in foggy weather.

Mr. SWINBURNE, in reply, said the question of the temperature of a Welsbach burner was a very large subject, with which he could not attempt to deal fully. If you examined a burner with the mantle off, there was a zone of very high temperature, which would easily fuse platinum; but most measurements made were erroneous, because they were taken with a thermopile, which never got the real temperature of the burner; the great difficulty was to get what was in the burner to the temperature of the burner. In dealing with the light given by incandescent bodies it must be remembered that the light depended on the emissivity. If the only temperature at which you got much light was very high—very close to the temperature of the gas—you must use something of very low emissivity; if it were large, the heat given by the burner was rapidly given off, and if infinite the temperature of the mantle would remain at the average temperature of the room, and you would not get any light. On the other hand, if the emissivity were very low, though the mantle would get to a high temperature, it would not give light for want of emissivity. A pure white body, such as pure zirconia, gave very little light, because the emissivity was too low, though the temperature was high. To get the highest efficiency you must have emissivity enough to give plenty of light without robbing the flame of its heat too soon. From a white oxide like thoria you did not get much light, but if you added a small percentage of ceria or some other coloured oxide—it did not matter much what—you got light. A great deal of unnecessary mystery had been introduced into the subject, because it was known that erbia gave some curiously characteristic spectra, but erbia was only present as an impurity. Another point was that cerium had two sets of compounds, and it was supposed that it was continually hopping backwards and forwards from one state of oxidation to another. Prof. Ayrton had quoted several anonymous authorities, but had not given the reasons for their opinions, and so it was impossible to deal with them. They involved questions of thermodynamics into which there was not time to go. The case of spongy platinum was altogether different, there was a chemical combination started by the heat, which would not otherwise take place. Here there was no reason to suppose there was such a combination, spongy black would give no light, and a solution of platinum put upon a mantle would destroy its light-giving power. He believed that colour was largely a question of temperature; but you could produce different colours by using different materials. With regard to a vacuum, its effect was to get rid of convection. If you tried to heat a long thin filament of carbon, it would be inefficient on account of convection; but with a short, thick rod the convection was not serious. Practically, he believed these Nernst lamps would not work in a vacuum. He had not tried many experiments himself, but so he was informed. The reason generally given was that electrolysis was going on, and that oxygen was being absorbed from the air at one terminal, and being given off at the other. That was Professor Nernst's explanation, but he thought there was another factor to be taken into account. It was perfectly simple on paper to electrolyse salt, and get out chlorine and sodium; but when you tried it you did not get either. He did not think true electrolysis took place to any extent, but there was a continual diffusion of the substances which was undoing the work of electrolysis all the time; but that was not sufficient to make it work properly in a vacuum. All the lamps shown were on the alternate current mains, but he had tested them with the direct current and found their efficiency continued right through. That was some six months ago, when they lasted 200 hours; now they had got to 500 hours, and he had no doubt they would go much higher. He did not think glow-worms had much to do with the matter. With regard to the emission of light at a given temperature, it was not the least likely that there was any such simple law as Mr. Maxim had suggested. With regard to deterioration and its cause, after running some time the material appeared to get crystalline; what else happened he did not know. Probably there was a gradual tendency for the rod to get uneven; then it would get more heated in one part, and softer, until at last it melted. Prof. Ayrton seemed to think that the compound in the Welsbach mantle was chosen entirely for giving light; but anyone who used those lights knew that the strength of the mantle was of great importance. You could get a very good light from yttria, but you could not get a strong mantle that would not warp, If you took a thoria mantle, and put lime on it, it would give a very nice light at first, but the lime would soon volatilise; so would many other substances; ceria went off quicker than thoria, and the result was that after running a thoria mantle with a small amount of ceria for some time you had a pure thoria mantle. It was not that the power of the ceria was exhausted, but that it was not there. He congratulated Major Flood-Page on the exceedingly broad-minded view he had taken of the subject. With regard to the early Jablochkoff lamp, he had no information; his own impression was that the Jablochkoff candle was the only thing which was at all successful; that was in use in 1878. There was another lamp which depended on a hot material between the poles, called the Lampe Soleil, in which an arc was struck across a surface of marble which got very hot, and finally conducted and gave an illuminant surface. The cathode ray experiments referred to by Mr. Swinton bore out what he had said about the earths, that it was simply a question of temperature. There was another inventor, he believed, working on a lamp with cathode rays, and no doubt they could be made to give an efficiency equal to the Nernst, if the earths were raised to a sufficiently high temperature. The amount of heat given off depended on the amount of power used; only a small percentage of the energy was converted into light, and until Mr. Maxim and Mr. Mordey could tame their glow-worms he was afraid it would always be so.

The CHAIRMAN (Mr. Alexander Siemens), in proposing a vote of thanks to Mr. Swinburne, reminded the audience that, with all their enthusiasm, the commercial success of this new lamp depended on the price at which it was offered, and as to this they had, as yet, no information. When electric accumulators were first discovered it was supposed they would revolutionise the industry, and do all sorts of wonders; but, though they had been certainly useful, they had not done what was expected of them. In the case of these lamps, if they were sold at 1s. 1d., all charges included, and an ordinary carbon lamp was sold at 1s., he feared the latter would be generally purchased.

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ELECTRICITY WORKS ACCOUNTS.

Westminster Electric Supply Corporation (Limited).

It seems quite appropriate that we should be enabled to commence our 1898 analyses of the accounts of electric light undertakings with the Westminster concern—the largest with which we have to deal. Started in November. 1890, the accounts for 1898 are those of the eighth completed year of working, and in respect of extension of business they show an improvement over any year of the successful career of this concern.

The authorised capital stands at £649,500, out of which £399,500 of share and £199,800 of loan capital has been received; the latter having been raised on 3½ per cent. mortgage debentures. Up to Dec. 31 last, the capital expended was £626,866, or £111 per kilowatt of plant in the station.

As already stated, there is no diminution in the rate of increase in the lamp connections. During 1898, about 500 new consumers, with an equivalent of 49,425 8 c.p. lamps, were connected to the mains; this represents an increase in the lamp connections of 17 per cent. The output for the year was 5,065,195 units sold, being more than 16 per cent. over the output of 1897. Owing to the increase in the plant capacity of the stations the output in relation to the plant capacity has fallen from 31 to 28·6 units per 8 c.p. lamp of capacity.

The average price obtained per unit was 5·26d., while the average total revenue was 5·58d. per unit as compared with 5·92d. in 1897.

The costs, unfortunately, show a slight rise—about 0·07d. per unit, the figures representing the total costs for 1897 and 1898, being respectively 2·34d. and 2·41d. Included, however, in these figures is the cost of supplying steam sold, which in 1897 represented 0·084d. and in 1898 0·072d. per unit sold. Deducting these values from the figures given we have the respective total costs for the two years about 2·26d. and 2·33d. per unit sold. Both works and management charges are responsible for the increased expenditure which, together with the decreased revenue, has resulted in an increase of the ratio of costs to revenue from 39·6 to 43·1 per cent.

A working profit of £66,929 was cleared, out of which £15,350 has been placed into the depreciation fund, £3,080 to the reserve or sinking fund, and £6,567 paid as interest on the debentures. Out of the balance of £47,848 available for distribution a dividend of 12 per cent. has been declared.

The increased price of coal, and the Welsh coal dispute last year, has alone been responsible, it is stated, for about £3,000 difference in the net revenue. Other influencing factors have been the absence of fogs during the winter season, and the reduction from 6d. to 4d. in the charge per unit (after 4,000 units have been consumed in the year for lighting), and from 4d. to 3d. for power supply.

We append a few interesting particulars relative to the Westminster undertaking since 1891:—

Year.	Lamps connected.	Units sold.	Plant capacity. Kilowatts.	Dividend.
1891	62,800	627,500	...	...
1892	98,646	1,217,871	...	3½%
1893	131,563	1,704,615	...	4½%
1894	167,700	2,173,298	...	5%
1895	210,980	2,830,396	3,765	7%
1896	249,318	3,503,054	3,765	9%
1897	290,561	4,355,781	4,533	12%
1898	339,986	5,065,195	5,658	12%

We learn that there are at present connected and applied for the equivalent of more than 351,750 8-c.p. lamps, while the length of roadway now laid with mains exceeds 48 miles. This represents about 197 miles of ways, into which upwards of 168 miles of copper (strip or cable) have been drawn.

St. James's and Pall Mall Electric Light Co. (Limited).

We are glad to find from the accounts of the St. James's and Pall Mall Electric Light Co. for 1898 that the already excellent state of affairs which marked the 1897 working has been much more than maintained. Improvements in every essential respect have been effected during 1898, and the Directors have again been enabled to distribute a dividend not less than that of last year, viz., 14½ per cent. on the Ordinary and 7 per cent. on the Preference shares.

Of the total authorised capital of £450,000 the share capital received to December 31 last amounted to £260,000, and the loan capital, borrowed on Four per Cent. Debentures, to £50,000. The expenditure on capital account has reached £263,046, representing £67·8 per kilowatt capacity of generating plant—a very moderate figure for a London concern.

Turning now to the year's business, we find that corresponding with an output of 3,448,858 units sold, representing an increase of nearly 14 per cent. on the output of 1897, a total revenue of £70,285 was received, being an average of 4·89d. per unit, as compared with 5·41d. in 1897. This is a result of a reduction in the tariff charged for both lighting and power supply.

Notwithstanding this, however, the ratio of the costs to the revenue has decreased to 40·4 per cent., thanks to very material reductions in the costs, which have dropped from the 2·23d. per unit of 1897 to 1·98d. for 1898—a figure which is well ahead, in point of merit, of that of any other London supply undertaking with which it may be compared. This is saying a good deal, having in mind the low capital charges which obtain on an expenditure of only £67·8 per kilowatt of plant in the station.

All the items of expenditure out of revenue, excepting that of management, have contributed to the increased economy, and a working profit of £41,904 for the year has been made, representing 16·2 per cent. on the mean capital during the period under notice. After carrying £10,124 to the depreciation fund, and paying £1,497 as interest, the balance available for a dividend was £30,274.

The 100 Founders' shares, now held in trust for the Company, are being cancelled, and the £50,000 of Debenture stock is being paid off.

The following table indicates the progress of the undertaking since 1891:—

Year.	Lamps connected.	Units sold.	Plant capacity. Kilowatts.	Ordinary dividend.
1891	38,500	1,067,996	820	8½%
1892	47,900	1,186,826	1,060	7½%
1893	60,000	1,211,451	1,300	4½%
1894	75,200	1,569,884	...	6½%
1895	91,800	1,846,064	2,100	7½%
1896	108,000	2,401,431	2,750	10½%
1897	123,000	3,028,242	3,880	14½%
1898	142,788	3,448,858	3,880	14½%

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	1899	Jan. 6	Kens'gton & Knightsbr'ge (Co.)		Sept. 30
Ayr (Municipal)	1898	Nov. 11	Kingston-upon-Hull (Mun.)	1898	Aug. 19
Bedford (Municipal)	,,	Mar. 4	Kingston-on-Thames (Mun.)	,,	Mar. 25
Belfast (Municipal)	,,	Sept. 23	Lancaster (Municipal)	,,	Oct. 21
Birmingham (Company)	,,	Dec. 16	Leeds (Company)	,,	April 8
Blackpool (Municipal)	,,	Oct. 7	Leicester (Municipal)	1899	Jan. 20
Bournemouth (Company)	,,	June 3	Leyton (Municipal)	1898	Sept. 23
Bolton (Municipal)	,,	Dec. 9	Liverpool (Municipal)	,,	Aug. 12
Bradford (Municipal)	,,	May 20	Manchester (Municipal)	,,	July 29
Brighton (Municipal)	,,	May 6	Newcastle and District (Co.)	,,	Dec. 2
Bristol (Municipal)	,,	July 29	Newcastle-upon-Tyne (Co.)	,,	April 29
Burnley (Municipal)	,,	Sept. 16	Northampton (Company)	,,	April 15
Burton-upon-Trent (Mun.)	,,	April 15	Norwich (Company)	,,	Dec. 2
Bury (Municipal)	,,	Nov. 25	Notting Hill (Company)	,,	Mar. 11
Cambridge (Company)	,,	June 17	Nottingham (Municipal)	,,	Oct. 23
Cardiff (Municipal)	1899	Jan. 6	Oldham (Municipal)	,,	Nov. 18
Charing Cross (Company)	1898	April 22	Oxford (Company)	,,	April 1
Chelsea (Company)	,,	May 20	Portsmouth (Municipal)	,,	Nov. 4
Cheltenham (Municipal)	,,	Oct. 7	Preston (Company)	,,	Oct. 28
Chester (Municipal)	,,	Oct. 14	Reading (Company)	,,	Sept. 16
Clerkenwell (Company)	,,	Mar. 18	Richmond (Company)	,,	Mar. 4
Derby (Municipal)	,,	Dec. 9	Scarborough (Company)	,,	April 1
Dewsbury (Municipal)	,,	Nov. 25	St. James' & Pall Mall (Co.)	,,	July 1
Dover (Company)	,,	Mar. 11	St. Pancras (Vestry)	,,	May 13
Dundee (Municipal)	,,	Nov. 4	Sheffield (Company)	,,	Dec. 16
Eastbourne (Company)	,,	July 22	Shoreditch (Vestry)	,,	May 27
Edinburgh (Municipal)	,,	Oct. 14	Southampton (Municipal)	,,	June 3
Exeter (Municipal)	,,	Aug. 5	Southport (Municipal)	,,	Dec. 23
Glasgow (Municipal)	,,	Aug. 12	Stafford (Municipal)	,,	Oct. 21
Guildford (Company)	,,	May 13	Sunderland (Municipal)	,,	Aug. 19
Halifax (Municipal)	,,	Nov. 18	Taunton (Municipal)	,,	Aug. 5
Hammersmith (Vestry)	,,	June 10	Tunbridge Wells (Mun.)	,,	July 22
Hampstead (Municipal)	,,	Sept. 9	Walsall (Municipal)	,,	Nov. 11
Hanley (Municipal)	,,	April 8	Wandsworth (Company)	,,	Mar. 18
Harrogate (Municipal)	,,	Dec. 30	Westminster (Company)	,,	April 22
Harrow (Company)	,,	Sept. 9	Whitehaven (Municipal)	,,	Dec. 23
Hast'gs & St. Leonard's (Co.)	,,	April 29	Windsor (Company)	,,	Dec. 30
House-to-House Co. (K'ns'gt'n)	,,	Sept. 30	Wolverhampton (Municipal)	,,	July 15
Hove (Company)	,,	May 6	Woolwich (Company)	1899	Jan. 13
Huddersfield (Municipal)	,,	Mar. 25	Worcester (Municipal)	1898	May 13
Islington (Vestry)	,,	June 24	Yarmouth (Municipal)	,,	June 17

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	WESTMINSTER.		ST. JAMES', LONDON.	
Undertaking Worked by	Westminster Electric Supply Corporation, [Limited.		The St. James' & Pall Mall Electric Light Co., [Limited.	
Date of Commencement of Supply	November, 1890.		April, 1889.	
System of Supply	Continuous-current, three-wire, with batteries.		Three-wire continuous-current.	
Chief Engineer	A. B. W. Kennedy.		Sydney T. Dobson.	
YEAR ENDED	DEC. 31, **1897.**	DEC. 31, **1898.**	DEC. 31, **1897.**	DEC. 31, **1898.**
QUANTITIES—				
Units generated	5,046,500	5,847,585	3,386,944	3,847,204
„ **SOLD (TOTAL)**	**4,355,781**	**5,065,195**	**3,028,242**	**3,448,858**
„ sold to consumers	4,355,781	5,065,195	3,028,242	3,314,492
„ sold for public lighting, &c.	nil	nil	—	134,366
„ used on works	61,096	64,216	48,944	58,166
UNITS SOLD PER 8 C.P. LAMP CAPACITY	31·0	28·6	25·2	28·7
Maximum supply demanded	3,650 kilowatts	4,400	—	—
Number of public lamps	—	—	60 arc.	60 arc.
Number of consumers	4,000	4,550	1,600	—
Connections to mains in 8-c.p. lamps	290,561	339,986	123,000	142,788
CAPACITY OF PLANT IN 8-C.P. LAMPS	140,500	176,700	120,000	120,000
CAPACITY OF PLANT IN KILOWATTS	4,533	5,658	3,880	3,880
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£499,500 / £110	£649,500 / £115	£300,000 / £77·3	£450,000 / £116
Share	399,500 / 88·2	399,500 / 70·6	200,000 / 51·6	300,000 / 77·3
Loan (including Debenture charges)	100,000 / 22·2	250,000 / 44·2	100,000 / 25·8	150,000 / 38·7
RECEIVED (TOTAL)	**499,500 / 110**	**598,800 / 106**	**250,000 / 64·4**	**310,000 / 79·9**
Share	399,500 / 88·2	399,500 / 70·6	200,000 / 51·5	260,000 / 67·0
Loan (including Debenture charges)	100,000 / 22·2	199,300 / 35·2	50,000 / 12·9	50,000 / 12·9
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	nil / —	**50,700 / 8·96**	**50,000 / 12·9**	**140,000 / 36·1**
Share (unissued)	— / —	nil / —	nil / —	40,000 / 10·3
Share (uncalled)	— / —	nil / —	nil / —	nil / —
Loan (including Debentures)	— / —	50,700 / 8·95	50,000 / 12·9	100,000 / 25·8
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	16,687 / 3·68	18,795 / 3·32	15,000* / 3·86	15,000* / 3·87
DEPRECIATION FUND	43,192 / 9·52	55,913 / 9·87	— / —	— / —
EXPENDED (TOTAL)	**560,388 / 124**	**626,366 / 111**	**254,077 / 65·5**	**263,046 / 67·8**
Lands and buildings	153,621 / 33·9	175,143 / 30·9	97,923 / 25·2	101,774 / 26·2
Plant	144,795 / 32·0	203,581[b] / 36·0	80,984 / 20·9	86,427 / 22·3
Mains	211,588 / 46·5	233,609 / 41·3	69,179 / 17·8	69,557 / 17·9
Miscellaneous	50,384[a] / 11·1	14,033[a] / 2·48	5,991 / 1·54	5,289 / 1·36
BALANCE OF CAPITAL ACCOUNT	**– 60,888[c] / – 13·4**	**– 27,566[c] / – 4·88**	**– 4,077[a] / – 1·05**	**46,954 / 12·1**
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£107,366 / 5·920d.	£117,700 / 5·580d.	£68,270 / 5·410d.	£70,285 / 4·890d.
Revenue from supply	100,561 / 5·550d.	111,001 / 5·262d.	64,879 / 5·140d.	66,170 / 4·600d.
„ meters, &c.	4,344 / 0·239d.	4,759 / 0·226d.	1,529 / 0·121d.	1,761 / 0·123d.
„ public lighting	nil / —	— / —	1,497 / 0·119d.	1,832 / 0·128d.
„ sale of lamps, &c.	nil / —	— / —	— / —	— / —
„ miscellaneous sources	2,461 / 0·136d.	1,939[f] / 0·092d.	365 / 0·029d.	522[f] / 0·036d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	**£42,491 / 2·340d.[i]**	**£50,771 / 2·406d.[i]**	**£28,079 / 2·230d.**	**£28,381 / 1·976d.**
WORKS COSTS	**25,681 / 1·420d.**	**30,818 / 1·461d.**	**17,977 / 1·420d.**	**17,757 / 1·236d.**
Generation of electricity	*23,919 / 1·320d.*	*28,563 / 1·353d.*	*16,459[b] / 1·304d.*	*16,186[b] / 1·127d.*
Fuel (including cartage, &c.)	11,450 / 0·632d.	14,643 / 0·694d.	6,514 / 0·516d.	7,307 / 0·509d.
Oil, waste, water, stores	1,737 / 0·096d.	1,845 / 0·087d.	922 / 0·073d.	949 / 0·066d.
Wages at station	7,114 / 0·392d.	7,490 / 0·355d.	5,138[c] / 0·407d.	5,429[c] / 0·378d.
Repairs and maintenance at station	3,618 / 0·200d.	4,586 / 0·217d.	3,773 / 0·299d.	2,360 / 0·164d.
Distribution of electricity	*1,762 / 0·097d.*	*2,255 / 0·107d.*	— / —	— / —
Wages, &c.	1,183 / 0·065d.	1,719 / 0·082d.	— [c] / —	— [c] / —
Repairs, renewals of mains, &c.	579 / 0·032d.	535 / 0·025d.	1,145 / 0·091d.	1,149 / 0·080d.
Public lighting	— / —	— / —	*373 / 0·030d.*	*422 / 0·029d.*
Attendance	— / —	— / —	373 / 0·030d.	422 / 0·029d.
Renewals	— / —	— / —		
MANAGEMENT AND PROPERTY CHARGES	**16,726 / 0·923d.**	**19,953 / 0·946d.**	**10,101 / 0·800d.**	**10,624 / 0·740d.**
Royalties	*nil* / —	*nil* / —	— / —	— / —
Rent, rates, taxes	*5,002 / 0·276d.*	*5,575 / 0·264d.*	*2,701 / 0·214d.*	*2,809 / 0·196d.*
Management	*11,724 / 0·647d.*	*14,378 / 0·682d.*	*7,400 / 0·586d.*	*7,815 / 0·544d.*
Salaries	8,226[d] / 0·454d.	10,458[d] / 0·496d.	5,963 / 0·472d.	6,012 / 0·418d.
Stationery, &c.	359 / 0·020d.	396 / 0·019d.	217 / 0·017d.	208 / 0·015d.
Establishment charges	579 / 0·032d.	597 / 0·028d.	394 / 0·031d.	396 / 0·028d.
Law charges, &c.	2,560[g] / 0·141d.	2,927[g] / 0·139d.	826 / 0·065d.	1199[g] / 0·084d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	**£64,875 / 12·5%**	**£66,929 / 11·27%**	**£40,191 / 16·2%**	**£41,904 / 16·2%**
Sum carried to Depreciation Fund	13,790 / 2·65%	15,350 / 2·586%	9,270 / 3·74%	10,124 / 3·91%
Sum carried to Reserve or Sinking Fund	1,500 / 0·289%	3,030[h] / 0·510%	— / —	— / —
Net interest on loans (incl. Debenture charges)	5,164 / 0·994%	6,567 / 1·107%	1,440 / 0·581%	1,497 / 0·579%
BALANCE FROM LAST ACCOUNT	**2,985 / 0·575%**	**3,119 / 0·526%**	**328 / 0·130%**	**384 / 0·148%**
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	**49,461[e] / 9·52%**	**47,343[e] / 7·98%**	**29,422[d] / 11·9%**	**30,274[d] / 11·7%**
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	12% / —	12% / —	14½%[e] / —	14½%[e] / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	39·6%	43·1%	41·2%	40·4%
Expenditure per kilowatt capacity	£9. 7s. 7d.	£8. 19s. 7d.	£7. 4s. 10d.	£7. 6s. 5d.
REVENUE PER KILOWATT CAPACITY	**£23. 14s. 0d.**	**£20. 16s. 0d.**	**£17. 11s. 7d.**	**£18. 2s. 0d.**
Expenditure per 8-c. lamp capacity	6s. 0½d.	5s. 9d.	4s. 8d.	4s. 8¾d.
REVENUE PER 8-C.P. LAMP CAPACITY	**15s. 3½d.**	**13s. 4d.**	**11s. 4½d.**	**11s. 8½d.**
REVENUE PER 8-C.P. LAMP CONNECTED	**7s. 4⅜d.**	**6s. 11d.**	**11s. 1¼d.**	**9s. 10d.**
Price charged for lighting, per unit	6d.[j]	6d.[j]	6d.	6d. to 4d.[h]
Price charged for power, per unit	4d.	3d.	4d.	3d.
Price charged for public lighting	—	—	£24. 19s. per arc.	£30. per arc.

WESTMINSTER.—REMARKS—*a* Includes £10,133 to purchase of City of Westminster Electrical Syndicate in 1897 and 1898, and £36,372 to "meters and cost of calibrating" in 1897. *b* Includes £40,883 to "meters and cost of calibrating." *c* Over-expended. *d* Includes directors' fees, £1,500 in 1897 and £3,000 in 1898. *e* Includes £2,055 in 1897 and £2,242 in 1898, accruing from rents and credited to net revenue account. *f* Includes £2,392 in 1897 and £1,841 in 1898 from supply of steam. *g* Includes £1,559 in 1897 and £1,522 in 1898 cost of supplying steam sold, and £445 in 1897 and £644 in 1893 to insurance. *h* Includes £1,530 written off debenture redemption account. *i* Includes 0·084d. in 1897 and 0·072d. in 1898 cost of supplying steam sold. *j* With rebates.

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SUPERFICIAL CRITICISMS AND SURFACE CONTACTS.

The surface contact system of electric traction, conjointly invented by Dr. Silvanus P. Thompson and Mr. Miles Walker, occupied the attention of the Institution of Electrical Engineers, at its meeting on the 16th inst. The first-named inventor occupied the chair, his colleague reading a short Paper describing the system, upon which a discussion afterwards took place. Rarely have we listened to so inane a discussion. If the weakness of this surface-contact system lies in nothing that was not laid bare by the speakers who took part in the debate, then is that weakness strength indeed. We congratulate the inventors upon their having succeeded in bringing a novel and scarcely tried system of electric traction before the *premier* society of electrical engineers in the United Kingdom without having brought down upon it anything but the most shallow and evanescent criticism. Speaker after speaker occupied precious time in slaying the slain, or in erecting straw bogeys for the mere purpose of knocking them to pieces. The Paper itself, it is true, gave nothing more than a slender sketch of the invention, being confined to a discussion of the principles which guided the inventors in the evolution of their system, rather than directing attention to the detailed construction and action of the mechanism in practical conditions. The latter points, however, were not ignored; and, taken in conjunction with Prof. Thompson's Paper, read before the British Association last September (see *The Electrician*, Vol. XLI., p. 751), this latest description of the most recently developed system of surface contacts afforded sufficient material for a telling attack. Instead of addressing themselves to attacking the actual system, however, many of the speakers turned their attention to imaginary defects, begotten of their individual ignorance of the nature of the invention. Robbed of this particular phase, the discussion would have shrunk to one-tenth of its actual length, and would have presented to the world a far less formidable aspect, more consonant with its real importance.

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It was only natural that Prof. AYRTON should have wished to claim for himself and his colleague, Prof. PERRY, who was seated beside him, the honour of having been the first to conceive the principle of a surface contact system of electric traction, so far back as 18 years ago, and of having, at that time, evolved and patented a system in actual detail. We are quite sure the electrical profession will admit that by this early—if not, indeed, premature—inventiveness, Profs. AYRTON and PERRY have given to the world a master invention, and all that subsequent inventors can claim is the development of details. Consequently, it was again only natural that the first parents of surface contact systems should desire to see successive generations of inventors doing credit to the initial genius, lest by the failure of later details blame should unjustly fall upon the heads of the original inventors. But, in pursuit of this quite reasonable desire to safeguard his own and his colleague's reputation, Prof. AYRTON would have done better to have directed his attack upon the new system as it stands, instead of devoting so much time to ridiculing what he once imagined—erroneously, as he admitted—the system to be. It seems that Prof. AYRTON read Prof. THOMPSON'S British Association Paper so hurriedly that he omitted to observe that an integral part of the invention necessarily consisted in a small accumulator in each car. As a consequence, his imagination conjured up a truly fearful condition of affairs, which might at any moment be precipitated by any one car on the system failing to take current from any one surface contact. The entire tramway system would be paralysed beyond recovery, and nothing would remain, we suppose, but to send out an army of horses and sadly bring the tramcars home. The picture thus drawn by Prof. AYRTON with such an expense of time and rhetoric was, of course, a travesty of the real system: he himself admitted this. It never existed anywhere but in his own fertile brain; and the wonder is that the preposterous nature of his idea of the system did not lead him to look into it more carefully. Prof. CARUS-WILSON also raised a bogey that had its origin in an admitted ignorance of details of the system. He drew on the blackboard an arrangement of a slider and contacts which would be bound to spark viciously, if adopted in actual practice; but his blackboard diagram differed from the real construction as widely as proverbial chalk differs from proverbial cheese. As a matter of fact, only in exceptional conditions is there any appreciable sparking at the contacts on the experimental line at Willesden. Another bogey that looked very formidable, but which was readily conjured to vanish, was the calculation by Prof. CARUS-WILSON that it would require 24 hours to replace all the surface studs in no longer than one mile of tramway. Reflection shows that it would rarely happen that all the studs in a mile run would require to be changed at once; secondly, that if in emergency this were necessary, several men and not merely one man would be put on the work; and lastly, that the estimate is excessive in any case, for a stud can be replaced in less than one minute, while the estimate allows for two minutes.

Leakage current was another bogey to which many speakers paid deferential respect, one speaker—a supply station engineer—even calculating upon a very respectable revenue in the event of his being required to sell units for this otherwise unprofitable item. All the horrors of leakage from surface contacts were duly—not to say unduly—exhibited:—How that the local authorities and the gas and water companies would have to take alarm at the enormous corrosive action that would ensue; how that energy, fuel and money would be recklessly squandered, with the result that the tramway company would have to go into liquidation; how that life, limb and property would be eternally menaced. But what does this leakage nightmare really amount to? In the first place, it is worth while inquiring where the "enormous leakage" is to take place. Inasmuch as it is to be produced by wetness of the track and by mud on the track, it must evidently be confined almost wholly to the surface; moreover, since the studs will lie between the track rails, the leakage current will merely occur in the strip of roadway between those rails, and will practically affect nothing either beyond or below. It is high time that engineers impressed on their own minds, as well as on the general public, the essential difference between track-rail return and earth return. The leakage from surface studs is not the latter, but the former, and is quite innocuous so far as concerns gas and water mains. Then, again, there will be no great amount of leakage from a stud, except during wet weather or when the track is in a muddy condition; and even then each stud will leak only during the time it is actually made alive by the passage of a car over it. Having regard to these facts, it will be evident that the annual leakage output will be very considerably less than has been estimated, on the assumption that all the studs leaked at their maximum rate all the year round. Such a calculation may make supply station managers' mouths water, but it over-estimates the humidity and leakage possibilities of the track. Moreover, inasmuch as each stud only leaks when covered by the car, it is difficult to see how the leakage current could do injury to anyone standing on the track. Broadly speaking, we fail to discover any special source of danger, or of economic loss, in the leakage that would arise on a well-laid and carefully maintained tramway on the Thompson-Walker system. The alarmists have fallen very short of showing any cause for apprehension; nor have they as yet pointed to one single defect in the system that could reasonably justify tramway authorities in declining to make a trial of the system on the public highways.

JAMES HOOKEY.

Although Mr. W. H. Preece's new position as consulting engineer has, we believe, not yet been officially settled, his retirement from the old position is an accomplished fact, and his successor has already been appointed. Mr. James Hookey, who takes up the duties of engineer-in-chief, is, like Mr. Preece, one of the officers of the old Electric and International Telegraph Co., his services dating from the year 1855. For some years he was engineer-in-charge of the West of England district. Early in the sixties he became attached to the division controlled by Mr. Culley, the well-known electrician of that Company, and remained with him throughout that gentleman's official career, retaining a similar position in the office of Mr. Graves, who, it will be remembered, succeeded Mr. Culley soon after the transfer of the Telegraphs to the State. For a short time there was some uncertainty as to whether Mr. Hookey would go over to the Post Office, or accept an offer made to him by one of the great railway companies, as superintendent of its telegraph system; but after a short trial, and fortunately for his future prospects, he elected to follow the fortunes of the majority, taking up the post of principal technical officer in 1882, under Mr. Graves and Mr. Preece—these two gentlemen being respectively engineer-in-chief and electrician.

On the decease of Mr. Graves the two offices were combined in Mr. Preece, the position of assistant engineer-in-chief falling appropriately to Mr. Hookey. This was in 1892. About the same period, Mr. John Gavey, who also hailed from the West of England and occupied a similar appointment at Cardiff, came up to the chief engineer's office in London as principal technical officer vice Mr. Hookey, who is now again followed by Mr. Gavey. There is this difference, however,

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that whilst the first-named officer becomes engineer-in-chief simply, his next in rank is designated assistant engineer and electrician.

It will thus be seen that the present arrangement reverts back to the time when Mr. Graves and Mr. Preece severally acted as engineer and electrician, Mr. Gavey taking the place of Mr. Preece in electrical matters, and Mr. Hookey that of Mr. Graves in the administrative duties of the Postal Telegraph service. To this important and responsible office Mr. Hookey brings a knowledge and experience which are probably quite unique, his close intimacy with the controlling forces which have been actively developing the telegraphs of this country for more than 40 years past rendering him peculiarly well fitted to fill the highest position in that branch of the public service now.

INDUCTION MOTOR DIAGRAMS.

BY C. C. HAWKINS, M.A.

(*Continued from page 529.*)

The condition of the motor under any load can now be determined. Even at no load there must be a certain loss from friction as the armature revolves, and its speed cannot be the speed of synchronism; hence to overcome the friction loss there must be current flowing in the armature giving a $C_a^2 R_a$ loss. There are also the losses from hysteresis and from the ohmic resistance to eddies in the armature core; both increase as the load on the armature and the frequency of its currents increase, but are always a very small item; still, strictly speaking, they form a portion of the watts transmitted from the field to the armature across the air-gap. If the gross watts transmitted to the armature be divided by the number of primary circuits and by the back E.M.F., their quotient $\frac{W_T}{me} = C_p$, the power component of the primary current in one of the circuits of the field-winding, or the component in phase with the back E.M.F., which, together with the other circuits, supplies the power transmitted to the armature and which takes its share in neutralising the ampere-turns of the armature by being in direct opposition to them. If C_0 is the value of the exciting current as previously found, and corresponding to e, we have only to complete the parallelogram having for its sides C_0 and C_p inclined to each other at an angle 90deg. $-\beta$ to find the resultant primary current C and its phase relatively to e. Or we may add the power component required by the exciting current to C_p and take the diagonal of the rectangle $C = \sqrt{(be)^2 + (C_p + ge)^2}$. If we now plot the volts lost over the field-winding by the passage of C along the line of the total primary current, and compound with the back E.M.F., the primary impressed E.M.F. and its phase is found. The value of E_i so found may not, however, correspond with the E.M.F. to be actually applied, so that the diagram must be corrected as before. It is, therefore, simpler to proceed as follows (Fig. 12):—Set off the lines OB and OC_0 at the initial angles $\alpha = 10{\cdot}8$deg and $\beta = 20$deg., as before found. With radius $OB' = E_i$ describe the portion of a circle B'D. The impressed E.M.F. must fall on this circle. Take any angle α' less than α and draw the radius OE_i. From E_i let fall the perpendicular E_iM' on OM, intersecting OB' at R, and OC_0 at N. The resultant of $be R_f$ and e must fall on the line OB, and for the angle α' this resultant is OR. Hence OM is the new value for $be R_f$ and $OS = M'R$ the new value of e corresponding to the angle α'. Join SE_i, and parallel to SE_i draw OC. Since the impressed E.M.F. is the resultant of the back E.M.F. and the ohmic loss over the primary, $OC = CR_f$ and $M'C = (C_p + ge)R_f$. $NM' = ge R_f$, whence $C_p = \frac{CN}{R_f}$ can be found for any angle α'.* Thus the primary current comes gradually more into phase with the impressed E.M.F. as the load increases, and ϕ reaches a minimum when the load on the armature is such as to hold it stationary. It never becomes zero, as even when the armature is stationary there is still an appreciable field; if a = the ratio of total primary to total secondary turns, and R_a = the resistance of the armature per circuit, $R_a a^2$ = this resistance reduced to the primary system, and standstill of the armature occurs when $C_p \times R_a a^2 = e$, the volts induced in the armature being then equal to the loss of volts over the armature. Thus the minimum values of ϕ and α (since this, too, decreases in such wise that $E_i \sin \alpha$ always $= be R_f$) are fixed by the resistance of the armature. The torque is a maximum when

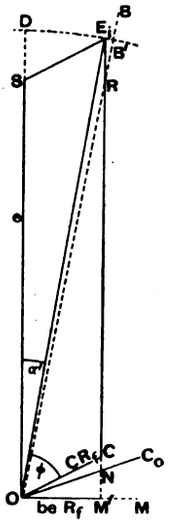

FIG. 12.
Complete no-load diagram. 978 revs.
$\phi = 51{\cdot}5°$. $\alpha' = 10°$

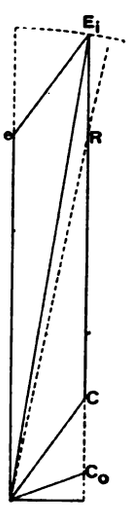

FIG. 13.
Maximum efficiency. 868 revs.
$\phi = 27°$. $\alpha' = 8{\cdot}75°$

NC or $C_p R_f = e$, *i.e.*, when C is slightly above R by the amount $ge R_f$ and the angle of lag between back E.M.F. and impressed E.M.F. is slightly less than the angle of lag between impressed E.M.F. and current, cp. Fig. 15. The gradual reduction of back E.M.F. and magnetising current as the load increases it in the ratio of $\frac{E_i \cos \alpha' - CR_f \cos(\phi + \alpha')}{E_i}$, *i.e.*, in the ratio of ($E_i \cos \alpha'$ minus the loss of volts due to the passage of the power components over the resistance of the primary) to E_i. If

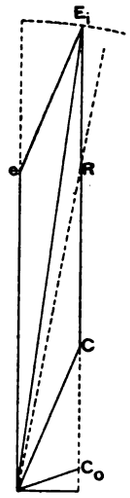

FIG. 14.
Max. B.H.P. 744 revs.
$\phi = 15{\cdot}7°$. $\alpha' = 7{\cdot}6°$

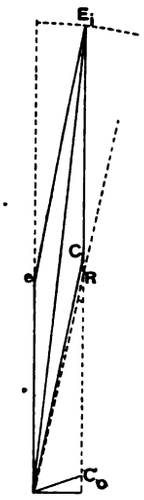

FIG. 15.
Max. torque. 333 revs.
$\phi = 7{\cdot}3°$. $\alpha' = 5{\cdot}3°$

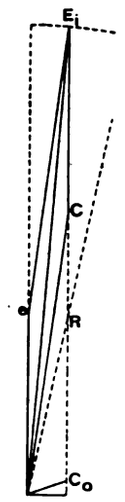

FIG. 16.
Standstill of armature.
$\phi = 4{\cdot}5°$. $\alpha' = 4{\cdot}3°$

C_0 is small as compared with C_p the angle ϕ is small; further if C_0 is small, the loss of volts over the resistance of the primary due to the magnetising current is small, and α is small. Hence in a good motor, at full load, it is approximately true that the back E.M.F., field, and magnetising current are reduced from their no-load values in the ratio $\frac{E_i - CR}{E_i}$.

* Since the diagrams are volt diagrams the value of CN as scaled from the figure must be divided by R_f to find C_p.

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Table I.

No. of fig.	a' deg.	e	C_p	C_μ	C	ϕ deg.	cos ϕ	Watts of input	C^2Rf	Hyst. and eddies $=950\times\left(\frac{e}{100}\right)^2$	Torque $\propto$ watts to arm. or eC_p	Volts in arm. $=C_pR_a a^2$	Slip $=\frac{C_pR_aa^2}{e}$	$C_a{}^2Ra$	Friction per phase $=\frac{360\times\text{revs}}{1,000}$	Brake watts per phase	% effic.	Revs. per min.
11	10·3	91·7	0·0	24·2	25·4	59·7	0·505	1,284	484	800	0	—	—	—	— syn	chronism	—	1,000
12	10·0	89·4	4·0	23·45	26·4	51·5	0·622	1,640	520	760	360	2·02	0·0225	8	352	0·0	0·0	978
—	9·5	84·0	11·9	22·1	29·5	38·3	0·785	2,320	650	670	1,000	5·95	0·071	71	334	595	25·6	929
—	9·0	79·8	17·8	21·0	32·9	30·6	0·861	2,832	810	602	1,420	8·9	0·112	158	320	942	33·2	888
13	8·75	78·2	20·6	20·6	34·7	27·0	0·891	3,090	900	580	1,610	10·3	0·132	212	313	1,085	35·2	868
—	7·75	69·0	33·6	18·1	44·0	16·0	0·961	4,220	1,450	450	2,320	16·8	0·244	562	272	1,486	35·2	766
14	7·6	68·0	34·8	17·85	45·0	15·7	0·963	4,323	1,520	440	2,363	17·4	0·256	605	267	1,491	34·5	744
—	6·25	56·0	52·7	14·7	59·9	8·0	0·99	5,947	2,700	297	2,950	26·4	0·472	1,390	190	1,370	23·0	528
15	5·3	48·0	64·0	12·6	70·0	7·3	0·992	6,949	3,660	219	3,070	32·0	0·666	2,050	120	900	13·0	333
—	4·6	41·0	74·0	10·8	78·7	5·7	0·995	7,840	4,650	160	3,030	37·0	0·905	2,740	34	256	5·5	95
16	4·3	38·8	77·6	10·2	81·8	4·5	0·997	8,158	5,000	143	3,015	38·8	1·0	3,015	0	0	0	0

In Figs. 12-16, five diagrams are drawn for the above motor for five different values of a and speed, progressively increasing from no-load to standstill. The numerical data chosen for

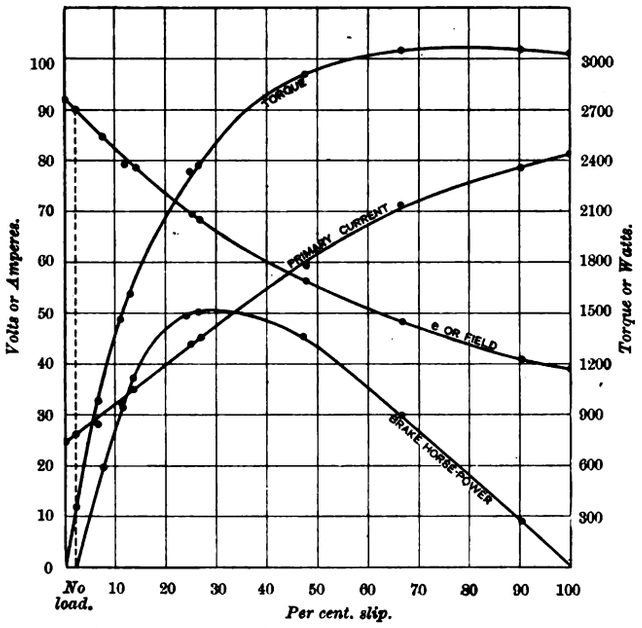

FIG. 17.—Current, torque and H.P. per phase without magnetic leakage.

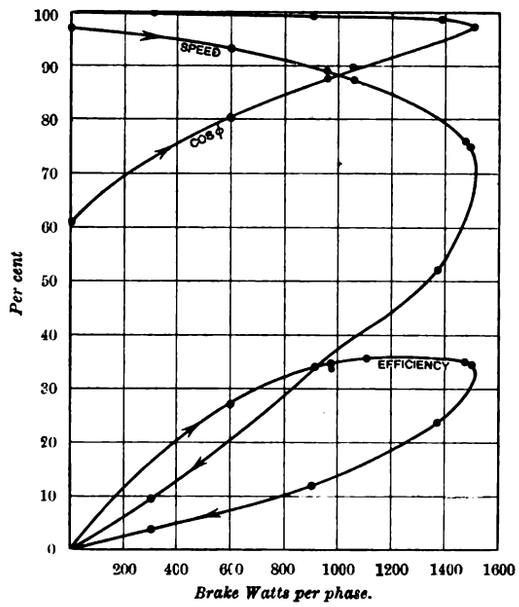

FIG. 18.—Speed, power factor and efficiency without magnetic leakage.

the various constants are not such as would occur in practice, but merely serve to bring out clearly in the diagrams the nature of the machine. A synchronous speed of 1,000 revolutions per minute is assumed, and Table I. gives a number of collected results, from which Figs. 17 and 18 are plotted. Fig. 17 shows clearly how the strength of field and of back E.M.F. are gradually reduced as the load is increased, and how the torque rises to a maximum when C_p $R_f = e$ and then falls, but the position of maximum torque does not necessarily correspond with the position of maximum brake horse power. In fact, the maximum torque should occur at a greater than the normal load, so that if the motor be momentarily overloaded, it will not stop. Fig. 18 shows how in the motor without magnetic leakage, cos ϕ or the power factor progressively rises as the speed falls and the load increases; while the point of maximum efficiency occurs prior to the point of maximum brake horse power. In both diagrams, the quantities deduced and plotted apply to one phase, the number of phases not affecting their relative values or the efficiency, so long as the total friction and other losses are divided by the number of phases.

(2.) Load Diagrams with Magnetic Leakage.

If the magnetic lines due to the field-winding with no load on the armature were plotted, it is evident that owing to the necessary mechanical clearance, a certain proportion pass through the air without entering the armature; these leakage lines are, therefore, not embraced by the secondary winding. Thus Fig. 19 illustrates the field at no-load of a two-phase

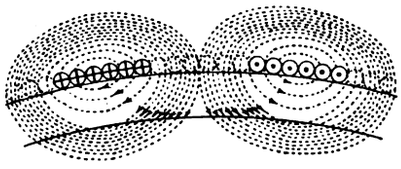

FIG. 19.

machine with maximum current in the one phase, and zero current in the dotted wires of the intermediate coils. Since the leakage through the air forms an appreciable percentage of the total field, and has great effect on the torque and running of the motor, it must be taken into account. Taking Fig. 8 as our starting point, this figure must be now modified; the total back E.M.F. must be divided into two items, one part being the useful back E.M.F. e due to the lines which also pass through the armature, and the other the self-induced E.M.F. e_s due to the leakage lines. So long as there are no losses other than copper losses in the field and the magnetising current is the only current, these two E.M.F.'s are in the same phase and may be directly added together. But as soon as the armature rotates and there is the smallest load on it even from friction only, these two diverge; hence it is necessary at the outset to distinguish between the two and find their relative proportion. Let the leakage be 15 per cent. of the total field at no-load, then of the total back E.M.F. of 100 volts in Fig. 8, 85 per cent. is due to lines passing through the armature, and 15 per cent. is self-induced (Fig. 20). Now let the armature circuit be closed and current flow in it due to the same lines as cause the back E.M.F. of 85 volts in the field. For the same reasons as above given, the field of Fig. 3 due to the secondary ampere-turns, if acting alone, must be modified, since some lines will leak through the air-space in nearly the same proportion

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as in the case of those due to the field-winding only. Considering the two fields as superposed the one on the other, those lines of the secondary that pass through the field-winding have exactly the same effect as before, and are taken into account in exactly the same way, *i.e.*, they are annulled by the inducing lines of the field; the remainder, however, as the induced current varies, act on the armature only and produce in it an E.M.F. in quadrature with the current, or an E.M.F. of self-induction, causing a lag of current behind the induced E.M.F. and a reduction in its strength. Hence the effect of the secondary leakage can be shown in the usual way by a right-angled triangle. In Fig. 21, let OC_a represent the armature current or the armature

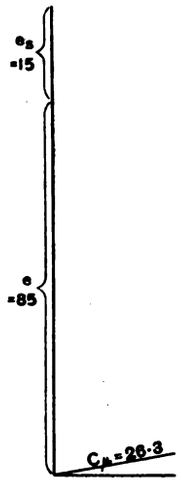

FIG. 20.

ampere-turns lagging behind the induced E.M.F. Oe, and let POQ represent the E.M.F. that would be produced by the armature current if acting alone, PO being the portion due to the lines not passing through the field winding, and OQ the portion due to the lines which do pass through the primary. Produce C_a O to O C_p, where O C_p represents the power component of the primary current or its ampere-turns. Then O C_p will produce the same number of lines passing through the armature as OC_a will produce through the field-turns, and these two groups of lines will mutually cancel out, since they are in opposite directions. Let C_μ be the magnetising current, producing the actual induced E.M.F. $Oe = e \times \frac{60\,n}{N} \times a$, where a = the ratio of transformation and N = revolutions per minute of the field, so that $\frac{60\,n}{N}$ = the slip. Then the total

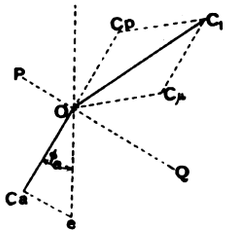

FIG. 21.

primary current being the resultant of C_p and C_μ is OC_1. We now have a certain number of lines passing through field and armature, due to C_μ and giving an E.M.F. represented in phase and amount by Oe, a certain leakage field OP caused by the armature current and not passing through the field, and an equal leakage field caused by C_p and not passing through the armature. This latter will be taken into account subsequently. The result, so far as the armature is concerned is that it is acted on by the E.M.F. Oe and the E.M.F. of self-induction OP. Their resultant is the actual ohmic E.M.F. acting over the armature resistance. Thus, in order to find the phase of OC_a relatively to Oe for any load, we need only take the frequency of the armature current corresponding to the speed, and credit the armature with a co-efficient of self-induction L_a proportional to its leakage lines per unit current. The angle of lag of the armature current ϕ_a is such that $\tan \phi_a = \frac{2\pi f_1 L_a}{R_a}$ or the ohmic E.M.F. of the armature is $Oe \cos \phi_a$.

Thus the field ampere turns of OC_1 are the resultant of the turns required to balance the armature turns in phase and strength and the magnetising turns, these two being inclined to each other at an angle $90° - (\phi_a + \beta^1)$. The leakage caused by OC_p has still to be dealt with. As C_p is really a component of the primary current, its leakage forms part of the total leakage of the primary current, the effect of which is to cause the primary E.M.F. of self-induction at right angles to the total primary current. The strength and phase of this current, C_1, has been found, so that it only remains to draw at right angles to the primary current OC_1 a line of length equal to our original e_s of Fig. 21, viz., 15 volts, raised in the proportion of $\frac{C_1}{26{\cdot}3}$, for the whole of the new primary current now acts round the leakage paths. This new e_s, when compounded with the useful back E.M.F. e of the field-winding, gives the total back E.M.F., and this, when compounded with the ohmic loss CR_f, gives the phase and strength of E_i, the impressed E.M.F.*

(*To be concluded.*)

CARBONS FOR ELECTRIC LIGHTING AND OTHER PURPOSES.†

BY FRANCIS JEHL.

(*Continued from page 440*).

In considering the pros. and cons. of the two systems that have been just explained, and in determining what furnace is the most suitable for carbonising carbons in a factory where economy, quality and commercial results are the chief objects of attainment, the writer thinks that preference will always be given to the Mendheim chamber system.

(*a*) In the gas ring furnace we have seen that the air that is necessary for combustion circulates horizontally through the whole cross-section of the ring, and that the combustible gases generally issue from the bottom or sides of the furnace. It is evident that under such conditions a thorough mixing of the gas and air cannot take place, which is one of the most important requirements necessary for a perfect combustion, and that no doubt some of the combustible gases and air escape out of that section of the ring that is in operation.—(*a'*) In the chamber system we have seen that the air and gas issue together from each opening or outlet, and thus a far more ideal mixing of these two ingredients takes place, insuring a better combustion as the mixture gets ignited.

(*b*) Along the top of the passage, in the ring system, there must be a flow of air that simply passes through the combustion division without doing any active work, while at the same time it may absorb and carry away some of the heat there created, so that, on the whole, either a lower temperature is obtained than desired, or a greater expenditure of fuel is necessitated in order to attain the desired intensity of heat.—(*b'*) In the chamber system the flow of air can be controlled and regulated by the valves or dampers that are placed in the air passages, while such a passage by which the air may escape unburned does not exist as in the ring system.

(*c*) Another fact concerning the ring furnaces, which has been verified by tests, is that the air in getting heated as it circulates through the hot finished divisions of the ring, gets specifically lighter than the heavy hydro-carbon gases, and thus when it enters that part where the combustion is going on, two strata or layers are formed by the air and gas which

* As a matter of fact, OC_1 is not quite the total primary current owing to eddy-currents in the field. These make a slight addition necessary, but they do not increase the leakage. Further, as will be explained later, a slight correction is necessary to allow for hysteresis.

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produce only a partly mixed fuel for combustion. At the top there may be air, and at the bottom of the furnace gas, both of which may escape out of the combustion division. This means the creation of a lower temperature, and a loss in fuel, while the heat from the finished divisions is uselessly taken away and absorbed by some air that serves no purpose.—(*c'*) In the chamber system of furnace it has been seen that as air and gas flow out together through small openings, no such stratification can take place, as the conditions of egress are totally different, and thus in this system there will not be such a tendency of unburned gas to escape.

(*d*) In the ring furnace it is evident that as the air supply is simply from one huge mouth, and that this air, later on as the finished parts have lost the greater part of their heat, will circulate in strata of various densities, thus producing an uneven distribution of oxygen.—(*d'*) The construction of the chamber system prevents such unequal distribution.

(*e*) Another thing to be noticed in the ring furnace system is that there must be an abundance—in fact, an excess—of air which must pass the first rows of orifices from which gas flows, so that the other orifices in the back may also be supplied. It can be imagined that as no regulation of air can be effected practically in the ring system, plenty of air must also escape by reason of what has just been said, as it is impossible to suppose that when the superfluous air passes the first rows of jets there is just sufficient oxygen left for the hind rows. In order to get combustion at these rows there must be a plenteous supply of air, some of which, it is evident, will escape. Escape of air or gas in a furnace always produces detrimental conditions.—(*e'*) In the chamber system the air flows out only in conjunction with gas, and thus no such conditions can obtain.

(*f*) It is also clear that when the combustion is going on in any part of the ring, as explained above under *e*, the chemical action of combustion must be somewhat weaker at the opposite end to that at which the air enters, as the dead gases resulting from the combustion going on there must pass the back flames and thus dilute and attenuate the surrounding air, thereby diminishing the chemical actions at those parts unless a considerable superfluous quantity of air flows, of which plenty will escape.—(*f'*) In the chamber system such a thing does not happen as each orifice of gas has its special delivery of air.

From what has been explained it will be seen that the chamber system has many good points over the ring system when considering it with regard to carbon baking, while generally also a higher temperature may be raised in the chamber system than in the ring furnace. Also the fact that each chamber, when heated up, holds and retains its heat much longer than a division in the ring system enables us to feed hotter air into the combustion chamber, or to keep the air hot longer than it is possible with the ring system. Practice has also shown that the horizontal flames that shoot on the retorts in the ring furnace have a great tendency to crack the latter, and it may be mentioned that a retort on the average can only be used 10 or 15 times under these conditions.

For electrode, chemical or smelting works, &c., which do not need such a large quantity of electrodes as to warrant the building of a chamber or intermittent chamber system, the Mendheim periodical furnace is no doubt the best to adapt. As such works only need from 2,000kg. to 4,000kg. of electrodes per week, they need only employ a few men who prepare the material, so that about one day in the week is almost sufficient for squirting and forming the electrodes. In such cases it is evident that a continuous or even intermittent working of the furnace is hardly possible, and that a periodical furnace is the best suited for the purpose of carbonising.

Although there is not such an economy in the fuel in these kinds of furnaces, as in the chamber system, yet a considerable portion of the waste heat is used in heating the air that feeds the combustion. But it is not possible to heat up the electrodes slowly by means of the waste heat, as is the case in the chamber system already described, because there is only one chamber in such a periodical furnace. On the whole, however, economy in fuel does not play such an important part in a small plant as in a large one. In the periodical furnace, after the electrodes have been packed and placed in the chamber, only a slow and low fire is at first started and kept up for a day or two, so that the goods will get gradually heated at the beginning; after a while, the intensity of the fire is increased, until it is brought up to its highest point. Subjecting the electrodes then to such a heat for 30 to 40 hours, the fire is allowed to sink again slowly and is at last extinguished. The furnace is then allowed to cool off by partly opening the dampers that control the air canals.

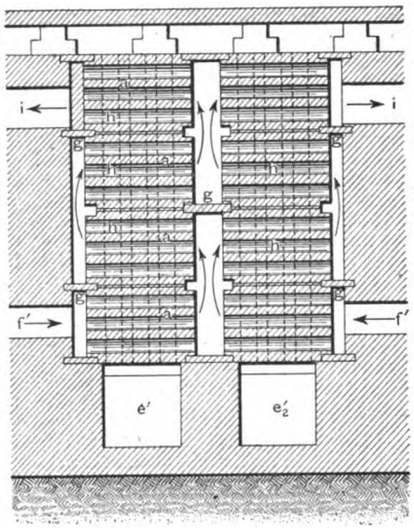

FIG. 41.—Mendheim's Continuous Regenerator. (Side view.)

The ingenious apparatus designed by Mendheim, for utilising a large part of the waste heat to warm up the air necessary for the combustion going on in the furnace, is shown in Figs. 41 and 42, which give two side views of his regenerator. In Fig. 45 we have a plan of the same at *g*, which is on a smaller scale than the other drawings, and in Fig. 44 we see the position of *g* with regard to the whole furnace. The generator consists of large moulded blocks, *a a a* (Figs. 41 and 42), made of fire-clay. These contain two series of passages, one set being at right angles to the

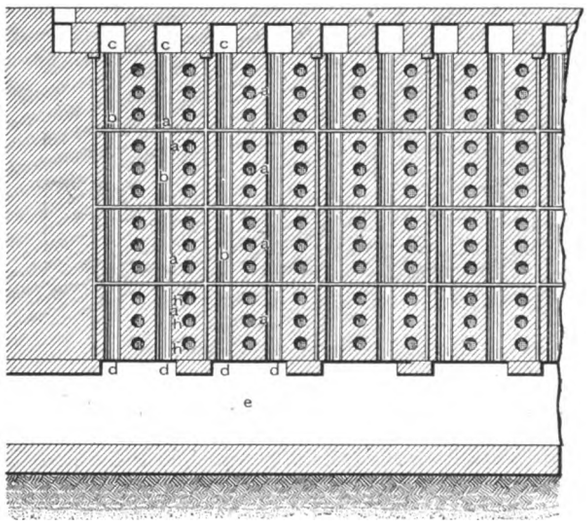

FIG. 42.—Mendheim's Continuous Regenerator. (Side view.)

other, as shown. The air flows through the one set *h h h*, while the waste heat passes through the other set *b b b*. In Fig. 41 the air enters at the passage *f'*, and goes into the space *g*, and through the passages *h* from one block to another in zigzag fashion until it reaches the passage *i* that leads into the fire-boxes of the combustion chamber. The waste heat of combustion enters the passages *c c c*, flows through the passages *b b b*, and out into the flues *e'* and *e'*$_2$

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that lead to the chimney. In passing through the passages *b b b* the fire-clay blocks take up a large amount of heat, which is in turn absorbed by the air that flows through the passages *h h h*, and thus a constant supply of heated air is delivered to the furnace.

In Figs. 43, 44 and 45 we have a cross-section and plans of the periodical furnace, which, as will be seen, consists of the gas generators *k*, to which fuel is supplied at *k'*. The gases generated flow into the fire-boxes at *l*, where they get mixed with air which enters the furnace by way of the passages *f' f' f'* into the regenerator G, and out into the passage *i* that leads to the fire-boxes *l l*. The flames that ensue from the combustion that takes place at *l* strike upward and then turn downward,

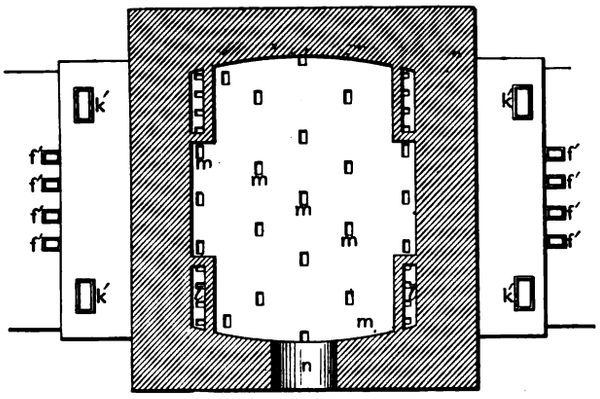

FIG. 43.—Mendheim's Periodical Half-Gas Furnace. (Plan.)

as shown by the arrows in the carbonising chamber C. It will be noticed that the fire is well distributed, as the flames divide and pass out through the numerous openings *m m m* that are in the floor of the furnace. From these openings the hot waste gases pass into the passages *c c c*, through the regenerator, and out into the passages e_1 and e_2 that lead into the common flue F that is connected with the chimney. The entrance into the furnace is shown at *n*, which is filled up with fire-bricks when in operation.

In starting the furnace only a little fuel is at first supplied at *k*, so as to obtain a low fire, while the air dampers of the passages *f f f* are closed. This starting of the fire is in all respects similar to that in an ordinary furnace, as the object

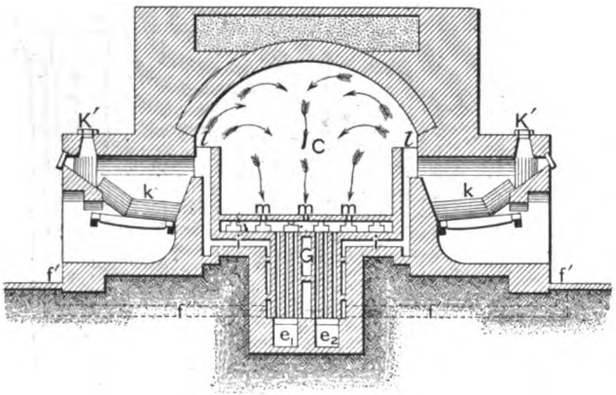

FIG. 44.—Mendheim's Periodical Half-Gas Furnace. (Cross section.)

is not to work it on the generator principle at first, so that a low fire can be obtained by means of which the articles in the furnace can be slowly heated up. The intensity of the fire is gradually increased until the electrodes, or rather the boxes in which they are packed, are at a red heat. After this stage has been reached fuel is added slowly until all signs of flames in the generators at *k* has disappeared. At this point of the operation we have the transition from the ordinary furnace into the gas generator, for when the flames are gone the gas begins to get produced, and it is then necessary to open the dampers of the air canals *f' f' f'*, so that air can be supplied to the gases as they issue into the fire boxes *l*, where the combustion takes place. For the above reason these furnaces are often called "periodical furnaces with half-gas firing," as they are started at first with an ordinary fire and later on change to the generator principle.

After the electrodes or carbons have been subjected to the highest heat for a sufficient length of time, the fuel is allowed to sink again, so that ultimately the furnace works again with an ordinary fire, which is also allowed to sink in intensity from time to time until at last it is extinguished. The furnace is then allowed to cool off slowly by means of the dampers that control the air passages. The whole operation of firing, &c., takes about four to five days, and we can also reckon about two days for cooling, so that in all a week is taken up in carbonising one batch of electrodes.

From what has been explained it will be seen that these periodical half-gas furnaces are especially well adapted for private concerns that wish to make their own electrodes, and do not need more in a week than what one furnace can bake. Large heavy electrodes can be thoroughly carbonised, as they must be subjected for a longer time to a higher heat than ordinary carbons that have on the whole a much smaller mass compared to some of the electrodes used in electrical smelting works. It takes time for the heat to penetrate through large masses of carbon, and, as we have seen, there is always a constant supply of hot air that materially helps to produce a very great and constant intensity of heat in the combustion chamber. We have seen that in the chamber system the air supplied receives its heat from those chambers in which the carbons have already been carbonised, and it is evident that the temperature of those chambers gradually sinks as the heat

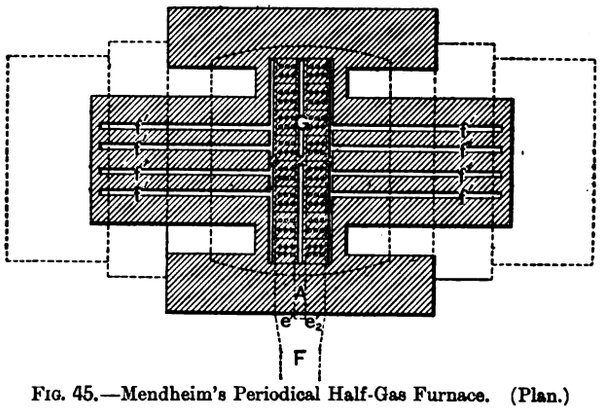

FIG. 45.—Mendheim's Periodical Half-Gas Furnace. (Plan.)

is taken away by the air in passing through them, and thus also the temperature of the air, until a new finished chamber is again added to the series. In the Mendheim periodical furnace the air always retains a constant high temperature when the furnace is in full operation.

(To be continued.)

ELECTRIC TRACTION BY SURFACE CONTACTS.*

BY MILES WALKER.

(Concluded from page 573).

One very important matter in connection with surface contacts is the water-tighting of the switch-boxes. Our method is to keep the opening of the switch-box as small as possible, and to provide a very solid lid screwed down hard against a rubber washer placed in a suitable recess. This gives a very perfect joint. The lid of the switch-box is the stud itself. The switch is attached to the underside of the stud and comes away with it as a single piece. To renew a switch, all that is necessary is to take out the three screws which hold it down, withdraw it by a holder made for the purpose, and drop in a new switch and stud and screw the whole down. The operation can be performed in less than two minutes. On the form of the switch contacts we have experimented a good deal. We have found that a particalar form of mercury contact is very satisfactory, but there is a prejudice against mercury contacts and so I show here a brush contact which answers its purpose admirably. The precautions to be adopted to keep a metal contact in good condition permanently are as follows. In the first place, provision must be made to absolutely prevent sparking upon the contact-

* Paper read before the Institution of Electrical Engineers, Feb. 16, 1899.

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surface. Secondly, a certain amount of friction must be introduced between the surfaces to keep them bright. The surfaces should be arranged to touch on as many points as possible, and yet there should be a substantial bulk of metal in the vicinity of the touching surfaces. A material should be employed which has good elastic properties, and in the operation of opening and closing all strains upon it must be far below the elastic limit. The cross-section of the material must, of course, be amply sufficient to carry the required current, and all causes of warming must be eliminated. If these precautions are adopted, a switch contact can be made to operate thousands of millions of times without injury. The switch has, of course, never to break the main current going to the car. It cannot open until the skate has been removed. It has, however, to break the current leaking from the stud and also the current taken by the magnetising coil, which is nearly half an ampere. To take the spark caused by this current we provide a contact between two arc carbons, D (in parallel with the main contacts), which does not break until the main contact has opened $\frac{1}{4}$in. This ensures the small spark always occurring on the carbon points. The switch being immersed in oil, this small spark is not pulled out any perceptible distance, and by providing a $2\frac{1}{2}$in. break the switch is enabled to break currents of ten times the amount if it were necessary to do so. The method of earthing the switch in the event of the yoke piece Y failing to open is seen at once from Fig. 10. The rod N is of copper, and has a collar on its upper end which will come in contact with the yoke piece Y whenever P moves down relatively to T. If Y and T should for any cause stick and keep the switch closed after the car has gone past, N in falling will connect the earthed mercury cup E with the yoke Y and blow the cut out. The mercury cup E is merely a hole drilled in the cast-iron switchbox. The box is permanently earthed by being connected to the rails by a stout conductor. It is found that a mercury cup of this kind remains unchanged for years, but still it is well to put a check upon its efficiency as a safeguard. This is done in the following way. It will be seen from the diagram of connections that one end of the shunt coil is connected to earth. The method of making the earth connection is to bring down a stiff conductor from the switch and make it dip into the upper portion of the mercury cup E. So long as that cup remains efficient as a connection to earth the switch will operate, but if for any reason (as, for instance, the box being cracked and the mercury spilt) the connection to earth is broken, then the shunt coil becomes inoperative and the switch cannot be closed at all. If, therefore, the switch will close at all, we are sure that the mercury cup E is full. In this way the risk of accident is reduced to the one risk of the plunger sticking in its tube. It is, therefore, necessary to consider somewhat carefully what risk there is in the plunger sticking up after the car has passed. It will be noted that there are absolutely no side forces upon the plunger to cause friction against the inside of the tube. The clearance is so great that even the introduction of grit does not have any effect. As a matter of fact, under the worst conditions the force due to friction is less than $\frac{1}{4}$oz. When the plunger and tube are polished and working in oil as in practice, we may safely take the force of friction as less than 0·01 of a pound. Now we can make the downward force upon the plunger when the iron skate is removed almost what we please; how great we shall make it is merely a question of economy in copper. We consider that a factor of safety of 200 is more than sufficient. We have adjusted the sizes of the iron heads of the plunger so that the downward force after the removal of the skate is $2\frac{1}{2}$lb. This, of course, becomes less as the plunger falls, but it still has a considerable value after the plunger has fallen $\frac{3}{8}$in. and earths the switch. Thus we see that the chance of the plunger sticking is absolutely *nil*.

There is one other risk to guard against, and that is the breaking down of the insulation between the main and the stud. This is most effectually done by surrounding the switch by a sheath of metal which is permanently earthed and supporting all parts connected to the main on the earthed sheath, so that if their insulation breaks down there is an arc to earth and the fuse is blown. Although the passage of the car from stud to stud is a continuous process, each switch being actuated by current derived from the last switch, it is necessary to have on the car some means of making a stud alive if by any means connection with the main should be lost. For this purpose we carry on the car a small accumulator battery capable of yielding a current sufficient to work a switch at a pressure of 500 volts. Its capacity need only be small, so it can be very solidly and cheaply constructed, and as it can be charged direct from the line it is always ready for use. In practice we find that it is very convenient in use. The ordinary car controller can be adapted with an additional contact on it, so that when the handle is swung round to a certain position the accumulator is connected to the skate. By this means the driver can in an instant pick up again, if through any obstruction the skate loses contact with the main. It is a distinct advantage in a surface contact system for the current which operates the switches to have a high pressure behind it, because it is able to overcome little obstacles such as mud and paper on the studs. For this reason switches requiring 500 volts pressure to operate them are preferable to switches operated by a low voltage battery carried on the car.

Throughout the whole of our work on surface contacts we have, of course, been aware that they could never be as simple in operation as the overhead wire, and that where the overhead wire is permissible it is to be preferred on account of its cheapness if for nothing else. We have merely directed our efforts to see how far surface contacts could be perfected. We believe that future experience will show that the studs can be laid so as to cause no obstruction to traffic; that the method of picking up current from studs in the road is much more feasible than it at first sight appears; and that the safety can be made as great as in any other system of electric traction.

One thing that augurs well for surface contacts is the ease with which they can be worked in conjunction with the trolley wire. It will be possible to run a car from one system to the other without any more delay than is required to hitch the trolley on to its line. Throughout the experimental work of the last two years we have had the assistance of Mr. C. E. Holland, and some of the most valuable suggestions have been due to him. Had it not been for his continual efforts the experimental line at Willesden could not have been made such a great success.

The following is an abstract of the discussion which took place in connection with the above Paper:—

Prof. C. A. CARUS-WILSON did not think the author had made as good a point as he might have done of some of the characteristics of the system. Anyone who had studied this particular system could see that leakage current could not make the studs alive. This was one of the most serious disadvantages to most existing systems, and the author deserved congratulation that this effect was entirely absent from his device. As regards the safety of the system, he could not conceive of anything more safe. Nevertheless, there were always other elements connected with safety that had to be borne in mind, some of which had been dealt with by the author, and he thought it possible to sacrifice too much to safety. Any electromagnetic contrivance should be easily accessible without interfering with the traffic, It had struck him as a very serious element in this system that the studs had to be opened when the traffic was not passing, and the author had stated in his Paper that it took a minute to open one of these studs. If they had studs at about 14ft. centre, at this rate of progression it would take about 12 hours to examine all the studs in a mile. As to the skate, it seemed to him that the only element in which this would not be at home was ice. He could not imagine anything but ice getting on the studs to interfere with the working or picking up by the skate. But as ice was not to be feared in this country, he did not think this a very important drawback. He did not think the actual ampere leakage was of importance, except as regards the current required for the shunt. If there was a considerable leakage from one of the studs, say, two amperes, the shunt which held up the plunger was itself shunted by a shunt of very low resistance to earth. He thought any question of leakage should be considered in relation to the current required to magnetise the shunt, and he should say that a leakage of two amperes to the earth or rail from one of these studs would demagnetise or render inoperative the high resistance shunt of the plunger itself. Of course, two amperes leakage was not likely to happen very often. He was sorry that the author had given up mercury contacts. He believed this form of contact was a good one and was sorry they had given up the use of it for the metal contact. On the question of sparking he drew a diagram on the board showing some studs connected by conductors containing switches with the main cable. The problem was peculiarly like the question of commutation, and if they could not get rid of the sparking he agreed with the author that there was a very serious defect. The author stated that the switch had never to break the main current going to the car. He did not want to dispute that statement altogether, because he had not examined the model, but it did not seem that this was at all obvious. Suppose, for instance, that the skate rested equally upon two of the studs. The current would not accommodate itself, so that exactly the same current passed from each stud; there was a certain amount of self-induction and the result would be that the current was greatest at the back of the skate. There would always be a larger proportion of current passing from the back stud to the back of the skate than from the front stud to the front of the stud, and the question was where was the current going to break first. It seemed that the answer depended upon the rate at which the plunger was going to fall, and after the meeting he would ask the author to draw away the skate in a horizontal direction away from the stud, and see how far away from the stud the skate must be before the plunger would fall.

Mr. SYDNEY SHARP understood that the plunger of the last stud could not fall until the skate had quite broken contact with the stud; therefore, Prof. Carus Wilson's fears on this ground were quite unfounded. Then, again, as the current was always passing from the other stud to the skate, he did not think the question of sparking was important. Having seen this system in operation at Willesden, and having spent a considerable time there in examining the working of the switches, and seen the ease with which they had been removed and renewed, he thought the system was one of the simplest and most easily get-at-able of surface contact devices which had yet been made public. An attendant had simply taken out three screws from the surface of the stud, and taken out the switch and put in a new one and without any loss of time or hindrance to the traffic. He thought it possible for this to be done when the system was

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in practical work without fear of interruptions to traffic or delays from breakdown. Stress had been laid on the possibility of the studs being left alive, but he thought this system of Mr. Walker's entirely obviated this. It would have to be proved by actual experience how the thing would work, but he was of opinion that, judging from the experimental line, the system would hold its own in practical use. The system was one which was applicable in many cases where the conduit was impossible. In Glasgow, for instance, the Caledonian Railway passes under Argyll-street for about two miles with only about 10in. between the surface of the street and the top of the arch of the railway. On this account, they had been unable to introduce the conduit system, and had had to resort to the overhead trolley.

Prof. W. E. AYRTON said that, as Mr. Walker had intimated, in addition to the well-known trolley and conduit systems, there were two other systems of electric traction, viz., the sub-divided conductor in which the principal conductor was divided into a number of sections, each fairly well insulated from the next, and from the ground; and, lastly, what had been called the surface contact system. These two latter systems were the subject of Prof. Perry's and his own patent 18 years ago. But it did not attract very much attention at the time, although it was admitted that this patent started the idea. It was now a question of detail, not of fundamental principle, that they had to consider. When he had read the account given by Dr. Thompson of this perfected system, at the British Association at Bristol last year, the first thing that had struck him was that the system was not as perfect as he imagined. If, through dirt, or through a piece of paper sticking to the top of the stud, the skate failed to make contact, then this contact box, he had imagined, was absolutely dead; it was impossible for the car to move on, and impossible for any car behind it to come up after it. The whole line behind, he understood, was absolutely dead by the failure of the skate on any car to make contact with any stud. Also, he understood that, if in the generating station, the main fuse went for an instant, and was, in some automatic way, replaced by another fuse, then the whole line was dead, and it was absolutely impossible for any car to regain current. He did not then know that each car carried a battery of accumulators at 500 volts. Of course, that got over the difficulty, but he thought it was a distinct disadvantge to teh system. The next thing that struck him was several serious defects in the mechanical parts of the contact box, and they had been shown a contact box that evening which differed in many particulars from the one described at Bristol. In the first place, the mercury contact, as Prof. Carus-Wilson had said, on which such stress had been laid in the British Association Paper, had been entirely abandoned in only a few months. Secondly, the way in which the contact was made was entirely different to that explained at Bristol. Why should a system, which was then supposed to be so perfect, and so good a few months ago, require to be entirely changed if the success of the thing was the details? The question of leakage seemed to him very serious and important. It seemed by the Paper that there was a possibility of 5 amperes leakage, and this, at 500 volts, amounted to 2½ kilowatts. He wondered what the Board of Trade would say about that in connection with the corrosion of pipes! This was a very serious matter, and required very careful consideration before they could say it was a system ready to be put on the roads, that the County Council are to work on the south of the Thames. He would not like the County Council, or any large body in this country, to adopt the system under the idea that every detail was worked out, and that success was guaranteed, whereas the system was, as the last six months had shown, in the beginning of its experimental stage. He should not like anybody to adopt such a system, and then say: "Oh, Ayrton and Perry's contact system is a failure after all!"

Mr. A. J. LAWSON asked what was the width of the skate and the amount of curve permissible without putting the contact studs very close together? It was just possible that if they had a very sharp curve they would get the skate making contact with the rail; in fact, it was practically certain to. With regard to the leakage, Mr. Walker had mentioned an average of half an ampere per car; on 40 cars this would be 10 kilowatts. He would be very glad to supply such a system as this from a central station, for on these 40 cars there was no less than 58,400 units leakage per annum, and over a very extended system, such as the South London tramways, it would be a very considerable amount indeed.

Prof. AYRTON: You mean you would make a good revenue out of the leakage?

Mr. LAWSON: Yes. He thought there were just as many difficulties to be met with in the matter of want of room in London streets as there were in Glasgow, and he would like to know what would be the cost of the removal of the 48in. and 30in. pipes of the gas and water companies in order to make room for these plungers. With regard to Mr. Sharp's remarks, he protested against the sentimental rubbish stated with regard to the overhead disfigurement. This sentiment stood in the way of the application of electricity to the propulsion of cars on the tramways of London.

Mr. EUSTACE THOMAS thought the success of surface contacts depended upon how the details were going to work out. For instance, when going over crossings, if they had an appreciable amount of leakage with mud over the rail, they would start an arc and blow the fuse in the stud, which would be rather awkward in practical working. This might be got over by having a second stud connected to the negative feeder. With regard to the switch, he could not help thinking that there were a lot of details which did not appear quite practical for ordinary working. It had been decided to work with the switches underneath the studs. He thought all who were interested in this matter would see that it was better to put the switch into a separate box at the side. Then, again, two joints are separated by micanite, and when they remembered that there were cart wheels striking heavy blows upon the studs, and that this occurs very frequently, and also they had the hammering of the plunger to a smaller extent, he thought micanite was a very unsafe material to use, even although it might be able to take a steady pressure of 15 tons without any damage at all. Then, in consequence of the hammering, he thought the joint likely to get loose which would allow water to get into the switch. It also seemed possible for the yoke of the switch to stick to the lower part of the rail, much in the same way as it was supposed to stick to the plunger when it was going down. If this were the case, they would have rather a large number of fuses going in the different studs from time to time which would, of course, make it a difficult matter to keep the line in active operation. But one very important difficulty, and one which he doubted whether it was possible to surmount, was the fact that they were working with a shunt coil. Those who had any experience with such knew what a great difficulty there was in breaking the circuit without having breakdowns. Mr. Walker's was a very pretty system in principle, but it had yet to be proved whether it would be possible for it to become a commercial success.

Mr. E. H. COZENS-HARDY thought Mr. Walker had shown great ingenuity in getting over the ordinary difficulties, but he also thought the safety of the system would only be assured by surmounting the extraordinary conditions. It seemed to him that there might be one or two conditions under which the skate would hold the plunger up. If a part of the coils became short circuited it was conceivable that when the plunger was up it might be held up on account of the disarrangement of the coil. He thought the amount of leakage depended to a large extent upon the behaviour of horses on the particular part of the road referred to. As a result of actual experiments on surface contact systems, the leakage under certain conditions amounted to 20 or 30 amperes on a 2ft. piece of rail at 500 volts. If anything, that was under the mark. The conditions under which he measured were by pouring stable liquid over the rail in the centre of the road, which would, of course, be an every day occurrence. He did not know how long the plunger took to fall, but it seemed that if it took an appreciable time, a dray, with an iron tyre coming up directly behind the car, might provide the necessary piece of iron to attract the plunger. Regarding wear, in Paris they had considerable difficulty with the wear of brass studs. They found it necessary on ordinary lines to renew these not less than once every six months. If they made these of iron he should imagine they would experience a very considerable trouble with the plunger.

Mr. A. M. SILLAR confirmed the last speaker's statement with regard to the excessive leakage with surface contact systems. He also thought the amount was rather under-estimated. It was in the practical application of the Walker system that the commercial success of it would be determined, and he thought that, if the author considered details as to carrying the skate round sharp curves and up steep gradients, he would find very great difficulty in dealing with his skate. In ordinary car building work it was customary to leave not less than from 3½in. to 4in. from the road to the underside of the car to clear obstructions, and this was considered sufficient to clear the motor. He thought that in turning sharp corners there would be a side swing of something like 2ft., with a skate 16ft. long, as Mr. Walker had stated the skate on his car to be. He also thought it would be necessary, in order to cover the whole of the track by a skate in turning a corner at a radius of 30ft., to have the skate some 4ft. wide.

Mr. E. TREMLETT CARTER suggested fitting a skate to an ordinary tramcar, and trailing or hauling it about, in order to see the effect of the humps in the road on the skate. Through the courtesy of the inventors, he had seen the experimental line at Willesden, and could testify to the rapidity with which studs could be removed. If, however, the studs happened to be covered with slush or water, at the time of replacing them, it seemed that in a few seconds the switch would be filled. Even if the box was filled with oil, stones would find their way into it. Nevertheless, he thought it was the most practical system of surface contacts yet devised, and merited trial on a short length of public highway.

Dr. SILVANUS THOMPSON (in the chair) said that, as well known to all, he was interested in this system, but he had left it entirely to his colleague to prepare this Paper, and would, therefore, leave it in his hands to reply. He had listened with intense interest to the discussion, and to all the extraordinary things that must happen when they get to work: the skates that must be 4ft. wide and other terrible things. However, it had fallen to his lot to spend time and money actually trying whether al these things would in practice take place, and they had the results of those experiments enumerated in the Paper before them.

Mr. MILES-WALKER, replying, stated that he had a full and complete answer ready to all the criticisms that had been made. He thought most of the objections raised were due to an incomplete knowledge of the system. In answer to Prof. Carus-Wilson's question as to sparking, he said the ends of the skate being turned up prevented this taking place. He thanked Prof. Ayrton especially for his criticism, because this was a system he had initiated. He congratulated him on being the first in this matter and on being so much before his time. He thought Prof. Ayrton was wrong in saying that it was not pointed out in the British Association Paper that accumulators were required. There was a distinct statement in the Paper, and the reason that the fact had not been emphasised, that the accumulators must be of 500 volts, was because they thought it a drawback. It was possible to make their system efficient with accumulators at 100 volts. With regard to mercury contacts, if Prof. Ayrton would look at the Paper more carefully, he would find that it was not stated they had abandoned these. They had a number of prejudices to fight against; mercury contacts were things about which the public had an enormous prejudice, simply because they did not know what a mercury contact would do. If they wanted to see whether they had abandoned them, they could go to Willesden and see that every switch there had a mercury contact. These switches had been there for 18 months and were still in good working order. It was wrong to say that a switchwas only in its experimental stage because they had made variations. They might as well say a dynamo was still in its experimental stage, simply because improvements were still being made in it. Regarding leakage, he said that

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this depended entirely upon the length exposed. The periphery of his studs was 15in., and the length of the rail (referred to by one of the speakers) was 48in. One speaker had mentioned as much as 20 amperes leakage, but the difference between this and the amount mentioned in the Paper, viz., two amperes, could only be accounted for by the particularly bad conditions. The conditions he himself had taken were ordinary street mud taken out of the street and put round the stud. Then, again, they must remember the amount given was for two studs, so that they must halve that. Mr. Thomas had raised a number of very interesting points, but he had good answers for all of them. With regard to the distance between the studs, they were quite satisfied that 15ft. was not an excessive distance, and even had hope of increasing it up to about 25ft. It made a great deal of difference in the cost of laying. With regard to the question of a short to earth, it must be remembered that they had a positive stop which prevented the skate coming within an inch of the earth, and he did not think an arc would form through about an inch of mud. It would be quite possible, if arcs were formed through an inch of mud, to carry in front of the car a brush which could be temporarily depressed and take away the thick of the mud at points where the rails crossed. With regard to the details of the switch, all the parts were really of a very simple character and could be made very cheaply. The question of special boxes was open to discussion. Was it better to have each switch in a separate box or to group them in boxes several together? They had thought it better on the whole to have each switch in a separate box. He did not think that water could possibly get into the boxes; they were as tight as a lemonade bottle. There was an indiarubber ring pressed down hard into a groove, and it was impossible for water to get in. The possibility of the yoke sticking was a question which did not arise, because the formation of the brass cup into which the yoke fits was not at all that of the formation of the iron plunger. He thought the question of the shunt coil was very easily answered: the coil was wound upon a very thick brass bobbin, and it had very thick ends. It was impossible for any short circuiting in the coil to make the plunger keep up. It was also impossible for a day, with an iron wheel to follow so closely on the car, to keep the switch open, because it opened in about $\frac{1}{4}$th of a second. He was glad to hear that studs lasted as long as six months in Paris. If they lasted as long as that here he would be satisfied. He thought it would be very easy to prevent mud getting into the boxes when they were removing the caps by brushing away any mud from the surface before opening the box.

ELECTRIC INTER-COMMUNICATION IN RAILWAY TRAINS.*

BY W. E. LANGDON.

(*Concluded from page 543.*)

Following the views of the Board of Trade, Mr. Hollins, the electrical engineer to the Great Eastern Railway, has succeeded in combining the electrical communication required for this purpose with the brake coupling. The electrical parts of the coupling are countersunk in the metal portion of the brake coupling, which is cut away for their reception. The wires are arranged inside the brake tube, being connected, at the coupling end, to the electrical connections, and carried through the tubing at the end which connects with the vehicle as shown in the illustration. Mr. Hollins has applied his electrical contact to both the Westinghouse and vacuum brake. The illustrations, Figs. 9, 10 and 11, refer to the

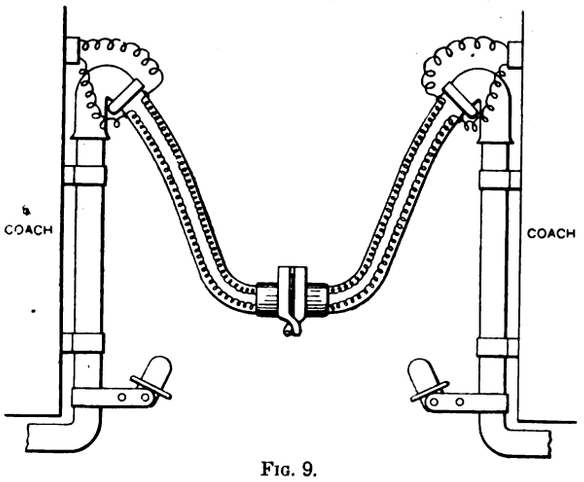

FIG. 9.

latter, which is perhaps the more simple of the two, although I believe it is Mr. Hollins's opinion that the Westinghouse forms the better contact. Fig. 10 shows the contact-making arrangement, which is screwed into the metal portion of the coupling, as seen in Fig. 11. A is a ring of insulating material, to which metal flange and tube, B B, is secured. This tube serves to hold within it the contact-making piece C, which is formed of a metal tube, reduced, as shown by the dotted lines at E, in order to receive a spiral spring, F, the duty of which is to press forward C so as to ensure good contact with the corresponding part of the coupling around the edge of the tube D, which is milled to assist in making good contact. G is a metal collar which limits the action of the spiral spring in that direction.

In 1885 the author was granted letters patent for combining an electrical with the vacuum brake coupling, but in this instance

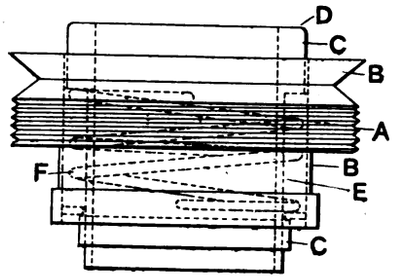

FIG. 10.

the electrical portion was superimposed upon the brake tube and coupling. It was not, however, allowed to remain long in use, serious objection being raised by that department of the service responsible for the satisfactory operation of the brake. It is believed these are the only practical attempts made with a view to effecting this combination. The coupling adopted by the author for the Midland train is shown in Fig. 12. The electrical portion

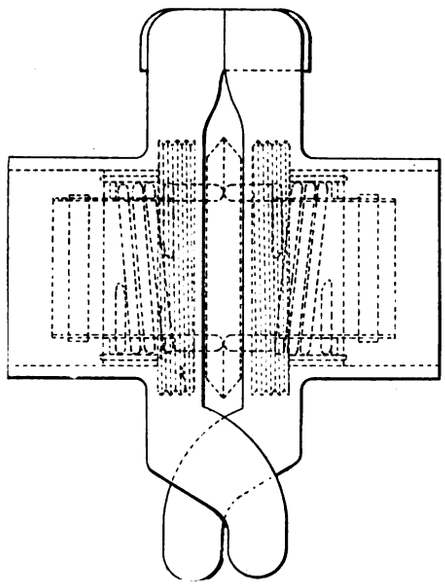

FIG. 11.

consists of two plates of metal, insulated the one from the other, to which the two wires forming the communication are attached. These plates are so cut that that belonging to one part of the coupling shall dovetail into that belonging to the other portion. The two plates are so fixed within an iron case, formed after the fashion of, but smaller than, the vacuum brake coupling, that that

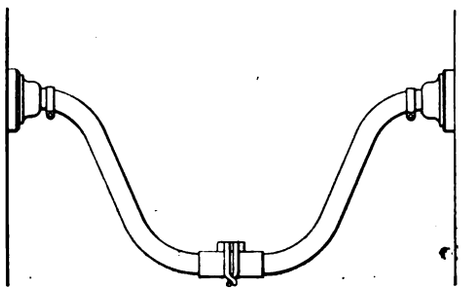

FIG. 12.

applicable to the positive wire of the one coach shall engage with that applicable to the similar pole of the connecting coach. It is thus impossible to cross the wires, while the one coupling serves for the two wires. The vacuum brake form of coupling has been selected as the protecting and guiding cover, for the reason that, the mode of coupling it up being so well known, no difficulty can possibly

* Abstract of a Paper read before the Institution of Electrical Engineers, Dec. 15, 1898.

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attend its application to the purpose of an electrical coupling. The wires are carried from the contact plates to the end of the vehicle in tubing similar in character, but smaller than the brake tubing. The wires of each vehicle terminate on an insulated plate fixed to each end of the carriage, so that any changes needed may be readily effected. The wires throughout are fully protected from moisture.

3. The Means for Claiming the Attention of the Officials in Charge of the Train.

In the Brigton Company's carriages this is secured by the operation of a knob, forming the handle of a commutator. On being pulled out it connects the line and earth wires. It is fixed in the centre of the partition which divides one compartment from another. On the knob being pulled out to a certain extent it becomes locked, and requires the presence of the guard to release it. The bells continue to ring so long as the commutator remains extended. The Brighton Company employ no outward indicator to identify the vehicle from which the alarm has been raised. It is not understood that any difficulty has attended the absence of such an indicator. In the South Eastern Company's stock, considerable improvements, in the mode of operating the alarm commutator, have been effected by Mr. Leonard. The commutator is placed over one of the quarter windows, and is provided with a knob as in the Brighton Company's trains; but this knob is arranged to pull *downwards* (*see* Fig. 13), and is thus more readily operated than if it had to be pulled outwards. Each compartment has but one point from which the alarm may be raised. Each first class compartment, and nearly all second class compartments, are provided with an outside indicator, but to the third class one indicator only is alloted to each carriage. On the Chatham and Dover, each compartment is provided with one commutator fixed in the centre of the division. There is no indicator to show the source of alarm. The commutator in each instance is of the most simple character—merely connecting the line and earth wires or the two line wires—and, where used, discharging mechanically the indicator affixed to the outside of the vehicle or compartment as may be arranged. The commutator, once operated, remains locked until reset by the guard.

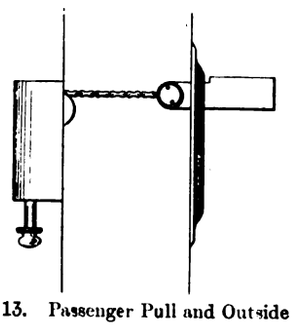

Fig. 13. Passenger Pull and Outside Arm.

The coaches which have been fitted by the Great Eastern are, in like manner, provided with a commutator fixed in the centre of the division between the compartments. The user turns a switch handle, capable of being moved in either direction—to the right or to the left—which closes the circuit. Each coach is provided with an outside indicator on either side of the vehicle for the purpose of indicating whence the alarm is raised. On the circuit being closed by any one compartment, the current passes through the indicators and discharges them. The principle upon which this indicator is constructed is that of the Sykes signal reverser. The current energises an electromagnet, A, Fig. 14. On the armature being lifted, a heavy bar, B, is discharged, and, falling upon C, forces it out of the notch, in which it normally rests, in the bar D. E is the indicator, and it is heavily weighted, so that, on C being lifted out of D, it pushes the rod before it in the direction of the arrow. As D is moved forward it carries with it the *replacer* F, which is attached to it, placing the spring which projects from it in contact with G, thereby short-circuiting the electromagnet. F at the same time forces back B into its normal position, where it is again held by the armature of A. On the guard lifting E into its upright position, the rod D is drawn forward until the detent, or locking piece C, falls into its slot, when the entire arrangement is reset and ready to be again discharged. The re-adjusting portion F has, along with D, been moved forward, and the short-circuiting spring attached thereto again rests upon an insulated part.

The means adopted for raising the alarm in the trains running on the Midland forms a marked departure from the course generally pursued hitherto. A flexible steel wire is carried inside a metal tube along each side of the carriage over the doors and quarter lights. This wire has one end made fast, either at one point in each comparment, or at the end of the coach; its other end is attached to the lever of a commutator capable of being operated in either direction. The wire, covered by a fabric suitable for handling, is exposed for some 12in. or 15in. over each quarter light. On the wire being pulled from any one of the exposed parts the commutator lever is operated, a disc on the outside of the carriage is discharged, the circuit is closed, and the bells set ringing. Each compartment has thus *four points from which the communication may be brought into operation.* Each coach has an indicator on either side, and if necessary, each compartment may be so provided. The commutator at the moment of sounding the alarm becomes locked, and can only be released by the guard, either from the outside or the inside of the vehicle.

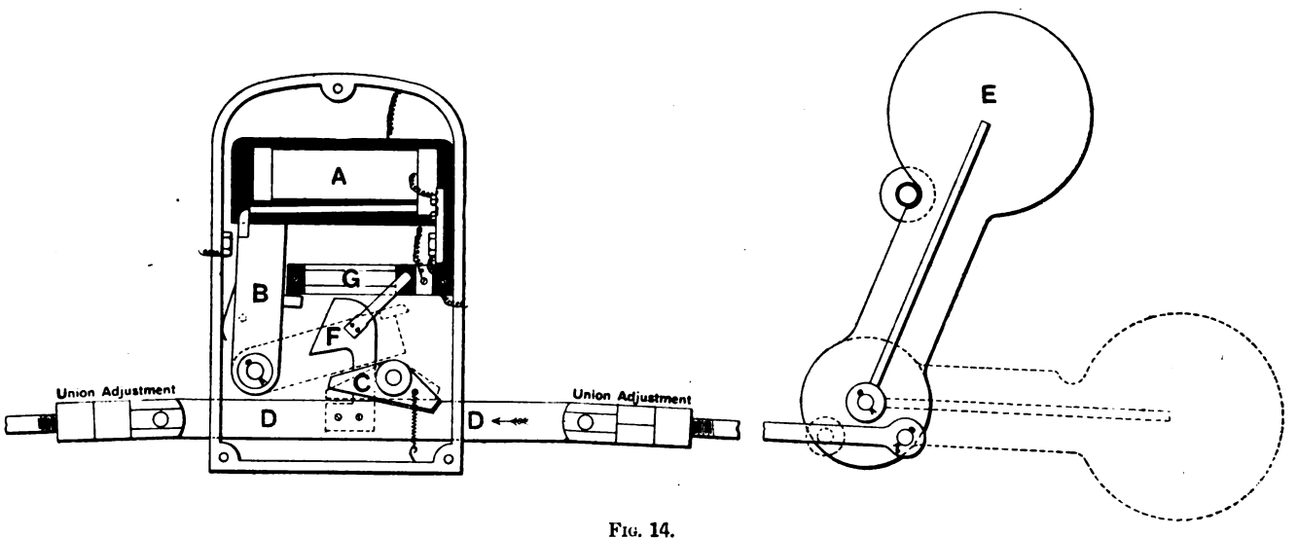

Fig. 14.

Experience tells us, and the Board of Trade Report suggests, that *the communication should be of such a character as to lend itself readily to the interchange of carriages between different railways.* This involves not only the electrical principle, but the mode and form of coupling, as well as the means of restoring the communication to its normal condition. The electrical system must be such as will conform to that in use on other lines of railway! We have seen that all those systems in use do practically stand upon a common basis. They have either one insulated wire, and an earth or an uninsulated "return," or two insulated wires. They differ to the extent of some switching arrangements; but it will be clear that that method which involves no special provision in respect of the position which the van occupies in the train, is that which must commend itself for adoption. To modify the arrangements of those vehicles which do not conform to this demand would be an extremely small matter. It would also be better, as has already been explained, to employ an insulated "return;" but it is possible, though not desirable, to use an open "return."

That the coupling for any electrical communication which might be established on railway trains should be combined with one of the mechanical couplings seems to be a sort of tradition handed down from those days preceding the period when railway companies found marshalling sheds indispensable. We have seen that the

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companies who have used an electrical communication have for years employed an independent coupling, and that they are now supplementing this by a second. The "cord" communication calls for coupling up, and certainly the time required for connecting together an electrical coupling cannot be so great as that now incurred in connecting up this "cord" communication. The question, moreover, is one which, in respect of the majority of trains, does not in any way affect platform work for the reason that the trains, as a rule, come to the platform ready coupled up. It may, and very naturally, be asked—But why, if the two couplings—the electric and the brake—can be combined, should they not? The question which here arises is mainly one of responsibility. A question on the cost and convenience will naturally also present itself, but that of responsibility is unquestionably the most material. Will such a combination lessen the responsibility which attaches to the efficient maintenance of the brake? When a failure arises in a brake coupling or tube, how is it to be dealt with without the presence of the electrical attendant, and *vice versâ*? Are these men to hunt in couples—the one tied to the other? What does such a combination entail? It means the replacement of some 150,000 brake couplings and tubes. Will the cost prove more economical, or so economical as if the two were established and maintained independent the one of the other, leaving the two departments freedom of action and individual responsibility? I advance these remarks from conviction, after mature consideration, that to combine the electrical with the brake coupling *is*, on many counts, undesirable. It has already been demonstrated that but one coupling, for the two wires composing the communication, is necessary.

It would appear that that which has now to be chiefly provided for is the protection of the traveller from outrage. Is this adequately provided for by the provision of a means of raising an alarm from one position only in each compartment? It is due to the conviction that this is not so, and that the only effectual mode of doing so is the provision of a means of communication in the neighbourhood of each corner of a compartment, that I have endeavoured to evolve the method referred to as that which has been applied to a Midland train.

Although seemingly a very small matter, there is another phase of the question which is material to the adoption of an universal system, viz., the means by which the communication, once used, is restored. This is done by a key carried by the guard. It is usually of private construction, and differs with most companies. It should be common to all, otherwise guards will require to be furnished with a key applicable to each of the companies' stock which may pass over the line upon which he is engaged. Other points of equal, although not of universal, importance will no doubt present themselves: the description of wire to be used; whether it shall be insulated with guttapercha or rubber; the character of the indicator, of the commutator, the description of battery, &c.—all questions of moment, but not vital to the question of interchange of stock.

There remain but two points at which to glance—viz., communication with the driver, and provision for calling attention to the division of a train when in motion. There is no difficulty in providing for communication with the driver, but it is desirable the battery on the engine should be dispensed with. This it is possible to effect by providing each guard's van with a coupling applicable to the locomotive. The cost of adopting this course would be less than that attending the provision and maintenance of a battery on the engine. Another point is whether it would not be better to sound a whistle on the engine, rather than operate a bell. The whistle would probably be easier to maintain. In the earliest established electric communication systems a means was provided for claiming attention should a train become severed. There is no difficulty attending this, but it would appear that the need for it no longer exists. Since those days the automatic brake has been introduced, and if a train should at any moment become divided, the progress of all portions of it would at once be arrested.

In concluding this Paper, I desire to tender to the general managers, and to my *confréres*, the electrical engineers, of the various railways, who have so kindly assisted me with information, my most hearty and respectful thanks.

RAILWAY PASSENGER COMMUNICATION.

Extracts from the Report of the Committee appointed by the President of the Board of Trade.

Systems in Use on Railways in other Countries.

In Austria all fast and express trains are fitted with an electrical communication (system Rayl). In Hungary the use of corridor carriages is said to be nearly universal, and, when these are fitted with an automatic brake, means are provided to enable the passengers to apply it, and thus call the attention of the servants in charge of the train, and no further means of communication is thought necessary. A system of electrical communication was formerly employed. In Belgium a means of communication by the application of the Westinghouse brake, similar in principle to that used in connection with the vacuum brake by the Great Central and other railways in this country, is in force on the State railways. The same arrangement is used on the principal Italian railways. In France the system to be adopted is left to the discretion of the individual companies, some of which employ electrical means, generally "Prudhomme's" system, whilst others prefer the Westinghouse brake system. In Germany, almost all passenger trains are fitted with automatic brakes, and means are provided to enable passengers to apply the brake in case of emergency. In Russia and Switzerland corridor carriages are generally used, and, when automatic brakes are provided, passengers can apply them. In Canada there is direct means of access from one part of a train to another, each carriage being connected to the next by a gangway, but a cord runs through the train by which a signal to stop can be conveyed to the driver. In India various means of communication have been tried, but the Indian Government state that the only one that has given satisfaction is an electrical method, invented by the late Mr. G. K. Winter. This system, in which the electric connection between the carriages is made by means of the side or safety chains, has been in use on the Madras Railway since 1880, and is being introduced on the South Indian Railway.

Conclusions as to Existing Systems.

Most of the witnesses examined by the Committee agreed that the ordinary means of communication by means of a cord outside the carriage is unsatisfactory, and with these opinions your Committee entirely concur. As regards the electrical systems of communication referred to above, the Committee had the advantage of making trial of that in use by the London, Brighton and South Coast Railway Co., on a train placed at their disposal by the company. They found it to work efficiently, whilst the company, as previously mentioned, have no record of its having ever failed.

Evidence was received by the Committee indicating that the electrical methods in use on the South Eastern and London, Chatham and Dover Railways had given satisfactory results. The Committee also had an opportunity of inspecting an electrical system fitted by the Great Eastern Railway Co. to one of their trains, in which the wires are carried along the brake pipes, and the coupling of the pipes between two carriages automatically gives the necessary connection between the wires. This system worked satisfactorily when tested, and it has the advantage of obviating the necessity for any additional coupling—a point which the Committee think will be found of considerable importance to railway companies in working their traffic. The Committee are of opinion that all these electrical systems, though some of them may be capable of improvement, may be considered as providing efficient means of communication.

The London and South Western Railway Co. have been good enough, at the request of the Committee, to fit up a train with a somewhat similar system, in which the electrical connection between the carriages is made by coupling the side chains. The system was invented by the late Mr. G. K. Winter, and, as has already been stated, is largely used in India. As the train has only recently been fitted with the apparatus, there has not been time for a prolonged trial of the system, but, so far as the tests have gone, they have, we understand, been satisfactory. The conducting surfaces, however, being open to the atmosphere and to dust or snow, are not likely, in the opinion of the Committee, to be as efficient as those which are placed within the brake coupling.

It has been suggested that the increasing use of corridor or other similar carriages will do away with the necessity for means of communication, but the Committee cannot agree with this view, as they are of opinion that some method of communicating with the driver and guards is as necessary upon corridor as upon other trains.

Your Committee have carefully considered the second point referred to them, viz, whether any system in use or available is so efficient as to make its general adoption desirable. The Committee do not think that any one of the electrical systems of communication in use at the present time possesses such advantages over the others or over the brake system as to justify them in recommending it for general adoption. On the other hand, many railway companies entertain a strong objection to granting to a passenger even a limited control over the brake, and the Committee do not think that a system which involves the grant of such a control, however efficient it may be, should be pressed upon a company against the advice of its responsible officers.

Conditions which a Method of Communication should Fulfil.

The following are the conditions which it appears to the Committee a method of communication should fulfil to be entirely satisfactory:—

1. It should be one which would lend itself readily to the interchange of carriages between different railways.
2. It should be easily applicable, and should communicate directly with the driver as well as with the guards, whilst the means by which it is actuated by the passenger should be in a conspicuous position, either in the centre or at both ends of the compartment, without affording too great a temptation to passengers to tamper with it.
3. It should be reasonably cheap, as to both initial cost and maintenance.
4. It should afford an indication outside the carriage of the compartment from which the communication has been made, and a passenger should not be able to replace the means by which the alarm is given.
5. It should not entail the use of additional couplings to those already existing—viz., the screw coupling, the side chains, the automatic brake and the heating apparatus (where in use).
6. It should be capable of being used as a means of communication between the driver and guards of a train, as well as between the passengers and the driver and guards.

Conclusions.

On the three points to which the inquiry of the Committee was directed, their conclusions may, therefore, be summarised as follows:—

I. That of the methods of communication at present adopted, the outside cord system should be condemned as inefficient, while the systems in which the cord or wire is inside the carriages cannot be regarded as satisfactory. The principal electrical systems and the communication by means of the brake may, however, be held to be efficient.

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II. That no one of the electrical systems so far excels the others as to enable the Committee to recommend it for general adoption, although they prefer the system of communication described above as experimentally used on the Great Eastern Railway.

III. That the law should be extended so as to require the provision on all trains of an efficient means of communication between passengers and the servants in charge of the train, which could also be used as a means of communication between the guards and driver.

DISCUSSION.

* Mr. W. H. PREECE said that from 1864 to 1868 he had taken as active an interest in the application of electricity to the working of trains as he had done in any other application of electricity. The system shown in Fig. 1 of the Paper was introduced on the L. and S.W. Railway. It met with a great deal of attention, and he read a Paper before the Institution of Civil Engineers in 1866. He had exhibited on that occasion, among other things, a model of a method by which the breaking away of a train was indicated to the guards and driver. In his system, the coupling was fixed on a hook which was worked by a very strong spring. When a carriage broke away the hook was brought into contact with a stud which set the bells ringing. When he wished to show the working of the model in the course of his Paper it did not work. He was very much taken aback, and had passed the failure off by the very silly excuse that perhaps some dust had got on the stud. The reply he had got in the discussion was that if mere dust in the Institution of Civil Engineers caused the system to fail, what would it do on the actual line where dust was in the ascendant. The explanation of this failure was that before the lecture commenced, the audience were very anxious to see if they could make the alarm go off, and to prevent this, one of his assistants had stuck a small piece of paper on the stud. On another occasion the L. and S.W. Railway Company had fitted up a train, all the railway officials and interested people were invited, and the alarm sounded when it ought not to have done so. The explanation was this. In each guard's van he had placed a lineman to see that everything was working, but in the front van the lineman thought the bell did not ring well enough so he put a second battery on which, of course, disturbed the balance of the batteries, and the bells rang.

* Mr. W. LEONARD corrected one or two errors on the part of Mr. Langdon in his description of the apparatus on the South Eastern Railway. Mr. Langdon had stated that the arrangement illustrated in Fig. 2 was inaugurated by Mr. C. V. Walker, but this was not correct, as the system in question was his (Mr. Leonard's) own invention. Further Mr. Langdon stated that a three-way switch had to be provided in each guard's van, and that the guard had to arrange the switch of his van according to the position the van occupied in the train. This was not so. Referring to Fig. 2, it would be seen that in No. 1 position the van apparatus was disconnected, No. 2 was for testing the circuit, and No. 3 the normal working position. All the guard had to do was to turn the handle from an upward to a downward position or *vice versa*. The switch was not a necessity, but it was an advantage under certain conditions. If a train had been put back in the sidings and the commutator was pulled by anyone accidentally or mischievously, and not restored, the batteries would be run down. The switches were turned up when the train was put into a siding and the batteries thrown out of use. Sometimes, also, there might be five or six vans on a train, and it was not necessary to have the batteries connected in all of them. In 1888 a different system was brought into use on the S.E. Railway, which Mr. Langdon had described as having but one indicator to a carriage, but he had not described the other portion of that system. It had one contact and one indicator, although there might be six or seven compartments, and each compartment had a means of bringing the communication into operation. However, the officials, after being accustomed to an indicator to each compartment, did not like having only one indicator for the whole carriage, as it sometimes caused delay. All the engines on the S.E. Railway are fitted with a battery, and the bell is placed on the tender. It was formerly placed over the firebox of the engine, involving a special connection from the tender to the engine, which was difficult to restore when out of order. His predecessor had used an outside brass disc on the carriage, but it had been found impossible to prevent these being stolen. After a time Mr. Walker had replaced the metal disc by one of wood. With regard to the rail return, he had never experienced any difficulty on the trains when they were running, but there certainly had been difficulties in the stations. With regard to the wire connection, he had used for many years the best electric light wire, Vulc. I.R. braided No. 18 copper, in place of 18/7 G.P. The coupling used on the S.E. Railway was but a solitary relic of the system which Mr. Walker introduced. In the form in which his predecessor had used it it had been a small iron strand of wire and an iron bow or coupling. Finding this depreciated very rapidly, he had introduced a copper strand and the same form of coupling, but in copper. It had been in use for some 20 years on the S.E. Railway. Several other companies had apparently adopted it. If a new form of coupler had to be introduced he thought the combined form invented by Mr. Hollins would be found the most useful.

* Mr. W. H. WINTER was very glad that Mr. Langdon condemned the use of the rails for the "return," and also that he deprecated the use of the vacuum brake. No mention had been made of his late brother's system, which had been used on the Madras railways since January 1, 1879. Side chains were used, and these had been submitted to every test imaginable. They had been covered with tar, the iron hooks had been heated to red heat and plunged into tar, but the apparatus had never once failed. They had even thrown dust and ashes over the tar, but it had been impossible to break the connection. They ran about two million train miles per annum on the Madras railways with this system in use, and it was used by the rear guard in all cases to start the trains, and if the train had to run through a station, unless the driver got the signal that all was well, he would stop the train. The great thing with it was that it involved no extra work on the part of the staff. It was very economical in application. It required no additional coupling, but he gathered from the last paragraph in the paper that an independent coupling was recommended.

* Mr. WOLFF (Midland Railway Locomotive Department) referred to the locomotive indicator. On the Midland they used whistles for the cord communication and it seemed objectionable, if it could be avoided, to introduce a bell and a battery on the engine. Such an arrangement, he thought, as that shown in Fig. 14, with an indicator placed in the engine in parallel with the guards' van bell, would be the sort of thing to meet the requirements. Its resistance would not enter into the question because, directly it was released, the magnet would be short circuited and the guards' van bell would work as if the indicator was not there. Put in a spring instead of a weight and couple the other end to the cock of the whistle. Could Mr. Langdon tell them if anything of this sort had been attempted? Another point which had not had much stress laid on it was the nature of the handle in the compartments.

* Prof. SILVANUS P. THOMPSON handed Mr. Langdon a specification of a patent dated 1852, taken out by John Mirand, the inventor of the trembling bell. At the end of the specification was a description of a communication through a railway train, requiring three wires from the head of the train to the guards' van at the end. Continuing, Prof. Thompson criticised the nomenclature used by railway electricians. Why did they call a short-circuiting switch a commutator?—a name used in every other branch of electrical engineering for something totally different. Then there was the expression "open return." The word "open" applied in any other branch of the profession to a circuit simply meant that there was no circuit at all. In the Paper it was used to mean uninsulated.

* Mr. W. E. LANGDON, in his reply, regretted that there were not more railway men present to take part in the discussion. Mr. Preece's remarks thoroughly illustrated the importance of a proper balance being maintained between the batteries. With reference to Mr. Leonard's remarks with respect to the use of the switch when the trains were standing in the sidings, there was no doubt that a disconnecting switch would save the battery. As to the question of an indicator to each carriage, the companies would consider the cost and balance that with the guards trouble in looking for the cause of the alarm. He thought that a rail return was on all counts unsatisfactory. Mr. Winter had spoken of the success of his brother's system on the Madras railway. The side chains were very heavy and the links would no doubt fit well together, but he failed to understand how the current could pass through a connection which had been well tarred over and in addition to that well sanded. Mr. Wolff would find some difficulty in applying the instrument in Fig. 14 to a locomotive. A locomotive engine was not the best place on which to put any electrical apparatus and what they did put there should be as strong and have as few parts as possible. He was indebted to Prof. Thompson for drawing his attention to Mr. Mirand's patent of 1852. It certainly was a very extraordinary patent. He had known nothing about it until that evening. He had heard and read the word commutator applied for years to instruments for which he had used it.

A hearty vote of thanks was accorded Mr. Langdon at the conclusion of the discussion.

LEGAL INTELLIGENCE.

Stegmann v. O'Connor.

On Saturday, in the Queen's Bench, Mr. Justice Bruce and Mr. Justice Ridley delivered judgment in this case. Particulars appeared in *The Electrician* of Jan. 20 and 27. Their Lordships now gave judgment affirming the decision of the Official Referee, and dismissed the appeal, with costs.

At the South-Western (London) Police Court Mr. Lane, Q.C., heard a summons against the County of London and Brush Provincial Electric Lighting Company for opening up the pavement of Trinity-road, Wandsworth, without having previously given notice in writing to the Battersea Vestry. The evidence given showed that the company's workmen opened the pavement in the dead of night, put their main down, and "made good." The Vestry applied to the High Court for a mandamus to compel the company to remove the main, and Mr. Justice Jeune granted the application, but his decision was reversed on appeal. The Vestry contended that, although the injunction was refused, the learned judge characterised the action of the company as a high-handed proceeding. Mr. Sidney Morse, for the company, admitted the allegation, but stated that Lord Justice Vaughan Williams considered the Vestry had acted unreasonably, as there had been little interference with their rights once the road was laid open. Mr. Lane thought the company wanted to take effective possession with utter disregard as to the legal question involved, and imposed a penalty of £2, with £2. 2s. costs.

BOOKS RECEIVED.

Electro-Technical Dictionaries, Nos. 2 and 3. French-Dutch and German-Dutch. Edited by G. C. J. Verkerk and G. J. Van de Well. (Amsterdam: Scheltema and Holkema). Price 30 cents. each.

"*Transactions* of the American Institute of Electrical Engineers." No. 12. Vol. XV. (New York: Published by the Institute.)

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TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London :—

NOW READY.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. The Author hopes that, besides Telegraph and Telephone Engineers, it may, perhaps, also prove of service to those in charge of cables for the transmission of light and power. The localisation of faults has been very fully investigated, including the different degrees in which the various methods are affected by the presence of a second fault or of general leakage.—*Extract from Preface.* Demy 8vo, fully illustrated. 10s. 6d., post free; abroad 11s.

"The Students' Guide to Submarine Cable Testing."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition now ready.*

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"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves."—By Dr. O. J. Lodge, with many original illustrations. *Enlarged Edition*, 2s. 6d. net, 2s. 9d. post free.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. The book is well printed, on good paper, and contains 230 illustrations. Price 10s. 6d., post free; abroad, 11s.

"Laboratory Notes and Forms."—With the above title we have ready the New Edition of a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

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"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. Prospectus on application.

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"The Alternate Current Transformer," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *New Edition.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"The Electrician" Primers.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"Armature Windings of Electric Machines."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"The Potentiometer and its Adjuncts": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s. post free; abroad, 6s. 6d. Digest post free.

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The "Big Blue Book" for 1899 is Now Ready. The Directory Division has been corrected up to Feb. 8, 1899, and all the latest new names, changes of address, &c., will be found included. The Handbook Division has been much extended, many valuable tables having been added. The volume will contain, also, the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways, finally corrected to Feb. 9, 1899. The price of the Directory and Handbook remains the same—10s., post free 10s. 9d.; abroad, post free, 12s. (United States 13s. 6d.)

TENDERS INVITED.

As announced in an advertisement, the *Dundee* Gas Commissioners invite tenders for the supply and erection of four Lancashire boilers, two 450 H.P. steam engines and dynamos and one 700 H.P. steam engine and dynamo. Specifications, &c., can be obtained from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope Crescent-road, Dundee, and tenders must be sent to the town clerk (Sir Thos. Thornton), City Chambers, Dundee, not later than March 15.

The committee of the *Stockport* Sunday School require tenders for the electric lighting of their premises. Some particulars are given in an advertisement, and applications for permission to view the premises should be made to the secretary not later than March 24.

The *Brighton* Corporation require tenders for the supply and erection of a 20-ton travelling crane at the electricity generating station, North-road. Further particulars are given in an advertisement, and tenders must be sent to the town clerk (Mr. F. J. Tillstone), Town Hall, Brighton, before 10 a.m. of Monday, March 6.

The Vestry of *Hammersmith* (London) invite tenders for the supply and erection of three water-tube boilers, two 1,000 H.P. slow-speed engines, coupled direct to two 600 kilowatt alternators, underground feeders and cast-iron pipes. Specifications, &c., may be obtained at the office of the Vestry clerk (Mr. W. P. Cockburn), Town Hall, Hammersmith, after 27th inst. Specifications and drawings may also be seen at (but not obtained from) the office of Mr. A. H. Preece, 39, Victoria-street, London, S.W. Tenders must be delivered at the Town Hall, Hammersmith, before 5 p.m. on Wednesday, March 15.

The Electric committee of the County Borough of *Belfast* invite tenders for the supply and erection of switchboard extension. Specifications, &c., may be obtained from the city electrical engineer (Mr. Victor A. H. McCowen). Further particulars are given in an advertisement, and tenders must be lodged at the office of the town clerk (Sir Samuel Black) by noon of March 16.

The Guardians of *Poplar* (London) Union require tenders for the supply and erection of plant, and for the carrying out of certain works in connection with their new electricity supply works. All particulars of this contract can be obtained of Mr. F. J. Warden-Stevens, consulting engineer to the Guardians, Connaught-mansions, 34, Victoria-street, Westminster, London, S.W.

The *Edinburgh* Town Council invite tenders for condensing plant, with water-cooling tower, feed-water tanks and filters, for their Macdonald-road electric lighting station. Tenders to Town Clerk (Mr. Thomas Hunter, W.S.), by March 6.

The *Edinburgh* Town Council also invite tenders for installing the electric light at Tollcross Tramway Power Station. Tenders to Town Clerk by March 6.

The *Edinburgh* Town Council invite tenders for the supply of steam, exhaust, feed and drain pipes, feed pumps and tanks for their Macdonald-road electricity station. Tenders to Town Clerk, by 27th inst.

The Lighting committee of the *Canterbury* Corporation require tenders for the supply and erection of :—(*a*) Boiler-house plant, (*b*) engine-house plant, (*c*) extension of switchboard, (*d*) extensions to mains. Tenders to town clerk (Mr. Henry Fielding), by March 14.

The *Hereford* Town Council invite tenders for the erection and completion of the electricity station buildings. Tenders to chairman of Electric Lighting committee by March 13.

Tenders are required for the covering of sundry steam and feed water pipes at the *Cardiff* electricity works. Tenders to town clerk by March 2.

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Stockport Corporation require tenders for two 140-kilowatt shunt-wound dynamos. Tenders to chairman, Gas and Electricity Committee, by March 9.

The Electricity committee of the *Huddersfield* Corporation invites tenders for mechanical coking stokers, and also for a complete switchboard. Tenders to Mr. F. C. Lloyd, Town Hall, Huddersfield, by Monday, 27th inst.

The Board of Police of *Greenock* invite tenders for the supply and erection of boiler house plant, overhead travelling crane and engine house plant. Tenders to Mr. G. MacCulloch, Municipal Buildings, Greenock, by March 3.

The *Harwich* Corporation invite offers for the transfer of their provisional order. Tenders by May 17 to town clerk.

The Electricity Supply committee of the city of *Gloucester* require tenders for jet condensers and air pumps, cast-iron condensing water pipes, and steam, exhaust and feed pipes, &c. Tenders to Guildhall, Gloucester, by 28th inst.

The *Shoreditch* (London) Vestry require tenders for stores for one year from March 26th, including electric cables and sundries, engineers' stores, ironmongery, tools, wiring and fitting materials, &c. Tenders to Dr. H. Mansfield Robinson, Town Hall, Old-street, E.C., before 3 p.m. 28th inst.

The *Oldham* Corporation invite tenders for two boilers. Tenders to the Water Office, Oldham, by 28th inst.

The *Lewes* Corporation invite offers for the erection of electricity supply works. Tenders to town clerk by noon March 24.

The *Great Northern Railway Co. (Ireland)* require tenders for the erection of an electric power station at Amiens-street, Dublin. Tenders to secretary by March 13.

Tenders are invited for the construction of a tramway in *Thornton, N.B.* Tenders to the clerk to Kirkcaldy Council, 220, High-street, Kirkcaldy, by March 4.

The Municipality of *Betanzos* (Spain) invite tenders for the concession for the electric lighting of the town. Tenders by March 16.

The Dirección General de Obras Publicas, *Madrid*, invite tenders until April 3 for the concession for the construction of an electric tramway in Madrid.

TENDERS RECEIVED AND ACCEPTED.

The Ealing District Council have accepted the tender of Messrs. Siemens Bros. and Co. for the supply of two 450 B.H.P. Siemens alternators, with Belliss engines, for £6,786.

The Islington (London) Vestry have accepted the tender of Messrs. Patman and Fotheringham for the extension of the electricity station buildings, Eden Grove, at £20,951.

The following tenders have been received by the Buxton District Council for the supply of feeders, mains, and arc light leads:—Callender Co. (*accepted*), W. T. Henley's Telegraph Works Co., British Insulated Wire Co., Western Electric Co., Siemens Bros. and Co., and W. J. Glover and Co.

The Wimbledon District Council have accepted the tender of Cowans Limited for additional switchboards at the electricity station at £212; also Messrs. Aston's tender of £464. 10s. for ironwork at the tipping platform.

The Highways committee of the London County Council have received the following tenders in connection with the lighting of the Victoria Embankment and Westminster Bridge:—

For the Supply of Dynamos, &c.

McClure & Whitfield (*accepted*)	£3,726	Electric Construction Co.	£5,535
Electrical Co.	6,877	Crompton and Co.	4,949
Safety Concentric Wiring Co.	5,625	Mather and Platt	4,600

For the Supply of Gas Engines, &c.

J. E. H. Andrew and Co. (*accepted*)	£1,900	Crossley Bros.	£2,300
J. Taylor and Sons	3,457	Safety Concentric Wiring Co.	2,260
Fielding and Platt	2,378	Premier Gas Engine Co.	2,260
		Campbell Gas Engine Co.	2,176

The following tenders have been accepted by the Lynn Town Council:—

Siemens Bros. and Co., 22 arc lamps and 225 pairs of 16 c.p. incandescents	£1,900	0	0
J. and A. Laws, lamp posts	827	0	0
J. E. Spagnoletti and Crookes, wiring public buildings	480	15	6

The following tenders have been accepted by the Glasgow Electricity committee for the supply of plant for Port Dundas and Pollakshaws-road electricity stations:—

Mavor and Coulson, two 200 H.P. engines and dynamos, with spare armature	£2,629
Mirrlees, Watson and Yaryan Co., one 400 H.P. engine and dynamo, and a spare armature	2,565
Crompton and Co., one 400 H.P. engine and dynamo, and a spare armature, for one of the 200 H.P. dynamos	2,601
Crompton and Co., two 1,100 H.P. engines and dynamos	14,780
British Thomson-Houston Co., two 1,100 H.P. engines and dynamos	14,278

The tender of the Electric Construction Co. has been accepted by the Shoreditch (London) Vestry for the supply of a booster at £399.

The Hastings Town Council have accepted the tender of G. E. Belliss and Co. for the supply of a steam engine at £1,385, and of the Brush Company for a 200-kilowatt Mordey-Victoria alternator at £1,280.

APPOINTMENTS VACANT AND FILLED.

There is a vacancy for an assistant in the Physics and Electrical Engineering Department of the Blackburn Municipal Technical School. Salary £110 per annum. Applications to the secretary (Mr. A. W. King), by March 13. See advt.

The Manchester School Board require a science teacher. Salary £170. Applications by 25th inst. to the clerk, Deansgate, Manchester.

The Wigan Corporation require a draughtsman for their electricity department. Salary £3 per week. Applications to town clerk by 27th inst.

The Fulham (London) Vestry require a clerk of works to supervise the erection of electricity station buildings. Salary £3. 3s. per week. Application to clerk by 25th inst.

BUSINESS NOTICES.

Messrs. Wm. Jas. Glover and Co., St. Helens and Warrington, have decided to establish a department for the manufacture of electric wires and cables. The firm propose to pot down patent machinery designed by Mr. G. E. Heyl-Dia.

The National Free Wiring Co. have opened a branch establishment at Redditch, and a contract has been entered into between the company and the Tunbridge Wells Corporation.

BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against the New Motive Power Syndicate are to be sent in by March 31 to the liquidator (Mr. J. W. Roberts), 18, Eldon-street, London, E.C.

A meeting of the Electric Trust (Limited), in voluntary liquidation, will be held at the offices of Mr. E. R. Robson, 9, Bridge-street, Westminster, S.W., on March 20, to receive an account of the winding-up. Mr. F. Cross is liquidator.

An order has been made continuing the voluntary liquidation of J. H. Pickup and Co. (Limited), electrical and general engineers.

Agency.—We are asked to announce that the English Industrials (Limited), of 55, Market-street, Manchester, have been appointed sole representatives for this country of Messrs. Ganz and Co., of Budapest. The Ganz patent plant is to be manufactured in this country. Mr. G. E. Heyl-Dia is at present acting as consulting engineer to the Ganz department of the English Industrials (Limited), and the manufacture of the plant is to be carried out by Messrs. W. R. Renshaw & Co., of Stoke-on-Trent. When financial arrangements are completed, Mr. James Swinburne will act as consulting engineer, and the services of Mr. Blathy in this connection will also be available.

For Sale.—As announced in an advertisement Messrs. Fuller, Horsey, Sons and Cassell have been instructed by the receiver for the debenture holders (pursuant to order of Mr. Justice Wright) to sell by tender in one lot the valuable leasehold engineering works, lately occupied by the London Stamping Co. (Limited), and known as the Castle, Barnsbury-street, Islington, London, N. The plant and machinery are practically new and the works may be viewed by order. Particulars, with forms of tender, may be had of the receiver (Mr. Robertson Lawson), 34, Old Broad-street, E.C., Messrs. Dale, Newman and Hood, solicitors, 75 and 76, Cornhill, E.C., and of the auctioneers, 11, Billiter-square, E.C. Tenders must be sent before noon of Thursday, March 23, to the registrar of companies (winding up), Bankruptcy-buildings, Carey-street, London, W.C.

Plant for Sale.—The Southport Corporation have for sale some electric lighting plant, particulars of which are set out in an advertisement. The plant may be inspected at the electricity works by arrangement with the engineer (Mr. C. D. Taite). Offers must reach the town clerk (Dr. J. D. Williams) by Tuesday, March 21.

The Brighton Corporation have for disposal by tender a quantity of pure electrical copper, old cast-iron fire bars, straight and tee cable joint boxes, and a few street disconnecting boxes. Tenders have to be sent in to Mr. F. J. Tillstone, town clerk, Town Hall, Brighton, by 10 a.m. of March 6.

Mr. A. J. Mather, Bowling Iron Works, Bradford, has for disposal a complete electric welding plant. See advertisement.

Electric Refrigerating Plant.—Messrs. Lyon and Crosbie, referring to our comments of the 10th inst. respecting the introduction of electric refrigerating plant in America and its effect upon the day-load of supply stations, write that the result of experiments made for some time past has been the completion of a machine which is now working satisfactorily, current being taken from the Glasgow Corporation mains at 200 volts. These machines,

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which are said to be suitable for small or large refrigerating installations, are likely to be shortly placed on the market to work on any voltage with either alternating or continuous current.

Exhibition.—We would call particular attention to a notification in our advertisement pages of the exhibition of electrical appliances to be held in connection with the Building Trades' Exhibition at the Royal Agricultural Hall, Islington, London, N., from April 26 to May 6.

Electric Launches.—Messrs. Laing, Wharton and Down, of 82A, New Bond-street, London, W., notify that they are now in a position to offer electric launches for river or sea. This firm represent the Vril Launches (Limited) for the sale of these boats both for home and export. We are informed that orders have been executed for the Imperial Russian Ministry of Marine for three boats which have given every satisfaction, The last of these boats, 32ft. in length, ran for five hours at full 7 knots, and alternatively for over 15 hours at 5½ knots. The Vril system for electric launches includes the entire equipment of the boat and the company's works situate in Brading Harbour are said to be fitted with every requirement for boat building of all sizes. Up to March 1 next one of these launches will be on show at stand No 23 at the Yachting Exhibition, Royal Aquarium, Westminster, London.

Book Catalogue.—Messrs. Whittaker and Co., publishers, 2, White Hart-street, London, E.C., have just issued a catalogue of electrical works for 1899.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Feb. 15 to Feb. 21, with the ports of destination:—

Argentina—Buenos Ayres, £438. *Australasia*—Adelaide, £104; Brisbane, £2,272 (including £1,976 telegraph material); Fremantle, £344; Melbourne, £3,916; Newcastle, £8; Otago, £250; Perth, £200 (telegraph material); Sydney, £1,443 (including £159 telegraph material); Wellington, £613. *Belgium*—Brussels, £30; Ostend, £19. *Brazil*—Rio Janeiro, £718 (telegraph material). *Ceylon*—Colombo, £121. *China*—Shanghai, £26; Tientsin, £238 (telegraph material). *Denmark*—Copenhagen, £330. *Egypt*—Suakim, £30 (telegraph material). *Germany*—Hamburg, £100. *Holland*—Amsterdam, £25; Rotterdam, £18 (telegraph material). *Hong Kong*—£251. *India*—Bombay, £132; Calcutta, £249; Madras, £55. *Malta*—£169. *North Atlantic*—£4,000 (telegraph cable). *Portugal*—Beira, £65. *South Africa*—Cape Town, £18,789 (including £18,480 telegraph cable); Delagoa Bay, £233; Durban, £2,173 (including £282 telegraph material); East London, £45; Port Elizabeth, £15. *Spain*—Bilbao, £50. *Straits Settlements*—Singapore, £122 (telegraph material). *Sweden*—Stockholm, £69 (telegraph material). *Uruguay*—Monte Video, £148 (telegraph cable). Total £37,808, against £48,584 in the corresponding week last year (Feb. 16 to Feb. 22).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Aberdeen.—The borough electrical engineer (Mr. J. A. Bell) and the borough surveyor have reported on the equipment of the Woodside route on the overhead trolley system. This will necessitate a reconstruction of a part of the line, at a cost of £13,271. 15s., while the electrical equipment will cost £10,335, eight new cars £4,800, and other materials and alterations bring the total up to £33,300. The report has been approved by the Tramways committee, who have instructed the electrical engineer and burgh surveyor to prepare specifications so as to have the line in working order promptly.

Asylum Lighting.—Electric lighting is to be adopted at the Richmond Lunatic Asylum, Dublin. The cost of the scheme must not exceed £3,000.

Barnes.—The District Council have received proposals from two companies for a transfer of the Barnes provisional order and a report upon the relative advantages of the offers is to be obtained from an electrical expert.

Battersea (London).—The County of London Company have not yet, it appears, heard the last of that "lawless Sunday." The Finance committee of the Vestry recommended, and the Battersea Vestry have decided, to serve a notice upon the company requiring the company to take up and remove the mains in Trinity-street within 24 hours, and to restore the pavement to its former condition.

Belfast.—The Electric committee recommend the revision of the tariff for electric current for private lighting by reducing the period of maximum demand from one and a half hours to one hour per day.

Bermondsey (London, S.E.).—The Thames Conservancy Commissioners have withdrawn their opposition to the application of the Bermondsey Vestry for an electric lighting order. The granting of the order is now opposed by the County of London and Brush Provincial Co. and the London Electric Supply Corporation. The Vestry are petitioning against the County of London Co.'s bill in Parliament.

Birmingham.—The Estates committee recommend the City Council to substitute electric for gas lighting at the Council House. The present gas fittings are to be adapted for electric lighting.

Blackpool.—*Correction.*—The note appearing in our last issue referring to the arrangement made by the Blackpool Corporation with Mr. Robert C. Quin, borough electrical engineer and tramway engineer, was partly inaccurate. The limitation was there stated to be two days per month for Mr. Quin's private practice, but we now learn that no such limitation forms part of the agreement.

Brighton.—The Town Council have decided to increase the pressure of supply from 115 to 230 volts in certain additional districts.

Broadstairs.—The Isle of Thanet (Electric) Light Railway Co. have offered to supply electric current for public and private lighting on the same terms as those arranged with the Margate Corporation. The maximum charge for current will be 6d. per unit.

Chelsea (London).—The surveyor (Mr. T. W. E. Higgens) and the medical officer of health (Dr. Louis C. Parkes) have presented their report on the alleged nuisance caused by the works of the Chelsea Electricity Supply Co. in Alpha-place and Manor-street. The report states that the Chelsea Company are now in a different position to any other electrical company as regards proceedings for nuisance. Since their 1898 act they appear to be free from an indictment for nuisance and from an injunction, provided that they are not guilty of negligence in carrying on their works, and as the company are under statutory obligations to supply light and power to the inhabitants of Chelsea, the Courts would probably require very strong evidence before they would interfere. As regards the alleged vibration and its effects upon the adjoining property, Mr. Higgens and Dr. Parkes state that, so far as their personal observations are concerned, they have been unable to discover any vibration which could reasonably be termed annoyance; but on comparing statements made by residents, they found persons living in houses within a few yards of one another making directly contradictory statements as to the existence of vibration on a particular evening; even people in the same house disagreeing as to particular instances. Messrs. Higgens and Parkes are finally of opinion that at present they have not sufficient evidence of nuisance caused by vibration to justify them in engaging technical assistance to examine the construction of the Chelsea company's station, supposing that the company would consent to such a proceeding. In reply to a request to allow an expert to examine their premises, should it be necessary, the company replied, "that in view of the formal inspection that was held last year by experts under the Order of the Court, and also of the exhaustive inquiry by Select Committees of both Houses of Parliament into the question of alleged nuisance caused by vibration, &c., and of the various decisions that no nuisance existed, the directors did not feel justified in re-opening the question." As to the alleged noise, the report states that during their investigations, Messrs. Higgens and Parkes had not found any inconvenience to arise from any noise caused in working the station, neither had they found that the steam or the smoke issuing from the chimneys caused any nuisance to the surrounding neighbourhood. Complaints had been made of fine grit escaping from the chimney and being deposited on the roofs, doorsteps, and streets in the vicinity of the station. The investigators had themselves observed the grit, and felt sure that on some occasions it was permitted to escape. This would, no doubt, be obviated by more careful stoking, and regulation of the draft to the furnaces.

Cork.—The Judicial committee of the Irish Privy Council have authorised the Cork Electric Tramway Co. to extend their tramway system to Ballintemple.

Covent Garden Theatre.—Mr. Edwin O. Sachs gives the following particulars of the electric lighting to be carried out at Covent Garden Theatre:—The entire stage and its appurtenances will be electrically lighted. Current will be taken from two stations to meet the exigency of any failure to the supply, and hence two distinct systems of wiring are being run. Four sets of different coloured lights will be used throughout—white, red, blue and amber. Numerous combinations will thus be possible. The installation will be the largest in the metropolis, 2,880 lamps being used on the stage proper.

Doncaster.—An inquiry was held here on Tuesday into the application of the Corporation to borrow £30,000 for electric lighting purposes. The application was supported by the town clerk, who gave the usual details of the rateable value, borrowing powers, &c., of the Corporation. Technical details were submitted by the consulting engineer (Mr. J. N. Shoolbred). The estimate for the station, including £5,000 for buildings, was £20,000; the distributing mains and street work, £10,000; generating plant, £15,000, the latter sum to include £2,200 for boilers, £3,000 for small engines and dynamo, £3,800 for two larger steam engines, £2,000 for condensing pumps, £300 for overhead travellers, £1,500 for electrical instruments, and £2,200 for storage batteries. There was no opposition.

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Eastbourne.—At an informal meeting of the Eastbourne Electric Light Co. on Saturday last, it was decided to decline the Town Council's offer of £83,413 for the purchase of the company's undertaking.

Electric Light at the Vatican.—A Reuter's telegram states that the installation of the electric light in the Vatican was inaugurated on Monday last, and comprises 6,000 16 c.p. lamps.

Electric Lighting Trunk Mains.—The Electric Lighting committee of the Paddington (London) Vestry, having taken the opinion of counsel, have recommended the Vestry to oppose the application of the Metropolitan Electric Supply Co. to lay down trunk mains through the Paddington district, on the ground that, by the laying of these mains, complications would be introduced should the Vestry decide to purchase the company's Paddington works and undertaking. The solicitor to the Vestry, at its last meeting, stated his opinion that the company had no powers to lay down these trunk mains for outside supply through the streets of the parish without the consent of the Vestry, and this view had been strongly confirmed by counsel to whom the question had been submitted. The Vestry approved the committee's recommendation.

Hampstead (London).—The receipts of the electricity department for the quarter ending December was £8,312. 12s. 8d., compared with £5,892. 7s. 11d., for corresponding quarter in 1897.

Hastings.—The Town Council has not been long in possession of the electricity works before extensions of the plant and mains have become necessary. The borough electrical engineer (Mr. Leonard Andrews) recently prepared reports, in which he advocated various extensions, at a total cost of £32,768, viz., £22,184 for new plant and machinery, extensions to buildings, changing system of distribution to the transformer sub-station system (so as to give a 200-volt supply), and extensions of the mains to the Marine Parade and Blacklands, and £10,584 for extending the mains in other parts of the town. Owing to the space at the Earl-street works being very limited, it was recommended that no more 100 kilowatt sets of plant be put in, but by using direct-coupled plant it was possible to get two 200-kilowatt sets in practically the space at present occupied by each of the 100-kilowatt sets. Direct-driven Brush-Belliss units were recommended. Mr. Andrews also advised that steps should be taken to stimulate the demand for current by entering into arrangements with the National Electric Free Wiring Co. for the wiring of consumers' premises, and that the charges for current should be reduced. The report was submitted to Prof. Kennedy, who practically endorsed Mr. Andrews' proposals. The Electric Lighting committee's minutes, recommending the adoption of the extension scheme, were presented at the meeting of the Town Council, on Friday, when Dr. C. H. Allfrey (chairman of the committee) made a very able speech in support of the scheme, which was ultimately adopted without a single dissentient voice. It augurs well for the future that so many opponents of the Council's purchase scheme should be so speedily converted into supporters of the municipal undertaking.

Hawaiian Islands.—Amongst the articles admitted free of duty into the Hawaiian Islands under special enactments are:—"And all and every article, goods, wares and merchandise appertaining to the building of such telegraphic line or lines, and the transmission of intelligence by electricity; and such articles and merchandise shall be exempt from duties, and the vessel or vessels chartered, or otherwise specially engaged in the laying or maintenance of a telegraphic line or lines, shall be exempt from all port charges, except pilotage."—Sec. 2, Chap. XLV., Laws of 1874.

Hendon.—The District Council have reiterated their intention to oppose the Electrical and General Engineering Co.'s application for a provisional order.

Lancaster.—The Town Council on Wednesday formally approved the appointment of Mr. W. Allan Fraser, of Edinburgh, to the position of borough electrical engineer, at a salary of £200 per annum. At the same time it was decided to reduce the price of current from 5d. to 4½d. per unit for private lighting, and from 4d. to 3d. for motive power.

Leamington.—The risk involved in the supply of electric current without statutory powers is very clearly shown in the case of Leamington, where the Midland Electric Light and Power Co. (Limited), after many years working at a loss, have now brought their undertaking into a successful condition, and are seeking parliamentary powers. This has brought the company into conflict with the Leamington Corporation, who also seek parliamentary powers for electric lighting purposes, and in so doing treat the existing company as a *quantité négligeable*. This treatment the company naturally resents, and as pioneers of electricity supply in the Leamington district, regard the opposition of the Corporation as most unfair. These strained relations between the company and the Corporation have existed for some time past, and it was feared that any way out of the trouble would be difficult to find. A very practical suggestion has, however, been made by a Mr. Gowan that the Corporation should allow the company to obtain their order unopposed on the understanding that the company will agree to supply current at a maximum price of 5d. per unit, and that at the expiration of the term of the order the Corporation shall have the right to purchase the business for the mere value of the plant at that date. We understand that the company are prepared to accept this as the basis of an understanding with the Corporation, so that without risk of a call upon the rates to provide an electricity scheme, either now or in the future, Leamington would at once have the advantage of a cheap supply of current, and ultimately purchase the works at small cost. It is generally considered that the basis of a working arrangement is foreshadowed in this proposal, and it is satisfactory to learn that many of the members of the Corporation are favourable to the adoption of some such proposal. The Midland company was one of the earliest to establish electricity supply works, and now that a reasonable return on the capital outlay is in sight, it is to be hoped that no action will be taken by the Corporation to debar the shareholders, who have risked their money for many years, from reaping the due reward of their enterprise.

Leatherhead.—The District Council are recommended to establish electricity supply works at a total estimated cost of about £4,600.

Leeds.—The Lighting committee decided on Wednesday night to apply for sanction to borrow £150,000 for carrying out extensions of the electric light mains, to enlarge the generating station in Aire-street, and to put down additional plant. It is anticipated that this expenditure will be sufficient to meet all demands for current for the next two years.

Light Railways.—The Works committee recommend the Islington Vestry to approve the Finchley and Hendon light railway scheme, and to sanction the use of the overhead trolley system in the Archway-road.

The Light Railway Commissioners held an inquiry on Wednesday into the application to construct a light (electric) railway from Edmonton to Waltham Cross. The portion of the scheme relating to the county of Herts was abandoned, and the Commissioners granted the application for the Edmonton-Enfield section.

The Light Railway Commissioners have rejected the application of the London United Tramways (Limited) for an order to construct a light electric railway from Acton through Ealing to Hanwell. Objections were raised by the Ealing District and Middlesex County Councils on the ground that it was not competent for the Light Railway Commissioners to review the decisions of Parliament, a bill for the construction of this line having been rejected last Session. This objection was upheld by the Commissioners. The company will, therefore, be unable to join up the two sections of its tramway system, and there will be a gap of about two miles in what would otherwise be a through electric tramway from Shepherd's-bush to Uxbridge.

London County Council.—At Tuesday's meeting the Highways committee presented a report recommending that, in view of the fact that the Council, under the London Tramways Co.'s Act, 1888, can apply to the Board of Trade for a licence to use mechanical traction on any section of tramways governed by that act, that such powers should be exercised. Before recommending the Council to adopt any particular system the committee advise that Prof. A. B. W. Kennedy, F.R.S., be appointed, at a fee of 500 guineas, with an additional 100 guineas for travelling expenses, to report to the committee upon the matter, such report to have reference to the system of mechanical traction, other than steam or cable, most suitable for experiments upon the Council's tramways. The discussion of these recommendations will take place at next Tuesday's meeting.

£23,213 is to be advanced to the St. Pancras Vestry and £14,285 to the Islington Vestry for electric lighting purposes.

The Parliamentary committee recommend that the Council oppose the Finchley, Hendon and District, the Hampstead, Finchley and Edgware, and the Highgate, Finchley and Wood Green Light Railway orders. The Earl of Onslow, opposing this recommendation, said that all but a very small portion of these lines were outside the Council's jurisdiction. They came to the London boundary, and would permit of junctions being made with the Council's tramways, and would give an opportunity for people to get out of London to reside, or for pleasure. The lines were to be worked by electricity, and would prove a great boon to the travelling public. It seemed to him that the attitude of the Council was one of hostility to any scheme of the kind promoted by private enterprise. He hoped the Council would not adopt a dog-in-the-manger policy. Mr. Sidney Webb said that these light railways were being promoted in evasion of the Tramways Act, and gave the local authorities no power of purchase. Mr. Westacott pointed out that the Council had power to compel the lessee of the Council's tramways to work lines outside the County of London, and he thought the proposed light railways should be worked in conjunction with the present tramways. Mr. Bond, M.P., said that if this meant the acquisition, by the London County Council, of tramways outside their own area, it would be entering upon a very hazardous enterprise. The committee's recommendation was agreed to.

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Manchester and the Telephone.—There is a committee in existence "for obtaining an independent telephone service for Manchester, Salford and district," and at a recent meeting of this committee a resolution was passed that a Manchester deputation should wait upon Mr. Hanbury, M.P., Financial Secretary to the Treasury, to urge upon him the granting of a telephone licence to the New Mutual Telephone Co. (Limited). The resolution has been submitted to the special telephone committee of the Manchester Corporation, who have replied that they are not desirous of taking part in the proposed deputation.

Municipal Trading.—The Nottingham Chamber of Commerce has passed a resolution in favour of the appointment of a joint committee of both Houses of Parliament to consider and define the scope and sphere of municipal enterprise.

Newcastle-on-Tyne.—The City Council have approved the report of the Tramways committee recommending the adoption of the overhead trolley system of traction on the tramways, but, in deference to the views of certain members, it was decided that the tramways in the central portion of the town should not be converted until the opinion of an expert as to the practicability of adopting the conduit system had been obtained.

Newhaven.—The Sanitary and Lighting committee have been instructed to report upon the advisability of establishing electricity works.

Norton (Stockton.)—An offer by the Imperial Tramways Company, to supply electric current for lighting and power purposes, is being considered by the General Purposes committee of the Council.

Partick (Glasgow).—A deputation from the Burgh Commissioners has inspected the Paisley electricity works. So pleased were the members with what they saw that they came back impressed with the desirability of establishing municipal electricity works in Paisley. Provost Wood said he was convinced from what they had seen that they should keep independent of the city of Glasgow and start an electric station themselves. Even though Glasgow were to give them electric current he was of opinion that they would require to erect a station in Partick, and he did not see that they would be doing any great harm to the city if they themselves started an installation on the lines they had seen in Paisley and other places. He was sure that the Paisley system, under the control of such a capable engineer as Mr. Teague, would be a thorough success.

Perth.—The Police Commissioners have given their consent to the application of the Perth and District Tramway Co. to adopt electric traction on their lines.

Redditch.—The following scale of charges for electric current will be adopted by the District Council:—For shops and private houses, 5½d. per unit; for places of worship, schools, clubs and licensed houses, 5d.; for motive power, 3d.

Shoreditch (London).—The Vestry on Tuesday referred back to the Electric Lighting committee, for further consideration, a recommendation proposing the entering into an agreement with a firm of printers, Messrs. Wertheimer, Lea and Co., for the supply of current for a period of 21 years. The agreement proposes the supply of current for lighting at 3d. per unit for an annual consumption of 50,000 units; and for power purposes at 1½d. per unit for 100,000 units per annum, 1¾d. for 75,000 and 2d. per unit for under 75,000 units yearly. It was contended that these terms were too favourable to the company. The Vestry are instructing the British Insulated Wire Co. to supply and lay the necessary conduits and cable (at schedule rates), for the proposed service to the printing works of Messrs. Waterlow and Sons.

The salaries of Mr. G. Kemp, chief assistant engineer, and Mr. H. J. Roscoe, superintendent of mains, have been increased by the Shoreditch Vestry from £156 to £180 per annum. Annual increments are to be made of £10 up to the maximum of £200.

Tenders are to be invited for a new switchboard.

Southport.—The Town Council have approved the Electricity committee's recommendation to reduce the price of current. At present the maximum demand system of charging is in force, the charges being 7d. and 4d. for lighting and 2d. per unit for current for power purposes. After July these figures will be 6d., 4d. and 2d. respectively.

Southwold.—The District Council have referred a proposal by Mr. L. Francis, for the erection of electricity supply works, to committee, for consideration and report.

Surbiton.—Electric lighting schemes have been sent in by Mr. Roger Dawson, Messrs. Hammond and Co., the Birmingham Installation Co. and the Electrical Power Distribution Co., and the clerk is preparing an abstract of the tenders for the Electric Lighting committee.

Teddington.—The members of the District Council are greatly exercised over the temerity of Edmundson's Electricity Corporation in asking the Board of Trade to dispense with the consent of the Teddington and Twickenham Councils to their application for a provisional order. The question of electric lighting has been before both Councils for a long time, but no progress was made until the Corporation gave notice of intention to apply for an order, when both Councils suddenly resolved to combine to oppose the application, and passed resolutions in favour of themselves applying for orders next year.

Telegraphists' Grievances.—The following is the reply made by Mr. Hanbury, Secretary to the Treasury, to a motion in Parliament that the grievances of the postal telegraph operators should be inquired into:—

Every grievance mentioned had already been threshed out by the Tweedmouth committee and the departmental inquiry. With regard to the telegraphists, it must be remembered that the five years' man, who was generally about 21 years of age, and received 24s. a week, had been paid during his apprenticeship. After all a telegraphist was only a superior kind of typewriter, and, as far as he could judge, sorting required even more skill. He thought the wages were good, and by qualifying for sorting and for a technical examination in telegraphy the clerk could get an additional increment of £12 a year. He did not think there was any ground for a fresh inquiry.

Theatre Lighting.—In a paragraph which appeared in our issue of Feb. 10, we referred to the electric lighting of the new theatre at Dalston, N.E., and at the Empress Theatre, Brixton, S.E., and credited Messrs. Vaughan and Brown with these successful installations. This information was supplied to us by Messrs. Vaughan and Brown, but was (of course, unintentionally) inaccurate, as the electrical work at both theatres was carried out by Messrs. Strode and Co., of 48, Osnaburgh-street, Regent's Park, London, N.W., to whom apologies are due. We are pleased at all times to insert particulars of electrical contracts successfully carried out, but we rely upon contracting firms to furnish us with statements which are open to no possibe misconstruction.

Tramway Enterprise in China.—The United States Consul at Chefoo calls the attention of American manufacturers to the proposed electric tramway in Shanghai recently advertised in our columns, and, in setting out the terms of the tender, writes:—"I sincerely hope that our contractors and manufacturers will give this tender their best attention. Shanghai is the great emporium for all Asia. It is to this port that the officials go to get their ideas of foreign enterprise, and if an American company can succeed in securing this contract and equipping the line with the best American appliances, it will be a valuable advertisement, and will no doubt have much influence in securing future contracts in the event of other cities in the East deciding to follow the example of Shanghai in having tramways. To-day, there is not a tramway in all China."

Workhouse Lighting.—The Shoreditch (London) Guardians have received official sanction to expend £2,000 in the electric lighting of the infirmary, workhouse, dispensary and casual wards. Tenders have already been obtained.

Workmen's Compensation.—From the reports so far issued, of the directors of the leading insurance companies, it will be found that the views expressed by us as to the excessive premium rates charged under the Workmen's Compensation Act have been fully warranted. In some cases the directors refer to the large amount of profit that has been made upon this class of insurance since the Act came into force, and in not one case that we have seen is any reference made to exceptional claims having arisen.

Electro-Harmonic Society.—A "ladies' night" concert takes place this (Friday) evening, at St. James's Hall Restaurant, Regent-street, W., at 8 o'clock.

COMPANIES' MEETINGS AND REPORTS.

National Telephone Co. (Limited).

The twenty-third ordinary general meeting of this Company was held at the Cannon-street Hotel, London, on Friday, Mr. JAMES STAATS FORBES (President) in the chair.

The SECRETARY (Mr. Albert Anns) having read the notice calling the meeting,

The CHAIRMAN said: The income for the half-year ended Dec. 31st last shows an increase of £66,000, the working expenses an increase of £29,376, while the profit balance is larger by £28,430, as compared with the corresponding six months of 1897. These are considerable increases, but they are only a continuation of the progression of the Company from half-year to half-year. The rentals carried forward for unexpired terms of running contracts amount to £536,654, as compared with £473,586 in the corresponding six months of the previous year. We have, therefore, considerably over £500,000 on account of contracts entered into which are running for our benefit during the current half-year. Out of the available balance shown by the net revenue account we propose to pay a dividend at the rate of 6 per cent. per annum on the First and Second Preference shares, 5 per cent. on the Third Preference shares, and Six per cent. on the Ordinary shares. The Board also propose to transfer £50,000 to reserve fund, leaving upwards of £8,000 to be carried forward. Perhaps you will think that that is a very satisfactory showing, considering the extremely adverse influences under which this Company has to carry on its work, and about which I shall have to speak more fully later. This is

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one of those companies where the capital account never closes, and that is a serious consideration. The elements of uncertainty are so great and varied in our case that there is not the ordinary room for a reasonable forecast. I do not want to alarm you; I only want you to understand what the increasing capital means. The amount of the Post Office royalties for the half-year is £54,350. In other words, the Post Office walk off with 10 per cent. of our gross receipts; that is a most enormous incubus upon this Company. Still we are accused of being extortioners and all that sort of thing by the man in the street. With regard to our capital, so far as the shares of the different denominations are concerned, there is now no unissued balance. Our only resource is Three and a-Half per Cent. Debenture stock, of which you long ago authorised £2,000,000 to be raised, and of which we have succeeded during the half-year in placing £330,000, and we have still a like amount to place later. That will exhaust all our capital powers, and the amount all told is £6,000,000. During the half-year we have spent £367,200 in the reconstruction of 6,932 additional exchanges and private lines. That is about the average rate of progress we have made during the last few years. In addition, we are carrying on large works of reconstruction out of revenue. We are constructing the single wire system into the double wire system, where we can get municipalities enlightened enough to appreciate the fact that it is to the advantage of the public that the wires should be taken out of the streets and off the houses, and placed underground. You cannot carry on a business of this sort under obstruction without spending a good deal more than would be needed if it were carried on under reasonable and business-like conditions. If you have no powers, and you have all sorts of capricious and adverse interests to conciliate, you have to pay for it. That means to say that the public have to pay for it. I will give you an instance of how prejudice is created against the Company. A great deal of the prejudice against the Company is created by people whose interest it is to do so, but that was not so in the particular instance to which I will draw attention. During the recent Parliamentary inquiry, as the report informs you, much stress was laid on the fact that this Company was exempt from the conditions as to service and charges which in the case of railway, gas and water companies are usually imposed by Parliament. That seemed to be something which hardened the Committee. One could not be present without seeing the effect which was produced by false impressions acting upon the minds of gentlemen both capable and honourable, but ill-informed. Mr. Hanbury, in his speech in the House of Commons on April 1, 1898, said, "They (the Company) had not only a monopoly, but one which was not under strict control or under stringent regulations." That is quite true. As to monopoly, let me point out that it is not our monopoly, but the monopoly of the Postmaster-General, and that we are nothing more nor less than his agents in carrying out a work which a good many people think he had much better carry out for himself. That did not suit the policy of the Postmaster-General or the Government, and so they induced, or were happy enough to get a number of people, themselves among others, to do all the preliminary work, and run all the preliminary risks of getting an undertaking such as theirs in order. Therefore, we are not placed under these restrictions and regulations, and Mr. Hanbury said that he thought we should be, and he made it a sort of complaint against us in the House of Commons. Mr. Hanbury had apparently forgotten that "this strange state of things," of which he spoke, was a direct consequence of the action of the Government themselves, who in several sessions vetoed Bills lodged by the Company with the express object of obtaining powers to enable them to carry on their business efficiently, and upon such reasonable conditions as might be imposed. The Company had again deposited Bills in order that the complaints against them, as set forth by Mr. Hanbury, might be removed, and also in order that the Company might be vested with powers sufficient to enable them to conduct this important national business in an effective manner. Mr. Hanbury had also made another speech in the House of Commons, no doubt in perfectly good faith. He himself cannot know anything about it; he is obliged to depend on other people, whom he has to consult. Well, Mr. Hanbury said that this Company with its business were powerful monopolists, and were growing dangerous to the State. That is how he put it, and he added that they had got an enormous capital, £6,000,000, and that he had an estimate prepared, which showed that the whole thing could be replaced for £2,500,000, or a little more. Naturally, such a statement created a great prejudice against the Company. I think that I shall be able to show you presently the real state of the case as regards this Company, and that there is nothing more important in the public interest than that the saddle should be put on the right horse. This Company has now got to a position of such magnitude and importance, and will continue to grow so rapidly that it ought to be put on what they call a proper footing. We will contribute our little share in a proper discussion, before a fair tribunal, to that end. Our present wants have exhausted our available capital, and having regard to the uncertain tenure of the Company, we have to consider what it would be wise to do. We consider that, on the basis of our capital expenditure for the last four years, that £1,000,000 should be sufficient to carry us on for the next three years. Within that period a good deal of light may be thrown upon this business, which will either make it extremely unwise to spend much money, in which case we shall refrain from doing so, or which might render it prudent to do that which, under present circumstances, might be considered a reckless course of procedure. Having said this I will content myself for the present, and will now move—

"*That the report and accounts for the half-year ended Dec. 31 last be adopted, and that the dividend therein recommended be paid.*"

Lord HARRIS, G.S.C.I., G.C.I.E., seconded the motion.

The resolution was carried unanimously, without discussion.

Resolutions were also passed authorising the Directors to borrow or raise such sums of money as they might think fit, provided that the amount borrowed or raised and then outstanding should not exceed three-fourths of the issued capital for the time being; and also approving the three Bills which the Company are promoting in Parliament.

The CHAIRMAN: There are a few matters of a general kind concerning which I have something to say. Let us just consider whether this Company deserves all the obloquy which has been cast on it by the ignorant or unthinking, and whether any apologies could not be found, in the circumstances, in favour of it. As you know, we went through our earlier troubles successfully, and our position became a very strong one. When the question was brought forward of the Post Office taking over the trunk wires, I received an assurance that we might rely on the loyalty of that department if we co-operated with them in trying to make the telephone service of value to the community and profitable to the Government. That was a straightforward, intelligent proposal, and we became parties to the bargain. The Post Office took over the lines, and, of course, we were to receive several things in consideration. One was the value of the lines as they stood, and there I am bound to say that I think the Government behaved with reasonable liberality. But there were other advantages promised us in the interest of the public, as well as of the Company, in the direction of increased facilities. Now, however, we are threatened with the practical withdrawal of the most valuable of those concessions which were granted as part of the purchase price of our trunk wires. I feel bound to say that if the Government deprive us and our customers of those facilities they will be doing a most immoral thing, having regard to the assurances that were made to us by Ministers of the Crown. Our grievances are the grievances of the community, who will suffer inconvenience by our being deprived of wayleaves and other rights, which, as I have said, were given us at the time the Post Office took over the trunk system. The fact is that the Post Office has conducted its part of the telephone service in a way which has made the Company largely responsible for its deeds. Instead of co-operating with the Company loyally, according to promise, it has impeded its work. There are 60 or 70 places where the Post Office has declined to develop the trunk system unless the Company agreed to guarantee the interest on the outlay. The Post Office ought to take the fat with the lean, and extend the trunk system wherever the convenience of the public requires that it should be done. Instead of doing so, however, it has tried to put the burden on the Company, and, rather than see their customers deprived of such a great convenience we have consented to bear it. The Board has statistics which shows a fearful want of energy and enterprise in connection with the development of the trunk lines. Between 60 and 70 per cent. of all the calls on the trunk wires means a delay of ten minutes, half an hour, and even an hour. The Company gets the discredit of all this lethargy, but they are not responsible for such a state of things. We are now told that we are to be competed with, that the Post Office is to establish an effective and real competition with the Company. Well, the Board does not fear competition with the Post Office on equal terms; we have already competed with it. What does competition mean? Competition between us and the Post Office would mean, immediately, the putting up of all classes of wages of people connected with telephones and a rise—a considerable one, too—in the price of materials. We are large users of copper—which has gone up 25 per cent. in the last few weeks—and of iron pipes and other things, all of which would go up in price in the event of competition. In such circumstances, what becomes of the estimate that the Company's service can be replaced for £2,500,000? I have no doubt that Mr. Hanbury and other honourable gentlemen who make these statements believe them, but they do not go to the right quarter for their information. This Company does not shirk competition with the Post Office, or anybody else, if it is forced on it, but we should be extremely unwise to force it on the Post Office, because our experience is that it is impossible to conduct this particular business efficiently and cheaply if half-a-dozen different people are engaged in it. There is no doubt that the object of all this opposition is to knock down the value of our stock in view of the time when we shall have to be bought out. There is no reason why the Post Office should not go about the matter in another way—a fairer way. The Government have the right to go to arbitration every seven years, but they have not taken advantage of the chances that they have had for doing so. The obstruction to which the Company is subjected is not consistent with fair play or the interest of the State or of the public, and I hope that public opinion will grow strong enough to insist that it shall not be continued. I see where all this is tending. Numberless Chambers of Commerce have made up their minds that this service is an impossible field for competition, and that the Post Office are the proper people to take it over and carry it on. The wise course would be for them to make up their minds to do it at once. But whether the Post Office decides on that course or not, I take this opportunity of protesting against the methods which I have described.

A vote of thanks to the Chairman and the other Directors, proposed by Mr. E. CHAPMAN, and seconded by Mr. G. ALEXANDER, brought the proceedings to a close.

Kensington and Knightsbridge Electric Lighting Co. (Limited).

The ordinary general meeting of the Company was held on Wednesday, at 1, Great George-street, Westminster, Mr. GRANVILLE R. RYDER presiding.

The SECRETARY (Mr. R. S. Erskine) read the notice calling the meeting.

The CHAIRMAN said: It is satisfactory that during the past year we have been able to earn the substantial dividend of 10 per cent., although the year was not one in which we could say that there was any special activity in our district with regard to electric lighting, nor was it one in which the progress to which we have now been accustomed for some years maintained. The dividend of 10 per cent., which we recommend, we are able to pay without straining our profits in the slightest degree or curtailing any of those amounts which prudence suggests should be placed in various capital funds. With regard to the figures of last year, I will, with your permission, bring forward a few of

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them as being the best mode of showing you how 1898 has been worked. First, with regard to the number of shops and houses connected with our system. They increased during the year from 1,620 to 1,851—that is, by 231 establishments. That, however, compares with an increase of 295 in 1897 over 1896, but I do not think that that is a matter of very much importance, because the number of lamps increased by 18,200 in the year 1898, against 18,000 in 1897. From these figures I suppose we may infer that houses which had already taken the light took more, or that larger establishments took it. Then with regard to the units sold. In 1898 the number was 2,081,074, and in 1897 1,898,362, which represents an increase of 182,712 units. In 1897, however, the increase was very much larger, namely, 383,633, but I do not think there is much difficulty in accounting for that. The year 1898 has to be contrasted with 1897, which was the Jubilee year, when there was a good deal of special lighting, both public and private. We did a good deal in Kensington in that way, and, moreover, in 1898 there was a greater absence of fog than in 1897, both at the beginning of the year and in the last three months of it. In fact, there was only one fog in the whole of last November, and that disappeared by noon. Of course, that is not a matter in which the public can be expected to sympathise with us, but still it was one which affected considerably the business of companies like ours. The cost of production of the 2,000,000 odd units in 1898 was £31,897, and of the 1,898,362 units in 1897, £29,270, or an increase in 1898 of £2,427. Against that, of course, had to be put the increase in the units generated and sold of 182,712. For 1898 the gross receipts amounted to £46,331, and for 1897, £43,910, an increase of £2,614; the amount to the credit of the revenue account at Dec. 31 was, however, £6,300, whereas, on Dec. 31, 1897, the amount was £7,263. That, on the face of it, did not look well, because it showed a decrease in net revenue of £963, against an increase of gross revenue of £2,614. That was not difficult to account for. In the first place, the distribution of the dividend in the year 1897 was different from that in 1898. In both years they paid 10 per cent., but in 1897 the interim dividend was 4 per cent., and in 1898 it was 5 per cent. The consequence was that there was 1 per cent. more to the balance of the Company at Dec. 31, 1897, than at Dec. 31, 1898. However, that 1 per cent. was in the pocket of the shareholders in 1898, instead of standing to the credit of the Company at the bankers. That made a difference of £750. Then the rates during 1898 increased by £400 and a sum larger by £300 was placed to renewal account in 1898 than in 1897. Then there were two smaller items which increased, insurance by £100 and salaries by £460, and last, but not least, there was a large increase in the cost of coal. In 1898 their coal cost £6,586, as compared with £5,267 in 1897, a difference between the two years of £1,115. That increase was to a considerable extent accounted for by the fact that they had no room to stow a large stock, and had to live from hand to mouth. Those increases made up the total of £3,110. There is another point I want to allude to, and that is with regard to the payment by consumers to us. The average amount paid by them during 1897 was 5d. and a fraction per unit, while during 1898 it was a fraction below 5d. per unit, the two fractions together making the difference of ¼d. per unit. Well, ¼d. was not a large sum, but if you multiply it by 2,000,000 odd units you get the figure of £2,000, or thereabouts. Therefore, if the rate had been the same in 1898 as it was in 1897 we should have had £2,000 more to the good. Some of the shareholders may ask, why should you reduce the rate per unit? We do not if we can help it, but you must remember that we live in a very considerable atmosphere of competition. I do not say that there is anybody actually competing with us, but there are always possibilities of competition around us. It is not only private companies which are trying to invade our sacred precincts, or unprincipled vestries which are seeking to obtain provisional orders to reap where we have sown, but there is a great deal of latent competition always going on with regard to large establishments. The point is, that if it does not pay them to come to us for the light they will make it for themselves, and that fact renders it necessary that we should be careful with regard to our charges. We must, therefore, meet our customers to a certain extent, and no doubt the general result is that there is a gradual cheapening taking place in the rate receivable for electricity. Going back to the figures, you will see that the capital account has increased during the year by nearly £19,000, £18,980 is the actual figure, on which we have received premiums to the amount of £2,429. Of that new capital, £11,000 has been spent almost entirely on mains and machinery up to the end of the year, leaving £9,000 to be carried forward on that account. With regard to the £2,429, which we obtained in premiums, we have, as before, placed that to the benefit of the capital account. Of course, in all capital accounts there are certain things which you may call wasting assets. No doubt their value decreases year by year. The Kensington Court licence is one of these, and so we have set the amount of premiums referred to against the original cost of that licence. The renewal account now stands at £25,615, a sum of £5,117 having been placed to it during 1898. That might seem a large figure, but, as a matter of fact, it is not a fancy one. We are now gradually getting up to the amount which, in the opinion of our experts, we should have in order to cover the depreciation which may occur in our securities. Our experts went very carefully into what you may call the natural life of the different categories of our plant and came to the conclusion as to what each should be put at, and these figures are the outcome of it; and I think that, in a short time, some two or three years, it will be unnecessary for us to put aside annually so large a sum as we have been doing of late. There is only one other thing, and that is with regard to the rates. It is perfectly monstrous that the rates should have reached the amount at which they stand at present. They amount to no less than 5 per cent. on our ordinary capital, so that but for them we could pay you 5 per cent. more than we do. In other words, they are equal to nearly ½d. per Board of Trade unit, and that shows what an enormous tax they are on a concern like this. On what principle the rating is founded I have never been able to discover, although I have tried to do so. I think there is nothing further which occurs to me as necessary to remark on, and so I will move—

"*That the report and accounts, now taken as read, be adopted and entered on the minutes.*"

Sir FREDERICK J. BRAMWELL, Bart., F.R.S., seconded the resolution, which was carried unanimously.

The CHAIRMAN next proposed that the interim dividend on the ordinary capital at the rate of 10 per cent. per annum be approved, and that a further dividend at the rate of 10 per cent. per annum be paid for the half year ended December 31 last.

The resolution was carried unanimously.

Sir Frederick J. Bramwell, Bart., F.R.S., and Mr. Granville R. Ryder, were re-elected directors, and Messrs. Lovelock, H. W. S. Whiffin, and Dickinson were re-appointed auditors for the ensuing year.

An extraordinary meeting followed, when a resolution confirming the special resolution passed on the 1st Feb. was carried unanimously.

A vote of thanks to the Chairman terminated the proceedings.

India Rubber, Gutta Percha, and Telegraph Works Co. (Limited).

The thirty-fifth ordinary general meeting of this Company was held yesterday at Cannon-street Hotel, the Hon. HENRY MARSHAM presiding.

The SECRETARY (Mr. T. J. Lloyd) read the notice calling the meeting, and the report and accounts were taken as read.

The CHAIRMAN said: Gentlemen, in moving the adoption of the report and accounts I have very little to say to you with relation to the latter, as they are submitted in as full a form as it is prudent to present them. The amount placed against premises, machinery, &c., shows an increase, when compared with 1897, of £1,727; but this amount does not represent the whole addition which has been made to this asset during the year, as the sum appearing in the balance sheet is what remains, after deducting the depreciation prescribed by the articles of association, which amounts for the year under review to £16,487, as will be seen on the debtor side of the profit and loss account. At Silvertown we have spent over £6,000 on buildings, and over £10,000 on machinery. We are bound to supplement our existing plant with new machinery, as inventions and improvements develop, so as to keep the works in the front rank and ready for all requisitions. The debts owing to the Company are lower than when I addressed you a year ago, but, on the other hand, the stocks are higher. However, the two items together are within a few thousand pounds in both years. The cash in hand and on deposit is £3,866 more than the amount appearing against this item in the accounts for 1897. On the other hand, the bills receivable, which we have discounted, show in the present account £5,097 more than in the account for 1897, but the bills are all good trade bills, and we only call attention to the item as indicating the scrupulous care of the auditors, that even our liability as endorsers of good bills should be shown. With regard to the work done during the past year, the Company's works, except the cable department, have been well employed in all the divisions, and we have been overpressed, fortunately, in some of the more recent and rapidly-developing branches. Steps are being taken to meet the demand for production in these special lines. With regard to cable work, we are ready and anxious to undertake any amount of it, but there has lately been none open to tender. The seas are occupied by submarine cables, and those that have been laid have longer lives than was originally contemplated, so that renewals are not required frequently. The high prices of some of the raw materials have been severely felt by all the indiarubber manufacturers, and although we were not able to arrange with the competitors of our French works to make a *pro rata* advance in our selling prices; yet, as I mentioned at the half-yearly meeting in July last, English manufacturers saw the necessity of an advance, which has been in operation during the greater part of 1898. The raw material shows no sign of an immediate fall, but we do not anticipate that we shall have to make any further advance in our selling prices. Your Board does not believe in the principle of continually raising and lowering price lists to meet the varying prices of the raw material, as they do not wish to disturb the trade to any greater extent than is absolutely necessary. Our cable vessels have had moderate employment during the year. The steamship "Silvertown" was engaged in completing the laying of a trans-Atlantic cable, on which this vessel and the steamship "Dacia" were employed in 1897. The work was carried out by our staff, under the superior direction of the charterers. All the operations in which our vessels were engaged were successful, and proved, if proof be necessary, the perfect efficiency of our men and ships, and of our system of organisation. The steamship "Dacia" has made one voyage, and our steamship "Buccaneer" has just returned from Cuba, where she was engaged by the Cuba Submarine Telegraph Co. to reinstate some of the company's cables, which had suffered during the late Hispano-American war. We are doing a fair business in the manufacture of electric machinery, and have just delivered to the Royal Arsenal, at Woolwich, one of the largest, if not the largest, single-current dynamo manufactured in Great Britain. This business, which we started some 22 years ago, has definitely assumed the nature of a healthy manufacturing business—that is, a steady business in which the risk is small. I now move the adoption of the report and accounts, and that a dividend of 7½ per cent. (or 15s. per share) be declared.

Mr. S. WILLIAM SILVER seconded.

Mr. LAMONT enquired if the Chairman had any comment to make on the statement by the auditors, in their certificate, as to the value of the debentures and shares in other companies, and the debts owing to the Company. They referred to those matters in a way that was rather terrifying. The words used by them were that these were amply provided for by the reserve fund. He should hope they were, because the reserve fund stood

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at £450,000. One must hope that there was nothing like a tithe of that sum in jeopardy.

The CHAIRMAN: This question of the auditors' certificate was brought to our attention last year, and I then said that the wording of it was not exactly to the liking of the Board, but I pointed out that it was for the auditors to decide how they should draw up their report, and on the present occasion they adhere to the same wording. I have, therefore, nothing further to say on the matter, except to repeat that we should prefer that the auditors worded their report otherwise. What Mr. Lamont has said with reference to the reserve fund should be satisfactory, I think, to the shareholders. There is that £450,000, which, in the wording of the auditors, is amply sufficient to meet any contingencies in connection with the matters referred to.

Mr. LAMONT remarked that the wording was calculated to excite a considerable amount of misapprehension in the minds of shareholders, and he thought it would be satisfactory to have an assurance from the Chairman that there was no item of any magnitude in danger.

Mr. COCHRAN also thought that it would be as well for the Chairman to give some explanation as to the way in which the debentures and shares were valued. In regard to the debts owing to the Company, it was hardly possible for an auditor to satisfy himself of the value of them, but he thought that the Board were bound to satisfy themselves that there were no very ancient debts carried over, and that they did represent, in a fair and reasonable way, the figures at which they stood in the balance-sheet.

The CHAIRMAN: In reply to the remarks which have been made, I may say that, of the debts owing to the Company, by far the larger proportion are ordinary trade debts of the business. As to the valuation of the debentures and shares, I stated last year that the valuation is made by the Board—and that it is not done without careful attention and consideration—and we are of the opinion that the valuation is a proper one

Mr. COCHRAN asked if the Chairman was satisfied that no debts were of long standing.

The CHAIRMAN: The debts are not of long standing; in fact, as the Secretary reminds me, a large proportion of them are already liquidated.

The resolution was carried unanimously.

Mr. S. William Silver and Mr. Abraham Scott having been re-elected directors of the Company, and Messrs. Turquand, Youngs, Bishop and Clarke re-appointed auditors, a vote of thanks to the Chairman terminated the proceedings.

Cambridge Electric Supply Co. (Limited).

The seventh annual general meeting of this Company was held on Friday last week, under the presidency of Mr. D. MUNSEY.

The CHAIRMAN, in proposing the adoption of the Directors' report, set out in our last issue, said that not only had they carried on a very profitable business during the year, but their prospects for the future were brighter than ever before. The number of consumers of electric current had increased, and there had been a general increase of their business all round. During the year the Company had been duplicating its system of cables, and putting in much larger ones. Within a few months this duplicated system would be complete right through. They had extended their mains, had received an application from the Town Council to send in a tender for lighting part of Cambridge, and the shareholders might depend upon the Directors doing their utmost to secure part of the lighting of the town.

Mr. SIMPSON seconded. He said from 1894 to 1898 the consumption had increased from 112,000 to 260,000 units. The shareholders were getting a dividend of 7 per cent., and he hoped to see the day when they would be getting 10 per cent.

Ald. W. BOND did not like to hear Mr. Simpson talk about a dividend of 10 per cent. In view of the enormous quantities of gold being found and the present rate of interest, the probabilities were that money would remain at a low rate of interest, and 10 per cent. was a dividend which it would not be fair to the public to expect. He would rather see the price of the light reduced from 7d. to 6d. per unit, or even less than that. At Bedford it was 4½d. In these progressive days he would be ashamed to share in taking 10 per cent. from the public.

The Rev. G. B. FINCH asked how many persons were there who were willing to embark their capital in the Company before it was known how it would turn out? The great bulk of the capital had to be subscribed by persons who had some faith in it, but certainly not by people in the town of Cambridge. Was there to be no return for those who embarked their money in what was a risk? Surely, the greater the risk the greater the return they had a right to expect for their venture. At the end of a certain time the more prosperous they were the more certain it was that the Corporation would take over the concern under the terms of the original arrangement, and then those shareholders who had embarked their money might find that for their £8 or £10 they would get £6 or something less. Therefore, they should now be getting more than a market price, not only because of their outlay in the first instance, but also because of the possibility that they would get less.

The report was adopted, and 200 guineas voted as remuneration to the Directors.

City of London Electric Lighting Company (Limited).

The report of the directors of this company for the year 1898 is as follows:

Capital.—The expenditure on Capital Account during the year amounted to £90,968. 6s. 1d. The directors propose to make a further issue of the authorised Ordinary shares in the course of this year, to provide for extensions of works and plant necessitated by the increasing demand for electric energy.

Revenue.—The total Revenue for the year was £175,607. 15s. 8d. Expenses of generation and distribution amounted to £48,448. 16s. 1d.; other expenses, including rents, rates, taxes, general and special charges, &c. £49,392. 7s. 1d.; total expenses, £97,841. 3s. 2d., leaving £77,766. 12s. 6d. Adding £1,055. 6s. 7d. brought forward, there is a total available revenue of £78,821. 19s. 1d., out of which £43,862. 10s. has been paid in debenture interest and interim dividends on the Preference and Ordinary shares, leaving for present distribution £34,959. 9s. 1d. The directors now recommend that dividends of 12s. per share on the Preference shares, making the full 6 per cent. for the year; 12s. per share on the Ordinary shares, Nos. 40,001 to 90,000, making 6 per cent. for the year; 8s. 1d. per share on the Ordinary shares, Nos. 90,001 to 100,000, making 6 per cent. for the year, calculated on the respective instalments paid. These dividends will be paid on March 2, and will absorb £31,577. 15s. 7d., and leave a balance of £3,381. 13s. 6d. to be carried forward.

The directors regret the decrease in the rate of dividend on the Ordinary shares. It has been mainly caused by the reductions made in the charges to consumers; by the decreased consumption of current per lamp, owing to the unusual brightness of the weather during 1898; by the increased cost of coal, and by the increased amount of capital which had to be issued in advance to provide plant and buildings for the steadily growing business of the company, and which capital ranked for dividend in the past year. The statutory provision for depreciation and reserve funds, in accordance with the City of London Electric Lighting Act, 1893, has been made, of which £20,075. 9s. has been set aside out of revenue.

The City Corporation availed itself of its rights, under the contracts, to inspect the accounts of the Company up to Dec. 31, 1897, in order to satisfy themselves that the regulations with respect to the statutory depreciation and reserve funds had been complied with. In consequence of the decreased receipts, owing to the reduced charges, &c., the generation and distribution expenses for the year, including repairs and renewals, were 36·1 per cent. of the gross earnings, compared with 31·3 per cent. in 1897, 34 per cent. in 1896, 35·87 for 1895, 46 for 1894, and 54·2 for 1893.

The following statement shows the position of the Company at Dec. 31, 1892, and subsequent yearly periods:—

Number of Customers and Lamps connected.

31st December	1892.	1893.	1894.	1895.	1896.	1897.	1898.
No. of Customers	242	1,080	2,740	4,230	5,303	6,322	7,414
No. (equiv) of 8 c.p. lamps ...	20,241	65,341	135,460	195,317	247,785	296,012	355,825

On Feb. 8, 1899, there were 379,314 8 c.p. lamps (equivalent) applied for, out of which 363,151 were connected.

The company's net revenue available for depreciation, reserve fund, interest on debenture stock, and dividends for the yearly periods to Dec. 31st in each year was as under:—

1892.	1893.	1894.	1895.	1896.	1897.	1898.
£500 (est.)	£16,910	£34,865	£59,100	£85,701	£107,550	£97,842

London Electric Supply Corporation (Limited).

The directors of this company have issued the following report for the half-year to Dec. 31:—

The capital of the Corporation has been reduced by £222,000 by writing down the nominal amount of the Ordinary shares from £5 to £3 each. The capital account now stands at £736,521. 14s. 2d. The issue of £200,000 First Mortgage Debenture stock—which was largely over-subscribed—enabled the Board to pay off the whole of the debenture debt and loans as at June 30 last, and the undertaking passed again into the hands of the shareholders as from July 1 last.

The satisfactory progress of the business of the Corporation has continued during the year. The number of lights added was 31,221, an increase of 25 per cent., bringing the total to Dec. 31 to 155,319, and the same ratio of increase has continued since the accounts were closed.

The new 2,000 H.P. plant was finished in October, and has worked satisfactorily during the winter. New distributing mains have been laid from Newington-causeway to Greenwich, and also in the whole of our compulsory area in Bermondsey, and partly in Rotherhithe. The plant and machinery have worked satisfactorily during the year, and have been entirely maintained out of revenue. The prolonged strike in the South Wales coalfield added materially to the generating costs during the year.

The profit on the working for the half-year was £13,535. 5s. 6d., to which is added interest on deposits, £291. 17s. 8d., making £13,827. 3s. 2d. Out of this interest on debentures to Dec. 31 (£3,344. 3s. 7d.) has been paid, leaving £10,482. 19s. 7d. now to be dealt with. The Board propose the payment of a dividend at the rate of 6 per cent. per annum on the Preference shares, absorbing £7,207. 10s., and to carry forward £3,275. 9s. 7d

Notting Hill Electric Lighting Co. (Limited).

The directors' of this company report that the expenditure on capital account during the past year amounted to £14,819. 14s., bringing the total expenditure up to £128,003. 19s. 4d., or £2,003. 19s. 4d. in excess of the capital received. Further issues of First Mortgage Debentures amounting to £21,000 were made during the year at premiums aggregating £1,308. 13s. 9d, utilised as follows: £973. 16s. 7d. written off balance of expenditure not represented by visible assets, bringing this item to £1,000, £324. 17s. 2d. placed to credit of renewal and reserve fund.

The progress of the company is shown by the following:—

Year.	Lamps.	Profits.	Year.	Lamps.	Profits.
1891 ...	6,056	*loss £554 18 6*	1895 ...	20,307	...£3,227 14 10
1892 ...	9,438	... 112 6 1	1896 ...	25,716	... 4,736 9 8
1893 ...	12,153	... 1,481 7 1	1897 ...	33,000	... 6,854 1 2
1894 ...	15,669	... 2,101 17 8	1898 ...	46,066	... 7,251 13 7

The reduction in the charge for current had but a slight effect upon the revenue, and the policy of the directors in encouraging the higher voltage

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has been so far successful, that already more than two-thirds of the consumers are supplied at 200 volts. When this conversion is completed the saving in the cost of distribution will be considerable. Owing to the coal strike in Wales the cost of coal shows an increase of £200.

During the year this company, in common with other metropolitan companies, was seriously threatened with competition, and the directors, besides joining in opposing bills before the Parliamentary committees, adopted a policy of strengthening the position of the company in the district by extensions of mains, so that should Parliament grant a competing order they might be able to protect the interests of the shareholders.

The present supply station being fully equipped, and in view of the increased demand for current, the directors are considering the advisability of extending their works on the north side of the station on the freehold land which was secured at the outset of the undertaking with this object. The Kensington and Knightsbridge Electric Lighting Co. are also desirous of increasing their works, and the two companies have met and decided to establish a joint station at some convenient position where current could be produced at minimum cost, and a joint bill, promoted by the two companies with that object, is now before Parliament.

The Vestry of Kensington, on the other hand, anxious to have the streets and public buildings of the parish lighted by electricity, also deposited a Bill asking for powers to erect works with that object. This Bill would have enabled the Vestry to enter into competition with the existing companies. After long negotiation the directors of the two companies succeeded in effecting an agreement with the Kensington Vestry, in accordance with which that body agreed to withdraw its Bill and petition in favour of the "Kensington and Notting Hill Electric Lighting Bill," the two companies agreeing, each in its own area, to supply current for the purpose of street lighting, and for the use of the Vestry's buildings, on terms which are satisfactory to both parties.

Of the £7.251. 13s. 7d. profit on the year's working, the directors have set aside £825. 2s. 10d. for depreciation and reserve, bringing it to £4,500. After paying debenture interest (£685. 16s. 8d.), and 6 per cent. on the Preference shares (£1,738. 16s. 10d.), there is a balance of £3,933. 18s. 11d., and the directors recommend a dividend at the rate of 6 per cent. per annum, less tax, on the Ordinary shares, making 6 per cent. for the year.

The directors place on record their appreciation of the services of the manager, secretary, and staff generally, more especially for the great assistance they have given to the directors during the delicate negotiations referred to in the report.

Charing Cross and Strand Electricity Supply Corporation (Limited).

The report of the directors of this company for the year ended Dec. 31 last states that the progress of the business has been very satisfactory. The Maiden-lane and Lambeth stations, and the plant and machinery have been maintained in a high state of efficiency. A provisional order for parts of the Holborn and St. Giles' districts, such as are south of High Holborn and New Oxford-street respectively, has been granted to the Corporation. An application for a provisional order to supply electric energy within the city of London is under the consideration of the Board of Trade, and (if granted) application to Parliament will be made to confirm the order.

There has been connected up to the mains of the Corporation during the past year the equivalent of 26,694 additional 8 c.p. lamps, making, with those previously connected up, the equivalent of 134,236 8 c.p. lamps. 18½ miles have been added to the mains laid, including seven miles in the new districts of Holborn and St. Giles, making, with those already laid, 101½ miles. The combined output in units from the stations of the Corporation increased by about 20 per cent. for the year 1898 over 1897.

The rapid extension of the business has necessitated a modification of the original plans of the station buildings at Lambeth, which will have to be still further enlarged, and for this purpose it has become necessary to determine tenants' leases of parts of the properties at Lambeth not at present in the occupation of the Corporation. The directors have acquired upon lease for 999 years a site upon which they are building a sub-station (rapidly approaching completion); from this station it is intended to distribute electric energy to the Holborn and St. Giles' districts, and to supplement the present supply in the northern parts of St. Martin's parish and the Strand district. It will be seen that the necessary outlay on building extensions, mains and plant, to cope with the present and prospective demand, has been exceedingly heavy; to meet this outlay and provide for future requirements in the present areas of supply, the directors propose to increase the Ordinary share capital by the issue of 20,000 shares of £5 each at a premium.

The net earnings have amounted to £21,377. 2s. 6d. £4,600. 1s. 8d. has been paid in respect of interest on debentures and temporary loans up to Dec. 31, and £4,500 was distributed as interim dividend at the rate of 6 per cent. for the half-year ended June 30, 1898. £12,277. 0s. 10d. remains, which, added to £3,014. 18s. 4d. from last year's account, makes £15,291. 19s. 2d., which the directors propose to deal with as follows:—Dividend on Four and a-Half Preference shares, £4,499. 17s. 9d.; dividend at the rate of £10 per cent. for the half-year ended Dec. 31 on the Ordinary shares (making £8 per cent. for the year), £7,500; carry forward, £3,292. 1s. 5d.

W. T. Henley's Telegraph Works Co. (Limited).

The report of the directors of this company for the year 1898 states that of the £50,000 additional capital authorised in 1897 the first issue of £25,000 was taken up by the shareholders or their nominees at 60 per cent. premium, enabling the reserve to be increased by £15,000. The second issue of £25,000 was taken up by the shareholders or their nominees at 80 per cent. premium, enabling the reserve to be increased by £20,000. During the past year a net profit has been made of £33,394. 18s. 7d. After payment of debenture interest and income-tax, and making ample allowance for depreciation of buildings, plant, machinery, &c., their remains £27,823. 7s. 9d., making, with £14,789. 11s. 7d. brought forward, £42,612 19s. 4d. available for distribution. The directors have transferred £7,500 to reserve (in addition to the £20,000 mentioned), and they recommend the payment of the following dividends, viz.:—On the Preference shares 7 per cent., including the interim dividend of 3½ per cent. paid on Sept. 1 last; on the Ordinary shares at the rate of 12 per cent. per annum, including the interim 4 per cent. paid on Sept. 1, and a bonus of 2 per cent. per annum. These payments will amount to £28,084. 5s. 1d., leaving £14,528 14s. 3d. to be carried forward. Dividend warrants will be posted on 28th inst.

Telegraph Construction and Maintenance Co. (Limited).

The thirty-fifth annual report of the directors of this company will be submitted at the meeting to be held on Tuesday, Feb. 28. The accounts for the year show a net profit of £71,593. 12s. 1d., after charging interest on debentures. To this is added £33,841. 9s. 11d. brought forward, making £105,435. 2s. From this amount is deducted the interim dividend of 5 per cent. (paid July 19), leaving £83,025. 2s. to be dealt with, out of which the directors propose to distribute a dividend of £1. 4s. per share (absorbing £44,820) being at the rate of 10 per cent., and making, with the amount already paid, a total dividend for the year of £1. 16s. per share, or 15 per cent., free of tax, leaving £38,205. 2s. to be carried forward.

The company's works have during the past year been fully occupied in the manufacture of submarine telegraph cables and insulated land lines, and the steamships have been actively employed in the laying and repairing of cables. The factories at East Greenwich and Wharf-road and the company's steamships have been maintained in a thoroughly efficient condition. An important addition to the latter is the s.s. "Anglia," 6,514 tons, built during the year. This ship is by far the largest telegraph steamer afloat. Her cable gear and machinery are of the most recent design and include all the latest improvements.

The company's £150,000 Five per Cent. Debentures, which matured on Jan. 1, 1899, have been extended for a period of 10 years from that date at the rate of 4 per cent. per annum.

The directors propose to establish a pension fund for the benefit of the staff. The details are not yet settled, but a sum of £5,000 has been placed to the debit of profit and loss, so as to furnish a sum available for the purpose of starting the fund.

The retiring directors, Admiral Sir Anthony H. Hoskins and Mr. Colin F. Campbell, offer themselves for re-election.

Windsor Electrical Installation Co. (Limited).

The report of the directors of this company for the year 1898 states that the business has progressed satisfactorily. The number of lamps and motors installed on Dec. 31, 1897, was equivalent to 4,985 8 c.p. During 1898 2,929 were added, bringing up the total to 7,914, of which total 540 represent motor power. A new boiler has been added to the station plant, and the mains have been extended. The mains have been extended to Windsor Castle, and since the close of the year the number of lamps connected has already increased by 550 8 c.p. The net profit for the year was £2,539. 12s. 9d., and this, added to the amount brought forward, makes available for distribution £2,830. 9s. 7d. The directors recommend a dividend be declared of 6 per cent. for the year; and that £793. 15s. 2d. be set aside to a depreciation, renewal and reserve fund. The shareholders will be asked to vote the directors a sum out of the balance of £687. 10s. 5d.

The remaining capital of £5,000 was issued during the year at a premium of 2s. 6d. per share, and the directors recommend that out of these premiums (£625) the whole of the preliminary expenses (£418. 15s. 2d.) be written off, and that the balance be carried to depreciation, renewal and reserve, bringing that account up to £1,000.

The total capital expenditure to Dec. 31, including the stock of the installation department, was £26,409. 15s. 11d., but as the total capital received was only £25,000, the directors recommend that the capital be increased from £25,000 to £50,000.

Current is at present being supplied at 7d. per unit, but on April 1 next it is to be reduced to 6½d. per unit.

Newcastle-upon-Tyne Electric Supply Co. (Limited).

The directors' report for the year ended Dec. 31, states that the demand for electricity continued to improve, the units sold having been 803,789, against 660,906 last year. The total profit, including the balance brought forward, was £6,020. 18s. 3d. Out of this the directors recommend a dividend of 8 per cent. for the year, on account of which an interim dividend of 3½ per cent. was paid on July 15 last, leaving a further dividend of 4½ per cent. now payable. The total dividend will absorb £4,026. 18s. 1d., and it is proposed to place to reserve and depreciation £1,000, increasing this account to £7,700, and to carry forward £994. 0s. 2d. The capital expenditure has been increased during the year by about £15,000, this including an additional large set of generating plant and the general extension of the company's system to meet the growing demand for electrical energy. Arrangements are being made for still further increasing the capacity of the station, and also for supplying continuous current for power and other purposes for which several applications have already been received. The special expenditure above mentioned has been met by the issue of 3,000 new shares.

At the meeting on Tuesday the Chairman (Ald. T. G. Gibson) said he was pleased to say that the directors, in view of the satisfactory state of the accounts, had resolved to relinquish the rent charge for transformers and apparatus, which would relieve consumers to the extent of £600 per annum. He thought that the Newcastle Corporation Bill, which would enable the Corporation to supply electricity, amounted to an encroachment upon their rights. The report was adopted.

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Hove Electric Lighting Co. (Limited).

The annual report of the directors to Dec. 31 states that the progress of the Company continues satisfactory. The units sold were 350,354 compared with 268,243 in 1897, the gross revenue was £9,480. 7s. 1d. against £7,269. 11s. 4d., and the gross expenditure £4,390. 8s. 11d. The net result is a profit of £5,089. 18s. 2d., an increase of £1,486. 8s. 6d. over 1897. The reduction in price of current has been amply justified, and the directors have no doubt that the most profitable policy which can be adopted by the company will be to further reduce the price, but until the station has been enlarged, and ample provision made for dealing with a further greatly increased demand, it will be inadvisable to make any further reductions. The number of lamps and motors connected to the company's system at Dec. 31 was equivalent to 36,967 8 c.p. lamps, and the number of houses connected 513, compared with 27,777 lamps and 397 houses at Dec. 31, 1897. To the net revenue of £5,089. 18s. 2d. has to be added £214. 13s. 2d., balance from last year, making £5,304. 11s. 4d. After deducting debenture interest and interim dividend paid in October, and providing for tax, there remains £3,264. 15s. 3d. at the credit of the revenue; and the directors propose to write £247. 17s. off preliminary expenses, to place £1,000 to reserve, to declare a dividend (payable April 15) at the rate of 8 per cent. per annum for the half-year on the share capital, making 6½ per cent. for the year, and to carry the balance (£400. 1s. 5d.) forward. The reserve fund now stands at £5,287. 17s., and £191. 3s. 1d. has been added to depreciation and maintenance reserve, which now stands at £1,105. 13s. 1d.

The directors have issued 1,000 of the new £5 shares at £7 each, the premiums being added to reserve. They have also issued £700 of Four per Cent Debenture stock, making the total Debenture charge £25,000. During the past year expenditure on capital account was £10,641, the total to Dec. 31 being £77,450. 12s. 2d. Two new steam dynamos of 350 and 40 H.P. respectively, and an additional boiler, have been added to the generating plant. Over £4,500 has been expended on new mains and strengthening the existing feeders and mains, and £1,120 on additional meters and demand indicators. The continued increase in the company's business has forced upon the directors the consideration of the extension of the lighting station, and additions to the generating plant therein. To meet the cost of these and of further extensions to the mains it will be necessary to raise additional capital. The directors propose, therefore, to issue the remaining 1,000 £5 shares, bringing the total subscribed capital up to £50,000. These shares are offered to members *pro rata* at £7. 10s. per share. It is proposed that the nominal share capital of the company shall be increased to £100,000 by the creation of 10,000 additional shares of £5 each.

NEW COMPANIES, STATUTORY RETURNS, &c.

BRITISH THERMOPHOR SYNDICATE (LIMITED).—This company was registered on Feb. 15, with a capital of £25,000, in £1 shares, to enter into an agreement with Salisbury-Jones and Bidwell, and to acquire, develop, work and deal with any patents and rights relating to the production, treatment, storage, application, distribution and use of heat and electricity.

COMMERCIAL TELEGRAPH CONSTRUCTION SYNDICATE (LIMITED).—This company was registered on Feb. 20 with a capital of £5,000, in £100 shares, to enter into an agreement with the Hon. James Roche to subscribe for or otherwise acquire the whole or any part of the shares, debentures, or other securities of the Northern Commercial Telegraph Co. (Limited), incorporated by an Act of the Canadian Parliament, and to carry on the business of telegraph and telephone proprietors, electricians, electrical apparatus manufacturers, suppliers of electricity, &c. The first subscribers are:—Hon. James Roche, M.P., H. S. Holt, A. Raymond, Fred. J. Abbott, B. W. Bell, B. H. M. Ritchie, and C. H. Gurney.

LINDSAY, BROWNING AND CO. (LIMITED).—This company was registered on Feb. 18 with a capital of £1,000, in £1 shares, to acquire and take over as a going concern the business now carried on by Lindsay, Browning and Co., and to carry on the business of electrical engineers, electricians, suppliers of electricity and manufacturers of and dealers in electrical apparatus. The first directors are:—Frederic L. L. Lindsay and Ernest F. Browning.

NEW ROTTINGDEAN ELECTRICITY CO. (LIMITED).—This company was registered on Feb. 16, with a capital of £2,000, in £1 shares, to enter into an agreement for the acquisition of an electric lighting plant at Rottingdean, Sussex, for £850, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity and electrical apparatus manufacturers. The first directors are:—C. Reed, S. J. Thacker, S. Reed, G. Mason, F. Thomas and W. Hilder.

WILLIAM JAMES GLOVER AND CO. (Established 1818) (LIMITED).—This company was registered on Feb. 16, with a capital of £100,000, in £1 shares (of which 40,000 are £5 per cent. cumulative Preference), to carry on the business of cable makers, wire rope makers, wire drawers, electricians, electrical and mechanical engineers, electrical apparatus manufacturers, telegraph, telephone and electric cable makers, india-rubber merchants, paint manufacturers, &c. The first subscribers are:—B. B. Glover, W. J. Glover, G. E. Heyl-Dia (electrical engineer), F. W. Maxwell, R. B. Glover, B. H. Glover and W. Hanchett. The first directors are:—B. B. Glover, W. J. Glover, R. B. Glover and G. E. Heyl-Dia.

CONTINENTAL WATER AND ELECTRICAL POWER SYNDICATE LIMITED.—The annual return to Dec. 29 gives the nominal capital as £26,000, in £1 shares (of which 1,000 are Deferred); 19,500 Ordinary and 890 Deferred shares have been taken up, and the full amount has been called.

DIRECT ELECTRIC GENERATOR SYNDICATE (LIMITED).—The annual return to Dec. 15 has been filed. The nominal capital is £100,000, in £1 shares; 99,725 shares have been taken up, and 95,000 have been issued as fully paid. The full amount has been paid on the remaining shares.

DIRECT ELECTRIC GENERATOR (FOREIGN RIGHTS) SYNDICATE LIMITED.—The annual return to Dec. 15 has been filed. The nominal capital is £100,000, in £1 shares, of which 95,283 shares have been taken up and 95,000 are considered as fully paid.

DIRECT WEST INDIA CABLE CO. (LIMITED).—The annual return to Dec. 28 has been filed. The nominal capital is £120,000, in £5 shares, of which 12,000 have been taken up. £2. 10s. per share has been called and paid.

DOE PORTABLE ELECTRIC LIGHT AND POWER SYNDICATE (LIMITED).—The statutory return to Oct. 29 has been filed. The capital is £40,000, in £1 shares, of which 7,208 have been taken up. £1 per share has been called on 7,201 shares.

DOUGLAS SOUTHERN LECTRIC RAILWAYS (LIMITED).—The annual return to Jan. 10 has been filed. The capital is £50,000, in £1 shares (of which 30,000 are Preference). 25,573 Preference and 15,472 Ordinary shares have been taken up, and 13,407 of the former and 9,668 of the latter have been issued as fully paid. The full amount has been called on the others.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 2, 1899). Price of silver 27 7/8d. per oz. (Feb. 23). Consols (2¾ per cent.) 111⅛—111⅜ for money, 111⅛—111⅜ for account; 2½ per cent. 104—104¼ (Feb. 23) Stock Exchange Settling Days: Consols, March 1; Stocks and Shares Continuation Day, March 8; Ticket Day, March 9; Pay Days, Feb. 24 and March 10; Mining Share Carry over Day, March 7.

BAKER STREET AND WATERLOO RAILWAY CO.—A special meeting of this company was held last week, when the bill now before Parliament was approved. The chairman said that the company's authorised line from Waterloo to the Great Central terminus was in course of construction, and that something like a quarter of a million had already been spent on it. In view of the fact that this was the only railway connecting Waterloo and the tramway systems south of the Thames with Charing Cross, Piccadilly-circus, Oxford-circus, Baker-street and the Great Central terminus, and that it would be able to exchange passengers with eight different railway systems, it was probably the most important of London's underground electric railways, and it was anticipated that traffic would be very great. The object of the present bill was to extend the authorised line to Paddington and Euston, which would solve the problem of linking up the great railway termini of London. It was proposed to change the name of the company to the Waterloo, Paddington and Euston Railway Co.

DEUTSCHE KABELWERKE VORM. HIRSCHMANN AND CO.—An extraordinary meeting has been called for March 13, for the purpose of authorising an increase in the capital from 1,000,000 to 2,000,000 marks for extensions of the business.

ELECTROID GAS LIGHT SYNDICATE (LIMITED).—Subscriptions have been invited to an issue of £50,000, in £1 shares, in a company with the above title established in Manchester, the object of the concern being "to carry on the business of an electroid gas light company in all its branches, and to manufacture and supply electricity and electroid gas light, and to light therewith cities, towns, docks, markets and other places." Mr. J. H. G. Davis (director of the Madeira Electric Lighting Co.) is chairman of the board of directors, and Mr. E. W. Donovan, A.I.E.E., is engineer and works manager.

GEURNSEY RAILWAY CO. (LIMITED).—At a meeting of this company on the 14th inst., the report of the directors, with slight amendment, was approved. The gross receipts of the railway for the year 1898 were £6,253. 14s. 4d., showing a decrease of £92. 11s. 7d. The working expenses showed a decrease of £199. 18s. 8d. The electrical equipment of the line, the car shed and pits and the rolling stock had been kept in efficient repair out of the revenue. A dividend of 4 per cent. on the Ordinary shares was declared.

LONDON PLATINO BRAZILIAN TELEGRAPH CO. (LIMITED).—The half-yearly coupons, which fall due on 1st prox., of the £100,000 Six per Cent. Debentures, will be paid by Messrs. Glyn, Mills, Currie and Co., 67, Lombard-street, E.C.

NERNST ELECTRIC LIGHT (LIMITED).—On another page will be found a complete prospectus of the Nernst Electric Light (Limited), formed with a capital of £320,000, in 140,000 Preference and 100,000 Ordinary shares of £1 each. The vendors take the whole of the Ordinary shares fully paid in part payment of the purchase money, and the public are now invited to subscribe for 115,000 Preference shares at par, payable—5s. on application, 5s. on allotment, 5s. on April 1, and 5s. on May 1 next. The remaining 25,000 Preference shares are, with £65,000 in cash, taken by the vendors as the balance of the purchase price. The company is formed to acquire and work "in the countries mentioned," the patent rights of the Nernst electric lamp. These countries do not include any part of Europe, North America, or Canada, but the company is free to operate in Australasia, Africa, Asia, South and Central America, and the islands adjacent. The completed patent rights which the company take over are those granted for Argentina, Cape Colony, Egypt, New South Wales, New Zealand, South Australia, Venezuela, and Victoria. The information given in the prospectus of the ground covered by the company's operations, and

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the limits thereto, is very full, and intending investors must carefully read the prospectus. We must repeat that the company has no rights in Europe, North America, or Canada, and consequently the purchase price of £270,000 may by some be considered excessive, and the £50,000 left for working capital may, by the same reasoning, considering the vast extent of virgin territory which the company is free to exploit, be considered unreasonably limited. However, the lists do not open until Monday, and it remains to be seen whether the investing public will consider the offer now made sufficiently tempting to justify the directors in proceeding to allotment.

PENNY-IN-THE-SLOT ELECTRIC SUPPLY SYNDICATE (LIMITED).—At an extraordinary meeting of this syndicate held on the 16th inst., resolutions were considered and approved:—(1) altering the name of the syndicate to The Bastian Meter Co. (Limited); (2) adopting an agreement between the Electric Lighting Extension Syndicate (Limited) and the Penny-in-the-Slot Electric Supply Syndicate (Limited) for the purchase of the whole of the undertaking of the former; (3) making 3,000 shares of £1 each, not already subscribed for or issued (Nos. 17,501 to 20,500), into Six Per Cent. Preference shares, such shares to participate *pro rata* in any surplus profits after the holders of Ordinary shares have been paid a dividend of 7½ per cent., and providing, in the event of the company being wound up, that the surplus assets shall be applicable to the repayment to the holders of these Preference shares the amount paid up thereon. The Company is not to create further Preference shares to rank with those now created, or to issue debentures, without the consent of a majority of the holders of these Preference shares. From a report of the proceedings at the meeting, which has been supplied to us, we learn that the managing-director, Mr. C. Orme Bastian (in the absence of the Chairman) presided, and, after an explanation of the object of the resolutions, these were put to the meeting, and carried.

SCARBOROUGH ELECTRIC SUPPLY CO. (LIMITED).—The ordinary general meeting was held on Thursday last at Scarborough. The chairman (Mr. G. Alderson-Smith) said that they had made steady progress during the year. They had not gone by leaps and bounds, but their increase had been remarkably steady. In 1896 they had 17,700 lamps, in 1897 20,000, and in 1898 22,000. Their receipts in 1895 were £3,466; in 1896, £4,383; in 1897, £5,179; and in 1898, £5,442. Their profits were, in 1895, £937; in 1896, £1,617; in 1897, £1,845; in 1898, £2,332. Their dividend was 4½ per cent. in 1896, 5 per cent. in 1897, and they proposed now to pay 5½ per cent. In 1896 they carried forward £143, in 1897 £188, and in 1898 £368. They must all feel that that showed the good position in which the company stood.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange committee to appoint a special settling day in and to grant a quotation to £200,000 Four and a-Half per Cent. Debenture stock of the *County of London and Brush Provincial Electric Lighting Co. (Limited)*, and to allow the further issue of 5,749 Five per Cent. Perpetual Preference £10 shares and £50,000 Four per Cent. Perpetual Debenture stock of the *City and South London Railway Co.*, £500,000 Three and a-Half per Cent. Preference stock of the *Eastern Telegraph Co., Limited* (in lieu of provisional certificates now quoted), and the further issue of £17,150 Five per Cent. First Mortgage Registered Debentures of *Crompton and Co. (Limited)*, to be quoted in the Official List.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).—The transfer books of this company are closed from the 20th to the 28th inst. inclusive, preparatory to the payment of dividend.

WEST AFRICAN TELEGRAPH CO. (LIMITED).—The half-yearly interest on this company's £300,000 Five per Cent. Mortgage Debentures, due March 1, will be paid by the National Bank of Scotland, 37, Nicholas-lane, E.C. See advertisement.

WEST INDIA AND PAWAMA TELEGRAPH CO. (LIMITED).—The estimated amount of the traffic receipts of this company for the half month ended Feb. 15 is £2,405, against £1,804 in the corresponding period of 1898.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Feb. 18	3,925	+ 398	...	...	...
Blackpool Corporation...	„ 16	129	+ 13	46	17,180	+ 2,496
Blackpool and Fleetwood Co.	„ 18	178	...	7	1,060	...
Bradford Corporation ...	„ 19	288	...	29	7,285	...
*Bristol Trams & Carriage	„ 17	2,595	+ 196	7	17,251	+ 726
City & South London Ry.	„ 19	1,087	+ 36	8	8,894	+ 329
Dover Corporation	„ 18	147	+ 43	46	8,199	...
Dublin United (Southern)	„ 17	637	+ 240	7	4,138	+ 1,312
*Glasgow Corporation ...	„ 18	8,058	+ 1,141	...	...	...
Liverpool Corporation						
Dingle Route	„ 17	442	...	13	7,063	...
Prince's Park Route...	„ 17	298	...	4	1,147	...
Liverpool Overhead Rly.	„ 19	1,297	− 23	8	10,344	− 486
*Sheffield Tramways.....	„ 19	1,275	+ 335	7	8,489	+ 1,714
*South Staffs. Trams.....	„ 17	641	+ 34	7	4,090	− 55

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price Feb. 15.		Price Wednesday, Feb. 22.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Week Ending Feb. 22. Highest.	Lowest.
			TELEGRAPHS					£ s. d.			
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	103	104	103	104	3 16 11	January and July	100½	..
25,000	10	—	Amazon Telegraph	3	4	3	4	—	—	—	—
£125,000	100	5%	Do. 5 per Cent. Debentures	87	93	87	92	5 6 5		—	—
£905,560	Stock	24/0	Anglo-American	67	69	67	69	5 0 0	Feb., May, Aug., Nov.	67½	—
£1,047,228	Stock	30/0	Do. Preferred	119	120	119	120	5 0 0	„ „	119½	119
£1,047,228	Stock	18/0	Do. Deferred	15½	15¾	14½	15	6 0 0	—	15⅜	14⅝
295,151	10	3/0	Brazilian Submarine	16	16½	16	15½	4 4 11	Mar., June, Oct., Dec.	16⅛	16
£75,000	100	6%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	110	114	110	114	4 7 9	June and December	..	..
10,600,000	$100	$2½	Commercial Cable Capital Stock	180	190	180	190	4 4 3	Jan., Apr., July, Oct.	183	..
£1,332,523	Stock	4%	* Do. 4 per Cent. Debenture Stock	105	107	105	107	3 15 2	„ „	106½	106
16,000	10	8/0	Cuba Submarine Ordinary (Deferred)	9½	10½	9½	10½	6 13 4	February and August	10½	9⅞
6,000	10	10/0	Do. Preference 10 per Cent.	17½	18½	17½	18½	5 8 1	„ „	18⅛	18
12,981	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October	..	—
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	„ „	..	—
£80,000	50	4½%	Do. 4½ per Cent. Debentures	104⅞	107⅞	104⅞	107⅞	4 4 1	January and July	—	—
60,710	20	3/0	Direct United States Cable	12½	13⅛	12	12½	5 4 0	Jan., Apr., July, Oct.	12½	12
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	102	103	102	105	4 5 9	—	..	..
£4,000,000	Stock	5%	Eastern Ordinary	179	181	179	184	2 16 4	Jan., Apr., July, Oct.	183	180
£1,295,000	Stock	3½%	Do. 3½ per Cent. Pref. Stock	104	107	104	107	3 5 7	„ „	106½	104
£1,442,260	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	126	130	126	130	3 2 0	May and November	128	127
£89,200	100	5%	* Do. 5 per Cent. Debentures, 1908	99	103	99	102	4 18 0	February & August	..	..
£500,000	Stock	—	Do. Provisional Certificates (all paid)	103	103	104	107	..	—	..	..
250,000	10	2/6	Eastern Extension	17⅞	18½	17⅞	18½	3 16 9	Jan., Apr., July, Oct.	18⅛	17⅞
£120,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	129	125	129	3 2 1	February & August	..	..
£16,200	100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Deb. 1901 (reg.)	99	103	99	103	4 17 1	January and July	..	..
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	..	—
£35,100	100	5%	*Eastern and S. African 5 p.c. Mor. Deb., 1900 (reg.)	99	103	99	103	4 17 1	„ „	—	—
£446,500	100	5%	Do, (Bearer)	100	103	100	103	4 17 1	„ „	..	..
£800,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102	105	102	105	3 17 8	February & August	103	102¾
£300,000	25	4%	Do. 4% Mauritius Sub. Debs. (red.)	104⅞	107⅞	104⅞	107⅞	3 16 2	May and November	..	—
120,237	10	1/9	Globe Telegraph and Trust	18⅜	18½	18⅜	18½	3 17 4	Jan., Apr., July, Oct.	18⅛	12¾
120,043	10	6%	Do. 6 per Cent. Preference	17	17½	17	17½	3 8 7	„ „	17½	17
150,000	10	5/0	Great Northern of Copenhagen	29½	30⅛	29½	30½	3 5 7	January, April, July	29⅛	—
£150,000	100	5%	* Do. 5 per Cent. Debs., 1893 issue Series "B"	101	104	101	104	4 17 7	March & September	—	—
£97,800	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.)	99	103	99	102	4 8 6	June and December	..	—
17,000	25	12/6	Indo-European	58	61	58	61	4 2 0	May and November	58	—
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	109	113	109	113	5 7 7	March & September	..	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red)	105	108	105	108	3 14 5	June and December	—	—
11,339	8	4/0	Reuter's	6½	7½	6½	7½	5 6 8	April and October	..	—
6,281	£100 Cert.	6%	Submarine Cables Trust	138	143	138	143	4 4 11	„ „	141½	139½
15,609	10	—	West African Telegraph	..	..	—	..	..	—	—	—
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	102	103	100	103	4 18 6	March & September	—	—
20,008	2½	—	West Coast of America	½	1	½	1	—	—	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	103	106	103	106	3 15 9	June and December	—	—
88,221	10	1/6	West India and Panama	1⅝	1⅞	1⅞	2	—	May and November	1⅞	1⅝
34,563	10	6/0	Do. 6 per Cent. 1st Preference	10½	10⅝	10½	10⅝	5 11 7	„ „	10⅝	10⅛
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	8½	9⅛	8½	9⅛	6 6 4	„ „	9⅛	—
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	104	107	4 13 6	January and July	..	—
64,269	15	5/0	Western and Brazilian Ordinary	12½	13	12½	13	4 11 3	May and November	..	—
33,129	7½	3/9	Do. 5 per Cent. Preferred Ordinary	8½	8¾	8½	8¾	4 5 8	„ „	..	—
33,129	7½	1/8	Do. Deferred Ordinary	4	4⅛	4	4⅛	—	—	—	—
£389,621	Stock	4%	* Do. 4 per Cent. Debenture Stock	106	109	106	109	3 13 9	June and December	—	—
1,162,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	—	—	—	—	6 7 10	Feb., May, Aug., Nov.	—	—
£158,100	100	6%	* Do. 6 per Cent. Sterling Bonds (red.)	98	103	98	103	5 16 6	March & September	..	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share	Last Dividend	Name	Previous Week's Price Feb. 15.		Price Wednesday, Feb. 22.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Feb. 2?. Highest	Lowest
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	2¾	3¼	2¾	3¼	6 3 1	August	—	—
221,850	10/0	1½d.	Consolidated Telephone Const. & Manufacturing	1/16	3/16	1/16	3/16	6 7 0	July	—	—
28,000	5	4/0	Monte Video Telephone 6 per Cent. Preference	—		..		—	October	—	—
490 000	5	8/0	National	5¾	6⅛	5¾	6	5 0 0	February & August	6 1/16	5 13/16
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	14	16	14	16	3 15 0	" "	16	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	14	16	14	16	3 15 0	" "	15½	15⅝
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	5⅝	5⅞	5½	5¾	4 6 11	" "	5¾	5½
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	100	102	100	102	3 9 0	June and December	101½	101
171,504	1	0/4	Oriental	⅝	¾	⅝	¾	6 13 4	April and October	—	—
58,000	5	6/0	United River Plate	4¾	5¼	4¾	5¼	5 14 3	July	—	—
£151,788	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	101	107	104	107	4 13 11	June and December	—	—
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	—	Bl'ckh'th & Gr'nw'ch D'st'ct Elec.Lt.Ord.(10s pd.)	⅜	⅝	⅜	⅝	..	—	—	—
6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	12½	13½	13	13½	—	—	—	..
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10¾	11¼	10¾	11¼	4 4 0	—	..	..
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	11	12	11¼	12¼	3 4 0	February & August	12¼	11¾
10,000	5	2/3	Do. 4½ per Cent. Preference	6	6¼	6	6¼	3 9 3	" "	—	—
£34,000	5	2/6	Chelsea Electricity Supply Ordinary	9	10	8½	9½	3 3 2	March	..	..
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	114	116	114	116	3 18 1	June and December	..	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red)	103	105	103	105	4 15 8	—	..	—
50,000	10	5/0	City of London Elec. Lighting Ord. 40,001 to 90,000	19	20	18½	19½	6 8 2	February & August	20	18½
10,000	10	1/9	Do. Ordinary 90,001 to 100,000	18	20	18½	19½	..	—	—	—
40,000	10	6%	Do. 6% Cumulative Pref.	15½	16½	15	16	3 15 0	January and July	15½	14 13/16
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	124	129	124	129	3 17 10	June and December	..	..
30,000	10	—	County of London & Brush Prov. Ord. (1 to 30,000)	12	13	12½	13½	—	—	12¾	—
10,000	10	..	Do. (30,001 to 40,000)	12	13	12½	13½	..	—	..	..
20,000	10	6/0	Do. 6% Cumulative Preference	14½	15½	14½	15½	4 0 0	March & September	15½	..
15,660	5	2/6	House-to-House Electric Lighting Supply Ord.	9	10	9	10	2 0 0	—	9¾	—
12,000	5	3/6	Do. 7 per Cent. Preference	9½	10½	9½	10½	3 6 8	March & September	—	—
15,000	5	10%	Kensington and Knightsbridge Ord.	13	14	13	14	3 18 7	—	—	—
10,000	5	6%	Do. 6% 1st Pref.	7½	8½	7½	8½	3 12 9	January and July	..	—
110,000	3	—	London Electric Supply Ordinary	3½	4	3½	4	—	—	4	3 11/16
48,050	5	—	Do. Preference	6½	7	6½	7	—	—	6⅜	6¼
£ 00,000	Stock	..	Do. 4% 1st Mort. Deb.	104	104	104	106	3 15 6	Mch., June, Sept., Dec.	105⅜	10.
62,500	10	5/0	Metropolitan Electric Supply Ordinary	17½	18½	17	18	3 6 8	April and October	17⅞	17¼
27,500	10	—	Do. (£7 paid)	14	15	13½	14½	..	—	—	..
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	118	121	118	121	3 14 7	June and December	—	—
6,452	10	6/0	Notting Hill Electric Ordinary	17½	18½	17½	18½	3 4 10	March	—	—
10,000	5	—	Oxford Electric Ordinary	6¾	7½	6½	7½	—	—	—	..
275,000	1	—	Rand Electric	1	1⅛	⅞	1⅛	—	..	—	..
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb	83	93	83	93	5 8 1	—	—	—
150,000	$100	$2	Royal Electric Company of Montreal Shares	160	180	160	180	4 9 5	—	—	—
130,900	100	4½%	* Do. 4½% 1st Mort. Debs.	107	109	107	109	4 3 9	April and October	—	..
31,980	5	9/6	St. James and Pall Mall Electric Ordinary	16	17	16½	17½	4 2 9	February & August	17¼	15⅝
20,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	" "	..	..
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.)	..		..		..	June and December	..	
65,000	5	..	South London Electric Supply Ordinary (£3 paid).	3¼	3½	3¼	3½	..	—	3 7/16	3¼
79,900	5	5/0	Westminster Electric Supply Ordinary	15	16	15½	16½	3 18 9	March & September	15¼	15⅛
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	2	1/2¾	Brush Electrical Engineering	1⅞	2⅛	1⅞	2⅛	2 16 5	—	—	—
90,000	2	1/2¾	Do. 6 per Cent. Pref. Non-Cumulative	2⅜	2⅝	2⅜	2⅝	5 1 1	—	2 5/16	2 3/16
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	111	115	111	115	3 19 0	February & August	—	..
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101	104	101	104	4 6 7	June and December	..	..
£20,000	5	5/0	Callender's Cable Construction	12½	13½	12½	13½	5 0 0	" "	13	12⅝
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	113	116	113	116	3 17 11	November and May	..	..
300,000	1	9¾	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅝	1⅛	1⅝	5 16 6	—	..	..
150,000	1	—	Chadburn's Ship Telegraph Ordinary	1⅛	1⅜	1⅛	1⅜	—	—	1 5/16	1¼
50,000	1	7½d	Do. 6 per Cent. Cumulative Pref.	1	1½	1	1½	4 16 0	—	—	—
32,098	3	1/6	Crompton and Co. (Nos. 1 to 32,098)	2¾	3¼	3¼	3¾	4 0 0	—	—	—
£82,850	100	5%	* Do. 5% First Mort. Deb. (red.)	98	101	98	101	4 19 8	January and July	—	..
99,261	5	2/1½	Edison and Swan United ("A" Shares) (£3 paid)	2½	2¾	2½	2¾	6 10 9	February & August	2¾	2⅝
17,139	5	3/1½	Do. (£5 paid)	4	5	4	5	6 0 0	" "	4¼	—
£194,023	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	97	99	97	99	4 1 0	June and December	98¼	98
17,400	5	5%	Edmundson's Electric. Corporation Ord (fully pd)	5½	5¾	5½	5¾	4 6 11	Half-yearly	5¾	—
112,100	2	1/2¾	Electric Construction Co. (Limited)	2½	2¾	2½	2¾	4 12 0	January & July	2 7/16	—
25 000	2	2/9¾	Do. 7 per Cent. Cumulative Pref.	3	3½	3	3½	4 0	July	3 5/16	3 1/16
£140,300	Stock	4%	Do. 4% First Mortgage Deb. (red.)	103	105	103	105	3 15 10	January and July	105½	—
91,196	1	—	Elmore's Patent Copper Depositing	½	¾	⅝	⅞	..	—	—	—
12,500	10	8/0	Henley's Telegraph Works Ordinary	25	26	25½	26½	4 13 1	February & August	25½	25⅝
8,000	10	7/0	Do. 7 per Cent. Preference	18½	19½	18½	19½	3 11 10	" "	18¾	—
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	111	116	113	116	3 19 1	" "	—	..
60,000	10	5/0	India Rubber, Gutta Percha, &c., Works	23	24	23	24	4 3 4	" "	23¾	23 1/16
300,000	100	4%	Do. 4% First Mortgage Debentures (red.)	102	105	102	106	3 15 6	March & September	—	..
87,850	12	12/0	Telegraph Construction and Maintenance	38	42	38	42	4 5 9	March and July	41½	40½
£18,400	5	—	Do. Manufacturing Ordinary	8¼	9¼	8¼	9¼	—	—	9⅛	..
13,400	5	..	Do. 5% Cum. Pref.	5½	6½	5½	6½	4 0 0	—	—	—
£10,000	5	4/0	Willans and Robinson Ordinary	8½	8¾	8½	8¾	4 11 5	April and October	—	—
£30,000	5	3/0	Do. 6% Cumulative Preference	7	7½	7	7½	4 0 0	" "	7½	7¼
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	103	105	106	108	3 18 8	May and November	—	—
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	..	Blackpool and Fleetwood Tramways	21½	22½	23	24	..	—	—	—
25,000	10	6%	Bristol Tramways and Carriage xd	23¾	24½	24	24½	2 9 0	—	24½	23¾
25,000	10	6%	Do. (£7. 10s. paid) xd	20½	21	21½	21¾	2 2 8	—	21¾	20¾
£90,410	Stock	4%	Do. 4% Debenture	120	121	120	121	3 6 2	—	—	..
80,000	10	..	British Electric Traction Ordinary	17	18	16½	17½	..	—	17	..
10,000	10	6/0	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm. pd.)	13¼	13¾	13¼	13¾	4 7 3	—	13 9/16	13½
£100,000	Stock	6/2·3	Do. 5% Perp. Deb.	121	123	121	123	4 1 10	—	122¾	122½
40,000	5	..	Buenos Ayres & Belgrano 6% Cum. Pref. (£3 paid).	—		3¼	3½	..	..	3 7/16	3⅜
27,500	5	..	Do. do. do. (fully paid)	—		4	4½	..	..	—	..
£260,000	Stock	5%	Do. do. 5% Deb.	..		107	110	4 11 4	..	..	—
£35,250	10	8/0	Central London Ordinary	9¾	10¼	9¾	10¼	2 18 6	June and December	10¼	9⅞
178,303	10	1/9¾	Do. (£8 paid)	7¾	8¼	7¾	8¼	2 13 2	" "	7 15/16	—
£530,000	Stock	2%	City and South London Railway Con. Ordy.	73	74	71	73	2 18 3	January and July	74	72
22,500	10	..	Do. Ordinary (£5 paid)	4½	5½	5	5½	..	..	5⅝	..
9,251	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	3 5 7	January and July	—	—
£187,701	Stock	4%	Do. 4% Perpetual Debenture	133	135	133	135	2 19 7	May and November	..	—
20,000	10	6%	Imperial Tramways Ordinary	22¾	23½	23	24	2 10 0	March & September	24	23
10,000	10	6%	Do. 6% Preference	15½	16	16	16½	3 11 9	" "	16½	16
£70,000	Stock	4½%	Do. 4½% Debenture	118½	119½	118½	119½	3 15 4	..	—	..
37,500	10	3%	Liverpool Overhead Railway Ordinary	10	10½	10 3/16	10 9/16	3 3 1	February & August	—	—
10,000	10	5%	Do. 5% Preference	14¾	15½	14¾	15½	3 5 7	" "	—	—
125 000	Stock	4%	Do. 4% Debenture	105	108	106	108	3 14 1	January and July	—	—
20,000	5	3/3¾	New General Traction 6% Cumulative Pref	4¾	5½	4¾	5½	5 14 3	—	—	—
£540,000	Stock	3%	Waterloo and City Ordinary	109	112	109	112	2 13 7	June and December	110	—

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

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CONTENTS OF THE CURRENT NUMBER.

NOTES	633	Carbons for Electric Lighting and Other Purposes. By F. Jehl. Illustrated. Continued	648
Meetings of Scientific Societies	635	Correspondence	652
Lincoln Corporation Electric Supply Works. Illustrated	636	American Notes	653
High Wycombe Electric Supply Works. Illustrated	640	Legal Intelligence	654
Physical Society	643	Trade Notes and Notices	656
A MODUS VIVENDI	644	Companies' Meetings and Reports	662
Obituary	645	New Companies, &c.	670
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe	645	City Notes	670
Electricity Works Accounts	646	Companies' Share List	672

NOTES.

IN the February number of the *Nineteenth Century* an all-British cable system is advocated by Mr. ARCHIBALD S. HURD, with the object of connecting a number of strategical points by means of submarine cable landed only on British territory. The cable is to be established by the Imperial and Colonial Governments at a cost of £6,000,000. The carrying out of part of this scheme, affecting the Pacific alone, on similar lines at a maximum cost of £1,800,000, is also urged in an article in *The Times* of February 21. It would be easy to criticise these articles point by point and at considerable length. It may, however, suffice to comment as briefly as possible on the summing up in the *Nineteenth Century*: "Finally, the advantages of this great scheme would be these: (1) The cable would be State-owned; (2) the present tax on intercommunication would cease, since the State would do all in its power to foster business; (3) the empire and its distant outposts would be in close connection, without fear of foreign interference: (4) all the more important coaling stations, except Malta and Gibraltar, would be linked to the War Office and the Admiralty by a double route." Such a scheme might well be objected to on many grounds, including those of justice, necessity, efficiency, economy and policy.

THE great majority of us can see the injustice of local authorities competing with their ratepayers in private enterprise, and it is not easy to differentiate such action from that of competition by the State with private capital, which has created a network of submarine lines connecting nearly all the important ports of the globe. Such an opposition might go far to render valueless nearly forty millions sterling, sunk in providing the world with under-sea electrical communication. Then, again, is not such State action, which could only be justified on very strong grounds affecting the welfare and safety of the empire, entirely unnecessary? The past history of cable enterprises abundantly proves that the policy of Cable Companies has been to lay additional lines even in advance of requirements from a commercial or strategical points of view. Further, is there any justification for thinking that the Imperial and Colonial Governments would establish and maintain cable communication more efficiently than private enterprise, which was the pioneer of submarine lines and has now had nearly fifty years' experience of everything connected therewith. It may also be said emphatically that long stretches of single or even duplicate cables afford no security for uninterrupted communication even in time of peace. To lay, in the sight of all the world, from 16,000 to 22,000 miles of single lines far distant from those tracks of commercial shipping, which would have to be patrolled by our cruisers in time of war, and then call these connecting links strategic cables must strike anyone who understands the subject as an utterly fatuous policy.

Next, would such State action be politic? It is clear that private enterprise would be chary about making extensions required for commercial or Imperial purposes, if liable to State competition. It may, however, be said that many of the difficulties here stated might be got over by Government acquisition of all cables laid by private enterprise; but is it reasonable to suppose that foreign countries would allow cables already landed on their shores, which are absolutely necessary to International commerce, to be worked by the British Government?

MR. HURD states that "the present tax on intercommunication would cease;" but it does not appear that messages are to be carried free, as, according to the article in *The Times*, it is proposed to reduce the rates to Australia, for instance, about one third; and it would remain to be seen whether the new lines would earn interest and working expenses in competition at such tariffs. Again, it is surely not to be imagined that Powers at war with us would abstain from cutting cables at sea, *because* they were landed on British territory or even because considerable lengths of such sections were in deep water; and then what becomes of the statement that "the Empire and its distant outposts would be in close connection *without fear of*

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foreign interference"? The italics are *not* Mr. HURD's. The whole question of cables in time of war was dealt with by Sir JAMES ANDERSON many years ago, and he pointed out then that wherever cables can be repaired, which is practically wherever they are laid, they can be more easily cut; and that the only security lies in having so many routes that all cannot be interrupted at once. There, and in cables laid secretly during or immediately before hostilities, lies in a nut-shell the question of strategic cables. Further, secrecy as to the cables which continued working or had been repaired would go far to baffle an enemy. Lastly, and this is an argument which requires to be very carefully weighed, such State action would destroy the international character which submarine cables have hitherto borne and would greatly intensify the desire of all the principal Governments to have cables of their own not landed on the territory of any other great power.

LAST Friday evening, Prof. LODGE delighted a large audience at the Royal Institution, with an experimental demonstration illustrating the effect of electrical waves upon metals, in "light contact." The title of his discourse was simply "Coherers," a matter of special interest in these times, when wireless telegraphy has become really practical. Prof. LODGE expressed some surprise that everyone should be so interested in wireless telegraphy, and should look upon it as in any way a new invention. He pointed out with characteristic humour that in ancient times wireless telegraphy was the only means of sending signals from one place to another, for men could shout then as they can to-day, and could reflect sun flashes by means of mirrors.

ONE striking result shown on Friday consisted in the arranging of two soap bubbles side by side, in such a way that they were almost in contact. Upon making "an electrical splash in the ether," the two bubbles flew together and united to form one large single one. A similar experiment was also shown with mercury beads which were just covered with a layer of oil, and almost in contact with one another. Attraction was shown to exist between metallic particles placed in light contact and washed by electromagnetic waves, the work of MINCHEN, BRANLEY and others being referred to. Perhaps the most striking of these experiments was a modification of one recently made by TOMMASINA (*The Electrician*, January 13, 1899, p. 398); a chain of filings was picked up by a metal rod when an influence machine was turned in the neighbourhood. The lecturer appeared to regret that his electro-physiological speculations with regard to the real nature of sight should not have met with a better reception by the medical profession. He showed, however, that in some ways our eyes behave for ether waves very much like a coherer does—for instance, the impression upon the retina only remains for a short time, and, perhaps, is then "tapped back" in some mysterious manner, just as has necessarily to be done mechanically in the case of the coherer. In conclusion, Prof. LODGE expressed the opinion that the forces we know least about in physics are cohesion and gravitation.

WE publish this week a letter from Mr. MILES WALKER explaining that he was in error when, at the last Institution meeting, he stated that in a British Association Paper the use of accumulators for "picking up" at the surface studs had been referred to by Prof. SILVANUS THOMPSON, in describing the system of traction associated with his name. No mention that accumulators are used is made in the actual Paper, although the fact was alluded to at the time the Paper was read. Another letter, from the pen of Prof. AYRTON, calls upon us to withdraw our criticisms on his speech at the recent discussion, apparently on the ground of Mr. WALKER having been in error. Mr. WALKER's error has but little to do with our criticisms, and we still maintain that careful perusal of Prof. THOMPSON's Paper would have indicated the necessity for a picking-up device, such as a small accumulator on each car, although we were certainly wrong in implying that it must necessarily assume that form. It should not be overlooked that the B. A. Paper was not intended to indicate every detail of the system, for in the concluding paragraph it is stated that "there are a number of practical details for which the authors have no room here." Moreover, we submit that no one could reasonably have inferred from even the bare text of the Paper that the system possessed in real life the defects so grotesquely pictured by Prof. AYRTON in his speech.

THE London Electric Supply Corporation (Limited) are to be congratulated on the satisfactory character of the report presented at a meeting of the shareholders yesterday. This is the first report since the undertaking emerged from the hands of the receiver. A report of the proceedings will be found in another column. By writing down the Ordinary shares from £5 to £3 some time since items of capital account amounting to £181,688 had been written off, leaving the capital account at £736,521. The past half-year shows a working profit of £13,535, against £10,471 during the corresponding half year in 1897.

Cable Interruptions.	Date of Interruption.
Dakar—Bathurst	Feb. 9, 1899
Paramaribo—Cayenne	Feb. 10, 1899

American Cable to Hawaii.—It is stated that the American Sundry Civil Appropriations Bill includes £50,000 towards the cost of construction, by the Government Department, of a cable to Hawaii. An additional £400,000 will be available when required.

Electric Power Transmission.—According to the *Electrical World* of New York, surveys have recently been made near Granite Falls, Washington, for a water power electric transmission system which is likely to be installed by the Monte Cristo Railroad Co. A dam across the south fork of the Stillaguamish river was one of the principal points in the work. It is proposed to operate the street railway, the manufacturing plants and the city lights in Everett, Wash., from the projected scheme, the cost of the installation of which, it has been estimated, would be repaid by the saving of fuel in three years.

Storage Battery Competition.—The following is a list of makers who had entered, up to January 31, for the storage battery competition promoted by the Automobile Club de France, as mentioned in *The Electrician* of January 6 last:—Société Anonyme pour le Travail des Metaux (Chloride cell), Compagnie Générale Electrique (Pollak cell), The French, Belgian and English Tudor Companies, Vereingte Accumulatoren und Elektricitäts-Werke, Société Cruto (Pescetto cell), Lagarde, F. Wueste, Blot-Fulmen, the Fulmen Co., the

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Phénix Co., G. B. Marzi, Compagnie Générale d'Electricité (Pulvis cell), John P. Hathaway (Hatch cell), Société des Soudières Electrolytiques, and Franz Heimel (Titan cell).

New German Telephone Tariff.—A new tariff for telephone subscribers is to be introduced by the Telegraph Administration of the German Government. It recognises the fact, which is so often overlooked by the public in this country, that the greater the number of subscribers to a telephone system the greater is the cost of erection and maintenance per subscriber, and, in consequence, the greater must be the subscription rates. In return for the higher rates the subscriber has, of course, the facility of obtaining connection with a greater number of other subscribers. The new German tariff includes the payment of a sum down per year, and a second sum according to the number of three minute conversations indulged in. The first rate is fixed at £3, £3. 15s., £4. 10s. and £5 for areas having 1,000, 5,000, 20,000 and above 20,000 subscribers respectively. In addition, £1 is to be paid for the first 500 conversations, 15s. for every additional 500 up to a total of 1,500, 10s. for every additional 500 between 1,500 and 5,000, and over 3,000 a sum of 10s. pays for any further number of conversations. Thus, the minimum cost of a telephone is £4, and the maximum £9. 10s. per annum. The tariff will be revised every three years. Extra has, of course, to be paid for trunk connections, but these fees are also much lower than in this country:—Up to 31 miles, 3d.; 62 miles, 6d.; 310 miles, 1s.; 620 miles, 1s. 6d.; and for greater distances, 2s.

Accidents to Trolley Cars on Railway Crossings.—Numerous accidents have been occurring of late in America, at places where trolley cars cross railway lines by level crossings. At Scranton, Pa., a motorman ran his car through the gates at a railway crossing and it was struck by a goods train, one of the 14 passengers on the car being fatally injured. From San Francisco comes the story of a narrow escape: a train of two coupled street cars was stopped on the tracks of the Southern Pacific by an accident to the electrical apparatus while crossing. In this instance the passengers, over 100 in number, left the cars, and the men of the party were able to push them across the tracks, just in time to avoid a collision with an approaching train. At Indianapolis recently, the trolley left the wire while a car was crossing the tracks of a steam railway, and the car stopped directly in front of an approaching train. By an emergency application of the brakes the train was stopped within four feet of the car which was filled with passengers. It so happened that the brake leverage on this particular train had been increased a short time previously and a quicker stop was made than would otherwise have been possible. The *Street Railway Review*, looking at the matter from a commercial rather than a humanitarian point of view, advocates interlocking signalling devices, for "in any of these cases there might have resulted an accident to settle the damage claims arising out of which would have paid for the installation of several interlocking systems."

The New Peloux Meter.—A motor meter in which the coils are fixed is described in the *Industrie Electrique* of January 25th. It consists of two larger fixed coils, through which the whole current passes, and four smaller coils, each of 3,000 ohms resistance, also fixed, and arranged in pairs. These are connected to the commutator, so that a shunt current traverses, each in turn, according to the position of the brushes in relation to the commutator. The larger coils are vertical, on a horizontal axis, and the smaller ones are horizontally placed about the vertical spindle of the meter as centres. Two Z-shaped pieces of iron, corresponding to each smaller pair of coils, are fixed on the spindle, the arms of the two Z's being at right angles to one another. The body of the Z in each case passes through the centre of the coils, and the arms, therefore, project horizontally just above and below each pair of coils. The connections of the coils to the commutator are so arranged that the successive magnetisation of the iron arms cause the larger fixed coils to produce a continuous rotation of the spindle, and the speed depends on the power, since the larger coils are series ones, and the smaller, or magnetising ones, shunts. The commutator, which is of silver, is fixed and the brushes revolve. The usual Foucault brake is employed. Tests made on the same meter, with pressures of 120 and 130 volts, and currents from a half to 10 amperes, showed that the meter was absolutely accurate, from 2 to 10 amperes, the errors at 0·5 ampere being −3·5 and −1·4 per cent. respectively for each of the two pressures, and at one ampere −0·3 and +2·4 per cent. The loss at no load is stated to be the same as for Thomson meters for the same maximum power, and the loss in the main coils somewhat less. The 10-ampere size absorbs 8·5 watts at full load, and the Thomson 10 watts under the same conditions.

Municipal Trading.—The following memorial has been addressed by the Council of the Society of Arts to the Home Secretary:—

SIR: The Society for the Encouragement of Arts, Manufactures and Commerce have been giving very careful consideration to the increasing tendency of municipal and local authorities to embark in trading enterprises which may be in competition with, or to the exclusion of, private enterprise, and they have had forcibly impressed upon them the fact that as yet no limitations have been defined as to what enterprises should, in the general interests of the nation, be undertaken by municipalities and local authorities, and what ought to be left to private effort.

They, therefore, venture to approach you in the hope that you may see fit to advise Her Majesty to appoint a Royal Commission to consid r the whole subject, and to lay down the principles and limitations on which Parliamentary powers should be granted to municipal and local authorities. They further venture to submit that until such Royal Commission has investigated the subject and reported thereon, no further powers for trading purposes ought to be granted to such bodies.

At the instance of the Liberty and Property Defence League the following petition to both Houses of Parliament has been signed by railway, tramway, gas, engineering, electric lighting, water, &c., companies, by chambers of commerce, and by the associations of employers, traders, property owners, and ratepayers throughout the United Kingdom:—

"That, inasmuch as numerous local Bills are now before Parliament containing further and novel provisions for municipal trading, to the risk of ratepayers, the injury of traders, the checking of private enterprise, and the arresting of national progress, it is desirable, before such provisions are sanctioned by the Legislature, that a Committee of both Houses, or a Royal or other Commission, be appointed to define the extent to which municipal trading should be sanctioned by Parliament; and that meantime all provisions in local Bills for the extension of municipal trading should be suspended until such Committee or Commission has reported thereon. And your petitioners pray that your honourable House may be pleased to appoint a Special Committee, or to obtain the appointment of a Royal or other Commission, to define the extent to which municipal trading should be sanctioned by Parliament, and that your honourable House will meantime postpone the consideration of all provisions in local bills for the extension of municipal trading until such Committee or Commission has reported thereon."

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, March 3rd.

INSTITUTION OF JUNIOR ENGINEERS.

8 p.m. Meeting at the Westminster Palace Hotel, when Mr. W. R. Cooper will read a Paper on "Carbon Consuming Batteries and their Possibilities."

SATURDAY, March 4th.

INSTITUTION OF ELECTRICAL ENGINEERS.

10 a.m. Students' visit to Messrs. Easton, Anderson and Goolden's Works at Erith, Kent. Train leaves Charing Cross at time stated.

THURSDAY, March 9th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Subject for discussion not yet announced.

FRIDAY, March 10th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Papers to be read: (1) "A Study of an Apparatus for the Determination of the Rate of Diffusion of Solids Dissolved in Liquids," by Albert Griffiths; (2) "Note on the Source of Energy in Diffusive Convection," by Albert Griffiths; (3) "An Exhibition of Dr. Wehnelt's Electrolytic Current Interrupter for Ruhmkorff Coils," by A. A. Campbell Swinton.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Measuring Extreme Temperatures," by Prof. H. L. Callendar, F.R.S.

SATURDAY, March 11th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture V.—"The Mechanical Properties of Bodies," by the Right Hon. Lord Rayleigh, F.R.S.

INSTITUTION OF JUNIOR ENGINEERS.

7 p.m. Conversazione at the Westminster Palace Hotel. Reception by the President, Sir W. H. White and Lady White.

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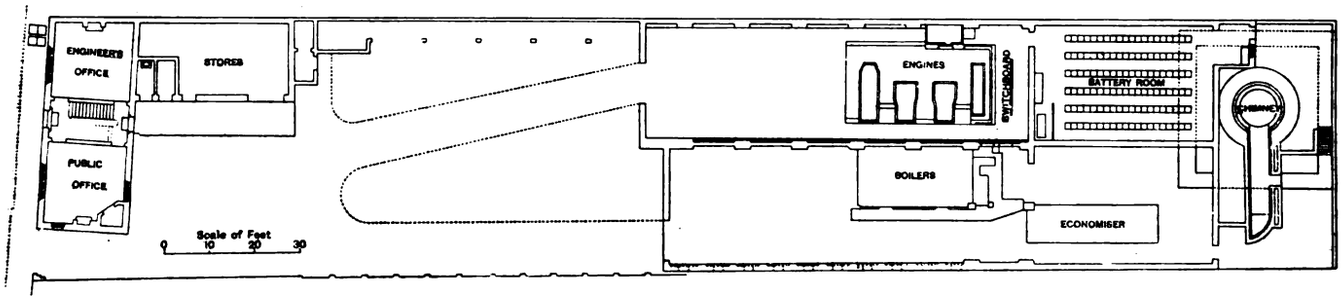
LINCOLN CORPORATION ELECTRIC SUPPLY WORKS.

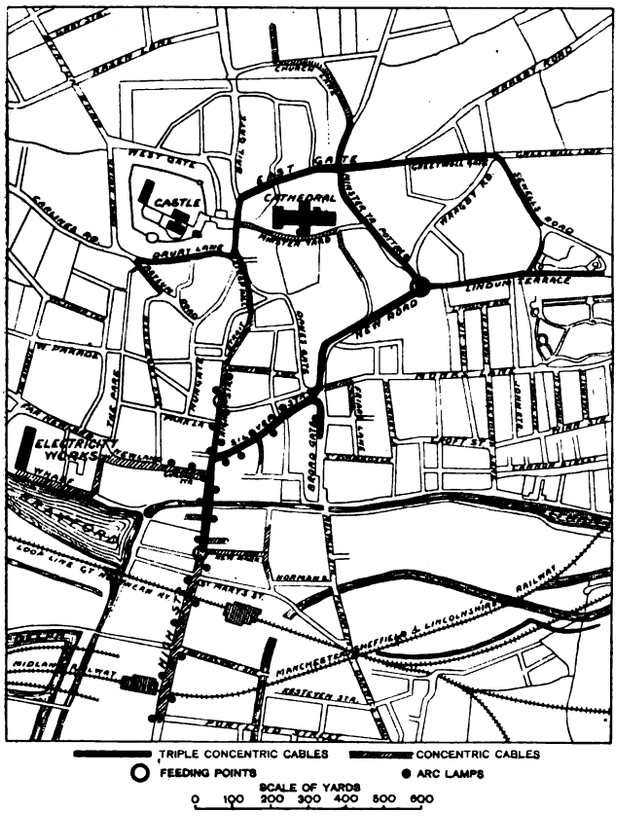
The electric supply works erected by Lincoln Corporation commenced regular supply on December 20th last, although at that date the works were not really completed. So numerous have been the applications for current that, even at the present time, considerable extensions are being projected, and powers to expend an additional £19,000 on works have been acquired. As the original scheme is now practically completed, the present is a favourable moment for giving our readers some description of the works. We may commence with a short summary of the history of the undertaking. In the early days the city of Lincoln exhibited its interest in electrical affairs by strenuously opposing every attempt made to obtain Provisional Orders by local capitalists, but in 1896 the Corporation engaged the late Dr. John Hopkinson to advise as to the establishment of a municipal electricity works. Dr. Hopkinson was not unfavourable to the project, and drew up a scheme, together with plans for the works, which have been carried out. In selecting a city electrical engineer the choice fell on Mr. C. S. Vesey Brown, who at that time was borough electrical engineer at Sunderland. Royal assent having been given in 1897 to the Corporation's Provisional Order, tenders were invited from various firms and active work very shortly afterwards commenced.

The generating station is favourably situated on the north bank of Brayford, a sheet of water formed by the junction of the River Witham and the Fosse Navigation, this water affording an excellent service for the condensers and boiler feed. The position of the power station with respect to the principal streets in the city is indicated in the accompanying map, which also shows the mains which have at present been laid, and the lamps which have been erected for public lighting. The site acquired for the station covers about 2,000 square yards, and has been acquired with a view to constructing a 4,000 H.P. station, a capacity which is calculated to satisfy all prospective requirements of the city for several years to come. The Electricity Committee and their engineer are, in fact, to be congratulated in having made ample provision for future demands. The system of generation and supply is the continuous-current low-pressure three-wire system, with batteries at the generating station. It will be noticed that the present area of supply is one of comparatively small radius, affording a compact district well suited to the system selected.

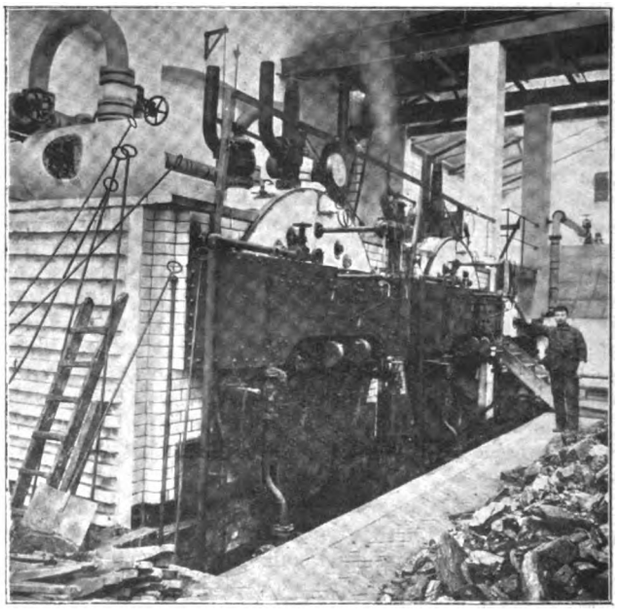
The general arrangement of the machinery room, the boiler house, battery room, &c., is shown in the accompanying plan of the works. The engine house is some 25ft. wide by 85ft. long, and at present contains three direct-coupled high-speed generating sets, each rated at 50 kilowatts capacity, but built to give on emergency an output of 66 kilowatts each. These sets consist of Willans central valve high-speed engines,



LINCOLN CORPORATION ELECTRIC SUPPLY WORKS. PLAN OF GENERATING STATION.



MAP OF LINCOLN CORPORATION ELECTRIC SUPPLY WORKS, SHOWING MAINS, STREET LAMPS, &C.



LINCOLN ELECTRIC SUPPLY STATION BOILER HOUSE.

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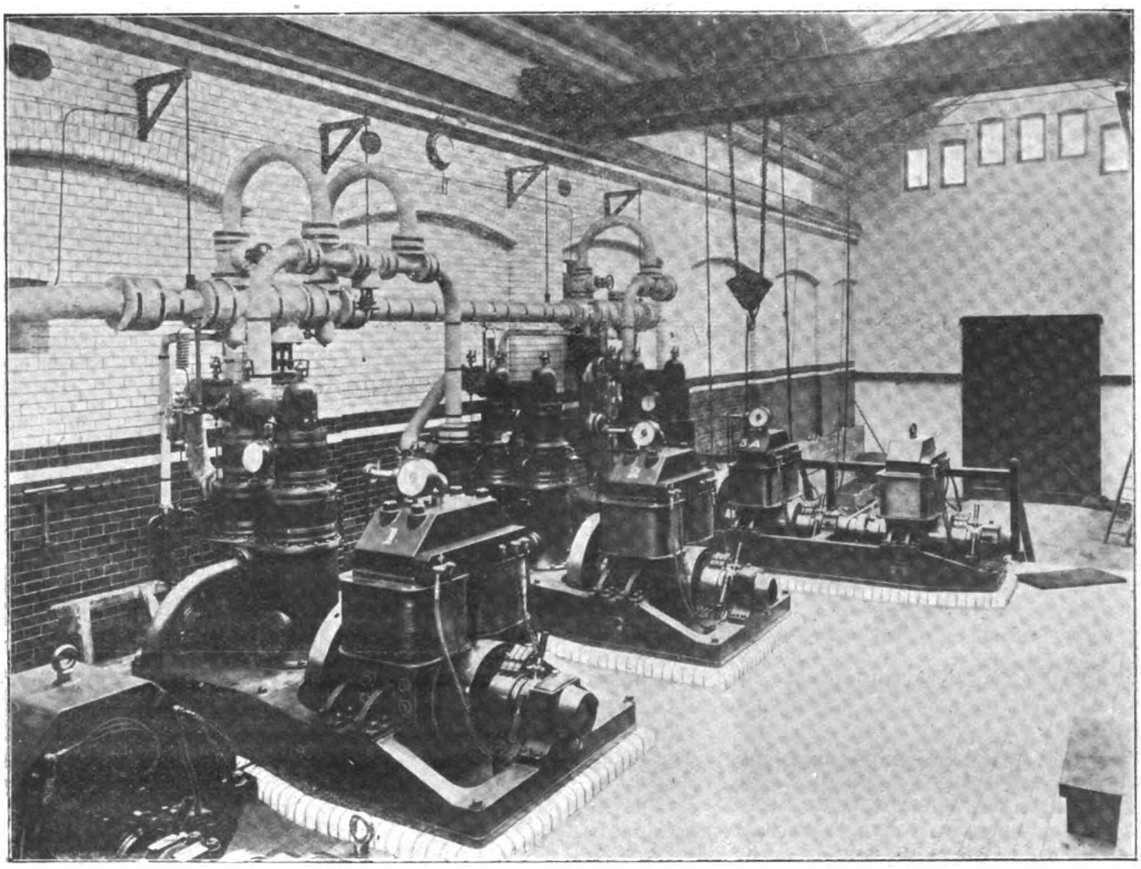
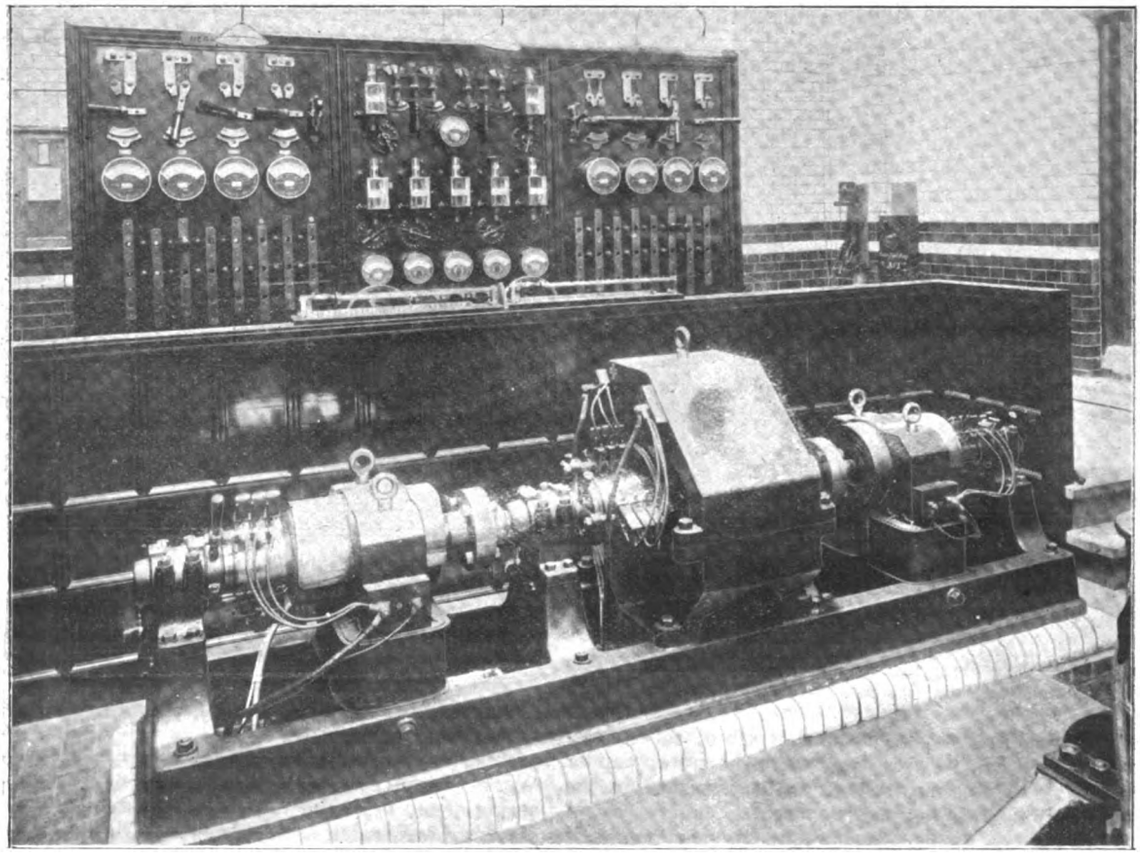


LINCOLN ELECTRIC SUPPLY STATION MACHINERY ROOM.



LINCOLN ELECTRIC SUPPLY STATION. BOOSTER AND SWITCHBOARD.

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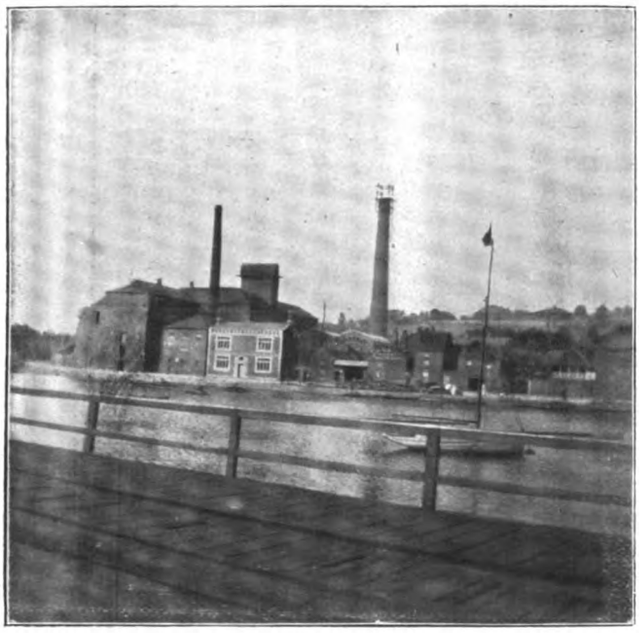
direct-coupled to continuous-current two-pole dynamos, built by Messrs. Laurence Scott and Co., of Norwich. One of the sets has its dynamo divided into two separate generators, so as to serve as a balancing set, this arrangement of three similar sets (with the balancer) being adopted with a view to rendering spare plant unnecessary. There is, in addition, a booster for charging the end cells of the batteries, which also



View of Generating Station from Brayford.

Erecting Arc Lamp Poles.

may be used on the Kennedy system of switching as installed at the Carlisle electricity works, described in *The Electrician*, December 23, 1898, p. 294. A 6-ton hand travelling crane traverses the entire length of the engine room. At one end of the machinery room is a serviceable switchboard, equipped with Weston ammeters and Kelvin voltmeters. The shunt

Trenching, &c., for Cables and Street Poles.

Cable Laying in High Street.

regulating resistances are placed on the rail of the switchboard platform, and consist of resistances in the subway under the platform. A Kelvin ampere-hour meter is placed in the circuit of each dynamo to register its output.

The battery room is at the rear of the machinery room, and is of the same width, forming an extension about 40ft. in length. It contains at the present time 240 cells of the Chloride "E" type, with 17 plates in glass boxes. These cells are capable of discharging at a maximum rate of 150 amperes. There is a small motor dynamo in the battery room for charging up or "milking" the weak cells.

The boiler house is adjacent to the machinery room, and measures 26ft. wide and 80ft. in length, excluding the economiser section, which is at the rear of it. Two boilers are of the dry-back marine type. Each boiler is 12ft. long by 8ft. 6in. in diameter, and supplies steam to a ring main. The steam pipes consist of straight lengths of lap-welded steel, with steel flanges screwed and brazed. The T-pieces are of cast-iron, and at each T there is a drain pocket to which is attached a steam trap, thus providing each section of the main with its own drain. For the feed-water the arrangements are in duplicate throughout—*i.e.*, there are two feed pumps, supplied by the Blake and Knowles Steam Pump Works (Limited). One of these is of the duplex, direct-acting, steam type, and the other is a three-throw pump, direct-driven by a Norwich enclosed motor. All the feed-water passes through a filter before entering through a furnace economiser. The economiser consists of 96 tubes arranged in 12 rows, constructed for a working pressure of 140lb., and tested to 350lb.

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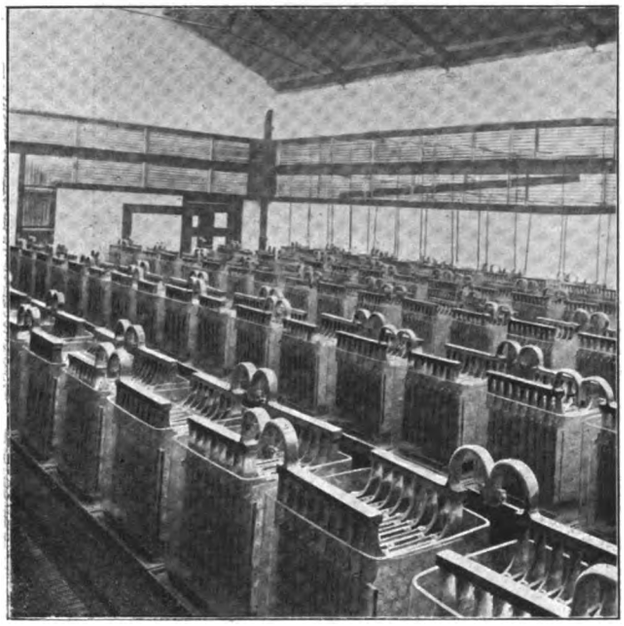
Over the space occupied by the pumps and part of the boiler space is a large cast-iron tank of 8,000 gallons capacity. A centrifugal pump driven by an electric motor delivers water into this tank, from which the water descends through three ejector condensers, one of which is fitted to each of the engine sets. These condensers maintain a vacuum of 26in. at full load.

A few words may be said about the network of mains.



Lincoln Electric Supply Station Battery Room.

There are three feeding points, viz., at Cornhill, Corporation-street, and Potter Gate, feeding the network consisting, at present, of about 4⅓ miles of frontage. Wherever a heavy demand was anticipated, or where supply is only on one side of the road, triple concentric cables have been laid. In all other places the cables are concentric. Throughout the system distributing cables are of ·075 sq. in. section of copper. The whole of the cables were supplied by Callender's

Cable Drum Carriage, as Designed by Mr. C. S. Vesey Brown, for use at Lincoln.

Cable and Construction Co., being laid on what is known as their solid system, *i.e.*, a wooden trench, made of timber well soaked in Stockholm tar, was constructed, and the cable laid in this trench, bitumen being run in to a thickness of about ¾in. At street crossings, under wood pavement, and at various important junctions cast-iron pipes for drawing in have been provided. One of our illustrations shows a cable drum carriage, designed by Mr. C. S. Vesey Brown, for transporting drums of cable from the railway siding to the trenches. By means of this drum carriage it has been found quite possible to take a three-ton drum straight from the station to the trench, and to reel off the cable without having to touch the drum at all. The carriage is provided with efficient brakes enabling drums to be taken up or down hills of very heavy gradient; and, in fact, at Lincoln, some parts of which are very hilly, the carriage has been in constant use on gradients as severe as 1 in 7 or 8. Another feature is that by removing the bar at the rear end of the carriage, this bar being so fixed as to brace the back wheels together, any drum which may be lying by the roadside may be picked up at once and carried away, or, if desired, the cable may be reeled off. We may add that the carriage was made by Messrs. J. and J. Bescoby, a local firm of coach and waggon builders. The middle conductor of the three-wire system is earthed at the station through a recording ammeter, an arrangement generally found to reduce leakage to a minimum, and to enable faults to be immediately detected when they occur.

For the street lighting 30 arc lamps have at present been erected, together with a number of incandescent lamps for use after 11:30 p.m., when the arcs are turned off. The arcs are carried in some cases on pillars, and in other cases on brackets. In the wider parts of the streets, such as High-street and Guildhall, Jandus enclosed arc lamps are used. The remaining arc lamps are of the open type, built by Messrs. Crompton and Co.

One of the most interesting pieces of work carried out in connection with the electrical supply at Lincoln has been the supply of current for driving the bellows of the new large organ in the magnificent Minster, of which the city is justly proud. This work has been carried out by Messrs. Bergtheil and Young. The organ having three wind pressures, three electric motors of 3, 1½, and ¾ H.P. respectively have been placed in the triforium, each motor driving an independent set of bellows. These motors are practically noiseless, and occupy but little space. The wires conveying the current to the organ motors enter the Cathedral under the vestry, and are laid mainly underground, direct to a position close to the key-boards. From this controlling point they are divided into three sets, the whole being under the absolute control of the organist, who is able to start or stop each motor by a simple movement of a switch. Immediately the motors are started wind is available, and by an automatic device fixed on the bellows the motors run faster or slower, according to the volume of wind consumed. It may be of interest to state that as supply for these motors was not ready on Nov. 17, when the opening service in connection with the new organ was held at the Minster, the organ on that occasion had to be blown by 12 soldiers, under the command of a sergeant, a fact which indicates that a considerable amount of work is required to operate this musical instrument.

Following is a list of the contractors for the Corporation electricity works:—

Buildings and chimney	Wright and Sons.
Cast iron works and roof.....	W. Foster and Co.
Boilers	Ruston, Proctor and Co.
Engines, dynamos, motors, &c.	Laurence, Scott and Co.
Switchboard	Nalder and Hilton.
Accumulators	Chloride Electrical Storage Syndicate.
Cables	Callender's Cable and Construction Co.
Arc lamps	Crompton and Co., and Jandus Arc Lamp Co.
Arc lamp pillars	Macfarlane and Co.

In conclusion, we may say that the price of supply has been fixed at 6d. per unit for the first hour's average maximum demand and 2½d. per unit for all beyond that consumption, accounts being rendered quarterly. There are no meter rents. As we have already stated, the success of the supply has been so pronounced that extensions are in active preparation. At the present moment tenders are in hand for 400 kilowatts of extension plant, including two new boilers together with extensions of mains, which will increase the length of frontage from 4⅓ miles up to about 10 miles. The whole of the work, since the initiation of the scheme up to the present time, has been carried out under the direction of the City electrical engineer, Mr. C. S. Vesey Brown, to whom we are greatly indebted for the illustrations and particulars included in this descriptive article.

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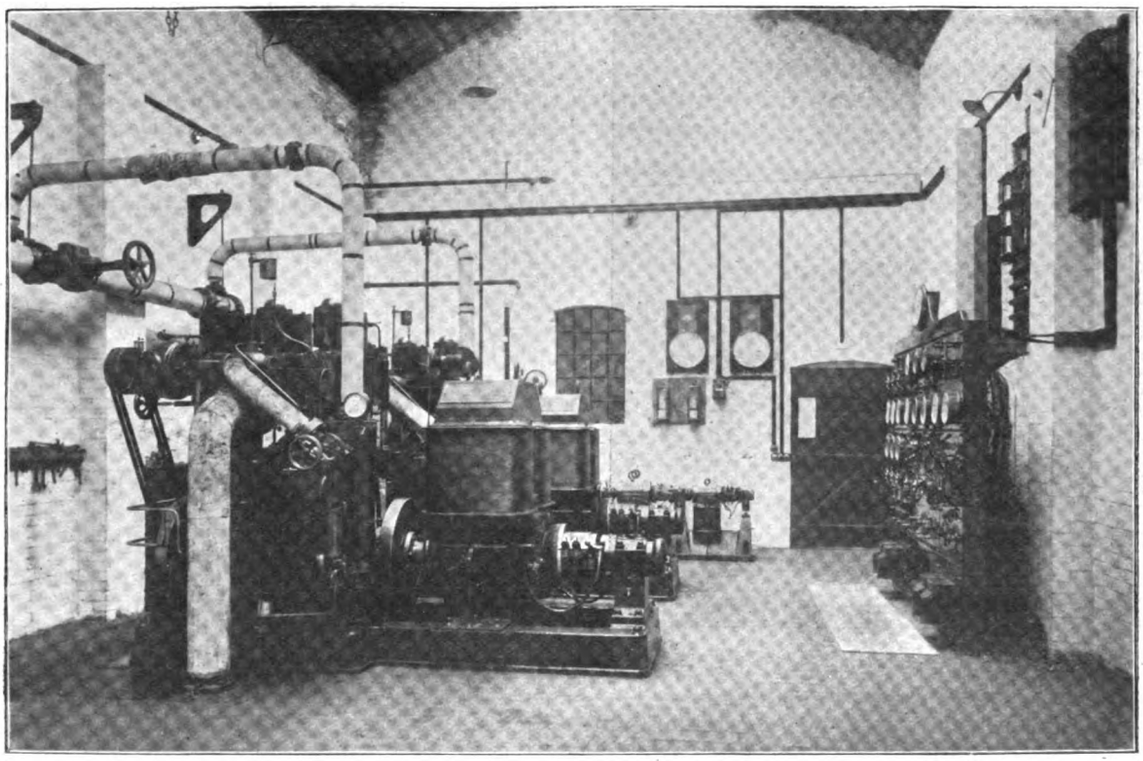
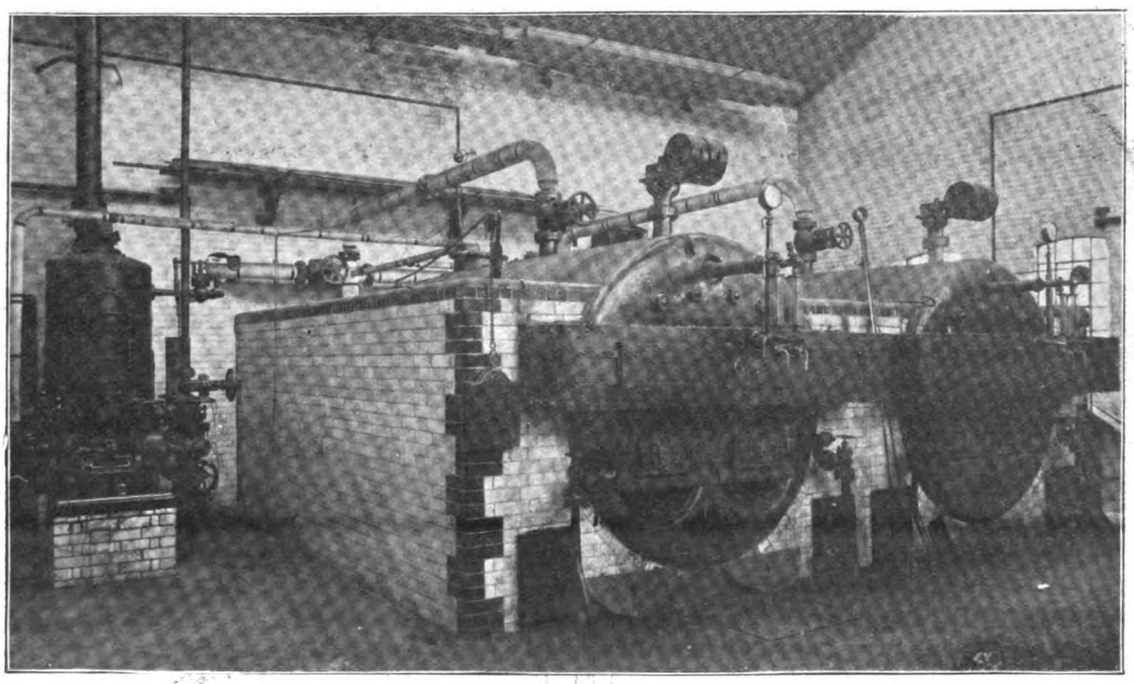
WYCOMBE ELECTRIC SUPPLY WORKS.

Wycombe, some six or eight miles from Maidenhead, is a small town in Buckinghamshire with a population of about 22,000, and is, perhaps, best known through its position in the chair industry, there being over 90 factories engaged in chair making and the allied trades. The Wycombe Corporation obtained a Provisional Order in 1894, but not being in a position to make use of it themselves, they decided to transfer it to a local company, and after negotiations with several people, they finally agreed to part with it to the Wycombe (Borough) Electric Light and Power Co. (Limited), which had been formed by Edmundson's Electricity Corporation. One of the provisions of the transfer was that the Council should adopt electricity for street lighting, and as a consequence the whole of the streets are lighted by this means, there being about 200 incandescent and 5 arc lamps. The Town Hall and police offices are also electrically lighted under the same agreement. Another clause arranges for a somewhat unusual system of "free" wiring. The company is



WYCOMBE ELECTRIC SUPPLY WORKS. INTERIOR OF THE MACHINERY ROOM.



WYCOMBE ELECTRIC SUPPLY WORKS. INTERIOR OF BOILER HOUSE.

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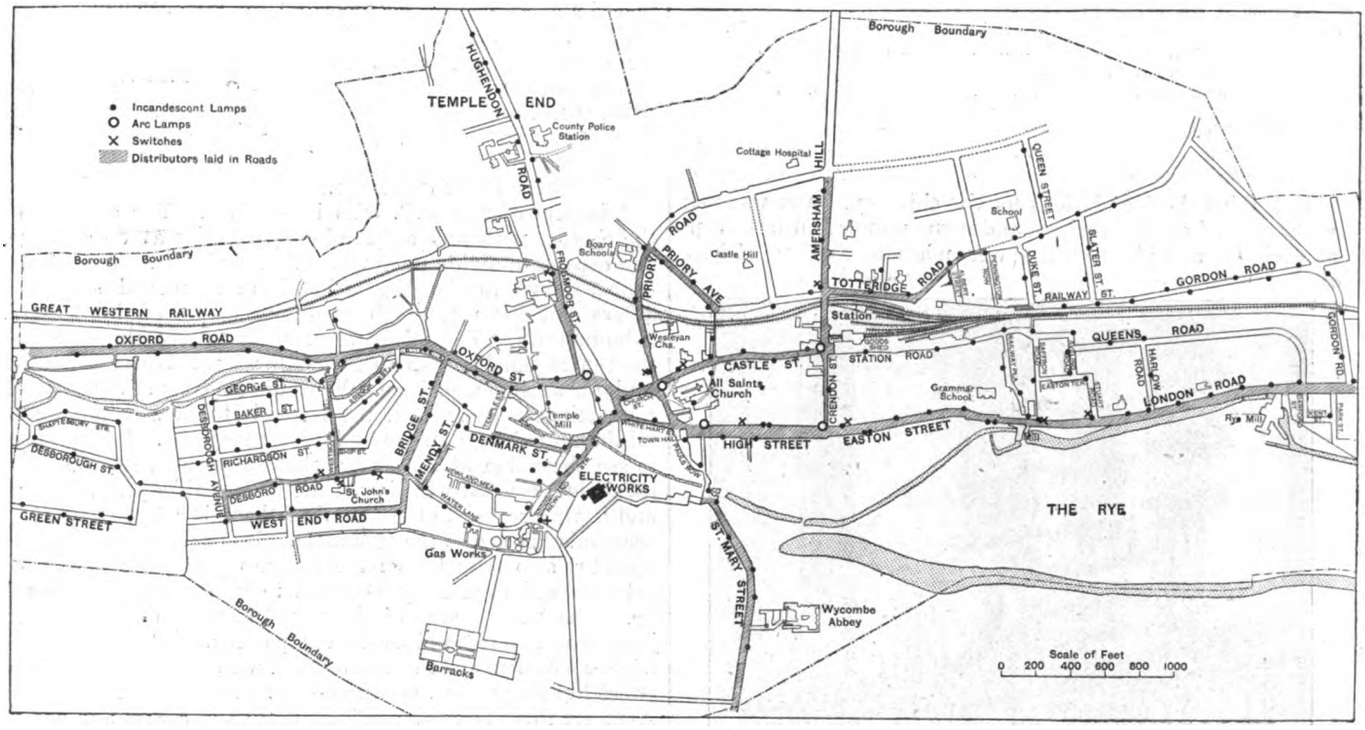
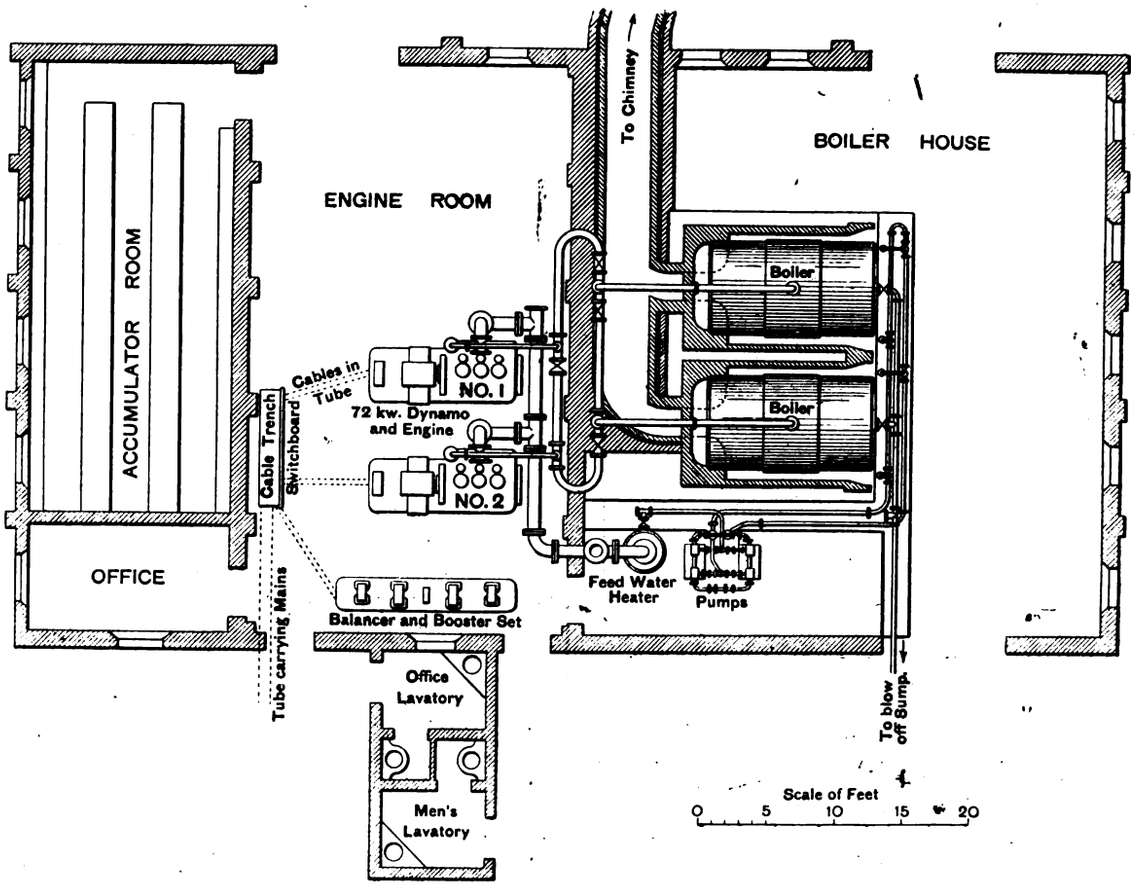
compelled to wire any premises free of initial charge and to accept payment at the rate of 9d. per lamp per quarter until the cost is worked off, no interest on the money expended being allowed. It is expected that this will cause a number of the smaller class of houses, which includes the majority in Wycombe, to adopt the electric light. The company are also offering arc lamps and motors on hire at easy rates.

As is seen in the accompanying map, the generating station is centrally situated, and the site being three-quarters of an acre in area, there is ample room for extensions. The price of coal in the neighbourhood is reasonably low. Messrs



MAP OF WYCOMBE, SHOWING ELECTRIC SUPPLY WORKS, MAINS, STREET LAMPS, &c.



PLAN OF WYCOMBE ELECTRIC SUPPLY STATION.

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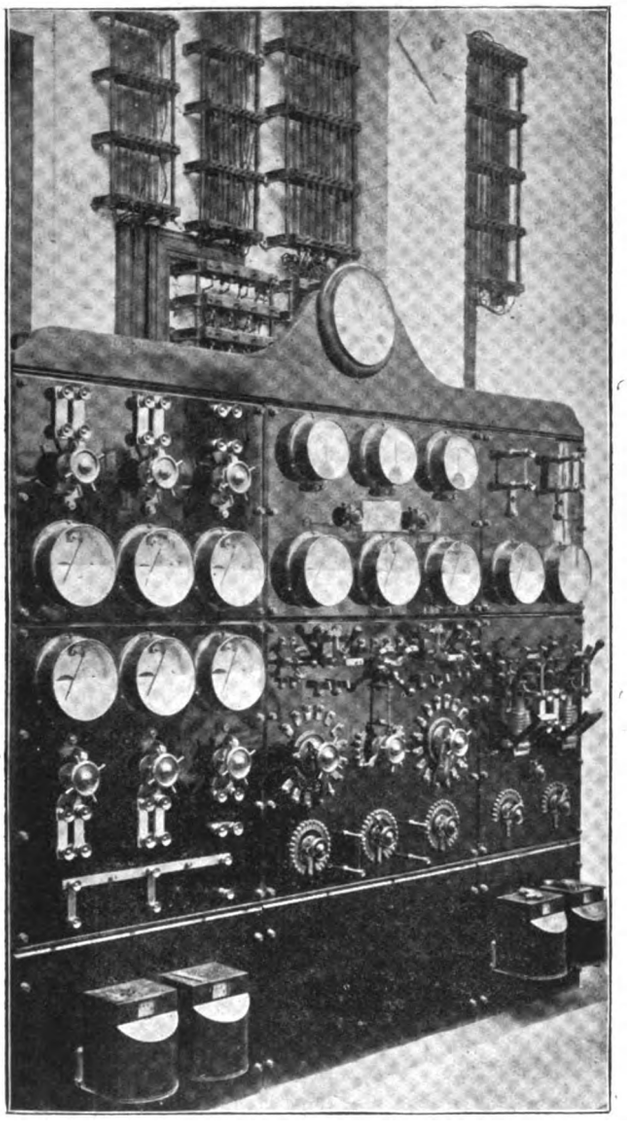
Edmundson were contractors for the whole work, and the following were the chief sub-contractors:—

Boilers and engines	Davey, Paxman and Co.
Piping work	Babcock and Wilcox.
Dynamos, balancer and booster set	Thomas Parker.
Pumps	Worthington Pumping Co.
Feed heater	Joseph Wright and Co.
Switchboard	Edmund Charrington.
Accumulators	D. P. Battery Co.
Meters	S. Z. de Ferranti.
Demand indicators	Reason Manufacturing Co.
Cables	Callender's Cable and Const. Co.
Buildings and chimney	Henry Flint (High Wycombe).

In sinking the foundations for the chimney, water was met with at 2ft. from the surface, and steam pumps had to be kept at work day and night until the foundations were in. These



WYCOMBE ELECTRIC SUPPLY WORKS. FRONT OF SWITCHBOARD.

were laid on a bed of very hard flint gravel, and all the ballast for the foundations, engine beds, &c., was obtained on the site. The chimney is 120ft. high and 3ft. square internally. Two Davey-Paxman "Economic" boilers, 12ft. by 7ft. 6in., have been erected up to the present. Their heating surface is 665 sq. ft., and they are built for 160lb. pressure. The feed pumps are two in number, and duplicate feed piping with valves to cut off any defective portion is used. In the engine house are two Peache high-speed engines, giving 120 I.H.P. at 480 revolutions per minute, coupled directly to two Parker dynamos, each giving 160 amperes at from 420 to 460 volts. A 5in. ring steam main is used, consisting of lap-welded steel pipes with heavy flanges screwed on and brazed. As in Edmundson's other stations, a Parker combined balancer and booster is used. The balancer armatures are wound for 50 amperes at from 210 to 230 volts. These machines are coupled together by a flexible coupling, and mounted on common girder rails. At each end of the combination is placed a small booster for charging the cells. The latter are designed for a current of 70 amperes, to raise the pressure by any amount up to 70 volts. The speed of this set is about 950 revolutions per minute. The magnets of this machine are fitted with hinged pole pieces, so that when these are turned back the armatures can be lifted out in a vertical direction. All the machines are wound with Eickemeyer coils, and all the bearings have ring lubrication.

A battery of 230 D.P. cells is provided. The cells are of the F type, with 585 ampere-hours capacity at 55 amperes, and capable of giving 60 amperes for four hours. The switchboard, shown in the illustration, is of enamelled slate, and differs but little from that usually employed by Messrs. Edmundson's. The left-hand panel is for the three feeders, the centre panel contains the middle wire, balancer and accumulator arrangements, and the right-hand panel the dynamo connections. As is seen, the latter is fitted with automatic minimum cut-outs and fuses for each machine. It is not easy to see the value of the latter when only two generators are paralleled, especially in view of the recent mishap at Brighton, and having regard to the fact that there is a large battery of accumulators across the terminals. Probably, as fuse connections are also provided on the dynamo panel, the automatic cut-outs will eventually be found to be permanently pinned up. The mains are of Messrs. Callender's impregnated jute, lead-covered and armoured pattern, the feeders being triple concentric and the distributors, with the exception of the street lighting mains, are three-core. As already mentioned, there are three feeders, one leading to the centre and one to each side of the district. These are of 0·1 sq. in. section with 0·06 sq. in. section neutral conductors. The distributors are in two sizes, viz., 0·075 and 0·05 sq. in. section, with neutrals of 0·05 and 0·03 sq. in. sectional area respectively. The arc lamp cables have all three of the conductors of 0·12 sq. in., and the incandescent street lighting cables are of 0·008 sq. in. section. The old gas standards and lanterns have been retained, and the Reason Company's lens reflectors have been fitted on the lanterns in straight roads, and "prism" globes at corners and crooked streets. The street lighting circuits are tapped off the same distributors as those for providing private lighting, switches to control these circuits being placed at points indicated in the map. To avoid confusion in the map, the cables to the street lamps have not been shown, only the lamps themselves being indicated. The switches are collected together in three groups, while it takes one man less than an hour to turn them all on or off. Three of the arc lamps are of the open type, these being connected together between the outer and neutral of the system. The other two are "Jandus" enclosed lamps, these two being connected in series in the same way. The station has been running with temporary arrangements since August last year. At the beginning of this year from 1,500 to 1, 800 8 c.p. lamps were connected, and since then this has been increased by nearly 1,000. On Wednesday last the works were formally opened by Earl Carrington.

BOOKS RECEIVED.

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"The Official Gazette of the United States Patent Office," No. 6, Vol. LXXXVI. Published by authority of Congress. (Washington: Government Printing Office.)

"Measurement and Weighing," by Edwin Edser. (London: Chapman and Hall). Price 2s. 6d.

Fourth Annual Report of the Boston Transit Commission for the year ending Aug. 15, 1898. (Boston: Rockwell and Churchill Press).

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PHYSICAL SOCIETY.

At the annual general meeting of the Physical Society, on February 10th, Mr. Shelford Bidwell, F.R.S., President, in the chair, the report of the Council was read by Mr. H. M. Elder. Dr. Atkinson then presented the treasurer's report, and showed that, although there was only a small balance in the bank, the financial position had somewhat improved. The list of Fellows lost to the Society by death was read; the obituary includes the names of Latimer Clark, C.E., F.R.S.; Sir James Douglass, F.R.S.; John Hopkinson, D.Sc., F.R.S.; J. E. Myers; Eugene Obach; Henry Perigal, F.R.A.S.; and Bartholomew Price, M.A., F.R.S. After some remarks with regard to the library and the subscriptions, votes of thanks were passed to the Council, the auditors and to the other officers of the Society. The President then moved a vote of thanks to the Chemical Society for the use of the rooms at Burlington House. Council and officers for the forthcoming year were elected as follows:—President: Oliver J. Lodge, D.Sc, F.R.S. Vice-Presidents, who have filled the office of President: Dr. J. H. Gladstone, F.R.S.; Prof. G. C. Foster, F.R.S.; Prof. W. G. Adams, M.A., F.R.S.; The Lord Kelvin, D.C.L., LL.D., F.R.S.; Prof. R. B. Clifton, M.A., F.R.S.; Prof. A. W. Reinold, M.A., F.R.S.; Prof. W. E. Ayrton, F.R.S.; Prof. G. F. Fitzgerald, M.A., F.R.S.; Prof. A. W. Rücker, M.A., F.R.S.; Capt. W. de W. Abney, R.E., C.B., D.C.L., F.R.S.; Shelford Bidwell, M.A., LL.B., F.R.S. Vice-Presidents: T. H. Blakesley, M.A.; C. Vernon Boys, F.R.S.; G. Griffith, M.A.; Prof. J. Perry, D.Sc., F.R.S. Secretaries: W. Watson, B.Sc. (Physical Laboratory, South Kensington); and H. M. Elder, M.A. (50, City-road, E.C.). Foreign Secretary: Prof. S. P. Thompson, D.Sc., F.R.S. Treasurer: Dr. E. Atkinson. Librarian: W. Watson, B.Sc. Other Members of Council: Prof. H. E. Armstrong, D.Sc., F.R.S.; Walter Baily, M.A.; R. E. Crompton; Prof. J. D. Everett, D.C.L., F.R.S.; Prof. A. Gray, LL.D., F.R.S.; E. H. Griffiths, M.A., F.R.S.; Prof. J. Viriamu Jones, M.A., F.R.S.; S. Lupton, M.A.; Prof. G. M. Minchin, M.A., F.R.S.; and J. Walker, M.A. The newly-elected President, Prof. Oliver Lodge, then took the chair, and an ordinary meeting was held. In his address he referred to the heavy death-roll of the Society during the past year, and to the tribute paid to the memory of John Hopkinson at Cambridge University. Prof. Lodge then commented on the quickness with which scientific discoveries were now applied to practice, and to the interest taken in such applications by men of science. He did not know whether this was due to the example and inspiration of Lord Kelvin, or to the progress of education among the public. He regretted that the public were so ignorant of scientific subjects. Rapidly reviewing the work done in physics during the past year, he spoke of the experiments of Righi, Preston, Michelson, and J. J. Thomson, and called attention to a prediction lately published in *Nature* by Prof. G. F. Fitzgerald with regard to the probability of being able to obtain magnetic effects by passing circularly polarised light through absorptive media. After commenting upon the important position now occupied by terrestrial magnetism among the sciences, and to the advantages of the publication now known as *Science Abstracts*, Prof. Lodge said there was one event of exceptional significance to physics, that had happened during the past year, an event of which science would feel the effect for centuries to come: the Government had decided to begin to establish a national laboratory. He wished to congratulate Sir Douglas Galton, and himself, on the speedy result of their urging the matter upon the British Association. He thought the thanks of the Physical Society were due to the Committee appointed by the Treasury, especially perhaps to Prof. Rücker, as acting Chairman of that Committee, and to Mr. Chalmers who represented the Treasury, for the way in which the work had been brought to an issue. There was much for which the present Government deserved praise during the past year; he wished there could be added to their laurels the inauguration of a university for London. Prof. Lodge then went on to the specific subject of his address: the opacity of conducting media to light and to electric waves generally, emphasising the brilliant work of Mr. Oliver Heaviside in unifying phenomena apparently different, discussing the effect of boundaries, and dealing specially with the question, first attacked by Maxwell, of the theoretical opacity of gold-leaf. This part of the address will be published in full in the *Phil. Mag.*

Prof. AYRTON said, with regard to the attenuation of electric waves by the earth, that Mr. Whitehead, some months ago, came to the conclusion that when the primary and secondary coils were placed flat on the earth at a distance from one another, nearly all the energy of the primary was absorbed by the earth before reaching the secondary. The degree of absorption was so great that Mr. Whitehead had hesitated to publish his theoretical results until experiment should confirm them.

Prof. LODGE concurred with Mr. Whitehead's result. Three cases were to be considered. In the first, one horizontal coil is superposed to the other, with sea-water or some other absorbing medium between them; in this case the absorption at moderate distances is not excessive. But, of course, if the coils are formed of cable sheathed with iron, as in the recent experiments made by the Royal Commission, the iron itself prevents the progress of electric waves from primary to secondary. In the second case the coils are wholly in the same horizontal plane. The earth, owing to its great magnitude, behaves almost as a perfect conductor; if the coils are now near the earth, there is no normal magnetic force between them; it is all tangential. In the third case the coils are opposed to one another, both being vertical and near to the earth. The high conductivity of the earth is here acting to the advantage of wave propagation, for the image of the primary coil is in phase with the coil itself, and the total effect is approximately doubled.

Prof. CAREY FOSTER then took the chair, and Prof. OLIVER LODGE read a Paper by Mr. BENJAMIN DAVIES, on

"A New Form of Amperemeter and Voltmeter, with a Long Scale."

These instruments are already well known, although no account of them has actually been published. They are of the moving-coil, long-range, portable type, with a very uniform scale from zero to maximum. The magnetic circuit has only one air-gap, which is generally the space between a central cylinder of iron or steel and a concentric tube of iron, modified in various ways for facilitating the adjustment of the magnetic induction and the placing of the coil. The central cylinder is bored axially, and one side of the rectangular coil is pivoted at the top and bottom of the hole thus made. The second side of the coil moves in a circular path in the annular air-gap. Photographs of the instruments in several modified forms were exhibited.

Prof. AYRTON said the instruments appeared to be very successful; he could bear witness of their value, particularly as regards the length of range. The general principle by which long-range was to be obtained on moving-coil, portable instruments, was developed some ten years ago by M. Carpentier, of Paris, who used a central magnet surrounded by a concentric hollow cylinder, with only one side of the coil in the magnetic gap between them; but it was not then a portable form of instrument; for the coil was suspended. Prof. Ayrton had himself worked in this direction in the "static station-voltmeter." In that instrument there were three magnetic circuits arranged to give staticism; this was described in 1892 or 1893. The vice-president (Prof. Carey Foster) proposed a vote of thanks to the author, and the meeting adjourned until Feb. 24.

At an ordinary meeting of the Physical Society on Feb. 24, Prof. Perry, F.R.S., Vice-President, in the chair, a Paper by Mr. S. F. J. LOVE, on

"The Joule-Thomson Effect, and its Connection with the Characteristic Equation, and some of its Thermo-Dynamical Consequences,"

was read by Mr. Watson. The author points out that the results of the original Joule-Thomson investigation of the thermal effects of fluids in motion have been utilised hitherto almost exclusively for the one purpose of determining the relation between various gas-thermometer scales and the absolute scale of temperature. He proceeds to deduce further consequences from those results, indicating the relation between the formula assigned to the Joule-Thomson effect, regarded as a function of temperature, and the particular form adopted for the characteristic equation of a gas. He further attempts to supply a theoretical basis to the various formulæ of Van der Waals, Rose-Innes, and others, at the same time insisting upon a very high degree of accuracy for the original experimental work of Joule and Thomson. Then follows a discussion of the relation between the intrinsic energy of a gas and its volume, and a method is given for calculating the ratio of the principal two specific heats of a gas. Lastly, the author considers some points in the thermodynamics of substances at their temperature of maximum density. It is shown that (1) the Joule-Thomson effect for every substance at maximum density is zero; just as it is, though for a different reason, in the case of an ideal perfect gas. And (2) that the infinite number of specific heats possessed by every substance are, at the temperature corresponding to maximum density, reduced to one specific heat.

Mr. ROSE-INNES congratulated the author on having written an interesting Paper on a difficult subject. At the same time he felt bound to acknowledge that he was out of sympathy with the general idea contained in the Paper. The experimental difficulties that occurred in carrying out the Joule-Thomson investigation were so enormous that it was better to rely on them as little as possible, notwithstanding the great skill of the experimenters. The Joule-Thomson results could not be disregarded altogether, since they were necessary for the establishment of the thermodynamic scale; but once that scale had been set up it was better to have recourse as much as possible to such experiments as those of M. Amagat on the compressibility of gases. He also pointed out that one of the deductions, given in the Paper from Van der Waals's formula, had already been given by Van der Waals himself.

Mr. WATSON replied, and the VICE-PRESIDENT proposed a vote of thanks to the author for his valuable Paper. The meeting then adjourned until March 10.

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A MODUS VIVENDI.

In a recent issue we suggested that the unfortunate disagreement between local authorities and companies, as regards the right to supply electricity "in bulk" over extensive areas, might admit of settlement by a compromise. Our desire to see this deadlock brought to an end is prompted solely by the conviction that its prolonged existence would continue to withhold from industrial and social communities of the United Kingdom one of the greatest of material blessings of modern times, viz., a cheap and abundant supply of electric power at all times of the day and night. Hitherto this boon has not been extensively available, either in districts where the local authorities have instituted electrical supply or within the areas of electrical companies. Cheap electric power at restricted hours is not uncommon; cheap power at all hours is a rarity; and as to its use in abundance, except for lighting or steady, continuous loads, station engineers and managers are often afraid to encourage it, for fear of spoiling things for the lighting consumers. What is sorely needed throughout the industrial counties, and what there is no engineering difficulty whatever in supplying, is a constant and abundant supply of electrical power on a much cheaper tariff than any now existing even for restricted hours. But the only practicable means of effecting it is by supplying from a large central station over an extensive area. Small undertakings, whether by companies or local authorities, cannot accomplish it. Its essential principle is a wholesale scale of operations. For a local authority to attempt it single-handed on commercial lines would result in economic failure; while for it to adopt rate-aiding in perpetuity would be a political blunder. Nevertheless, there is nothing to prevent Parliament sanctioning the co-operation of several local authorities, in working one combined scheme; and we have ourselves recommended this course for Plymouth, Devonport and Stonehouse. It will be understood, then, that our wish to see the present difficulties removed arises from the conviction that schemes in the nature of those which have been projected are a national industrial necessity. Not only

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the electrical profession but also a very wide circle of industrial interests are involved, and the fate of the schemes actually before Parliament and the Board of Trade is being anxiously awaited. Even during the past week the fate of three has been determined. The Bills for three of the schemes for the supply of electricity "in bulk" were rejected by the Standing Orders Committee of the House of Commons on Tuesday last, and are therefore dead so far as the present session is concerned. These were the Lancashire Electric Power Bill, the South Lancashire and Cheshire Electricity Co.'s Bill and the Leicestershire and Warwickshire Electricity Supply Co.'s Bill, all of which dealt with supply from a large central station over an extensive area. The ground of objection in each case was non-compliance with the standing orders, owing to certain omissions of the names of boroughs and urban districts which it was proposed to supply. By this decision a considerable amount of Parliamentary fighting at the instance of local authorities has been obviated, for the schemes in question were to have been actively contested. It will be observed, however, that the general principle of electricity supply "in bulk," so far as regards the relation between companies and local authorities, is not even touched by the decision, which arises from purely accidental contingencies.

It is with this general principle, or, at any rate, one phase of it, that we now propose to deal. There are numerous cases where local authorities are not so anxious to undertake the responsibilities of electrical supply as to secure a portion of its profits for their ratepayers. Rightly or wrongly, the notion very extensively exists that a group of capitalists—whether as a limited company or not does not affect the case—ought not to be allowed to exploit the streets and other public places, for the purpose of carrying on profit-making works, without the ratepayers of the districts containing those public places deriving direct benefit by the profits. It is in localities of this particular description that companies projecting electrical supply have met with the most violent and unflinching opposition; and it is scarcely matter for wonder that extinction of private enterprise in such districts has appeared inevitable. We do not think, however, that extinction is an absolutely necessary consequence. It is possible to satisfy the craving of the local guardians for a vicarious share in the profit-making, without conceding to them the whole of the risky business of electrical generation and supply; and two distinct schemes to this end appear to us to have the elements of possible success in them. According to one of these schemes the electric supply company would sell at a wholesale rate only to the local authorities in its area, these being enabled to make a profitable revenue by retailing current to the consumers. The second proposal is that the whole of the business should be carried on by the company, which should also own the works, but that a rate should be levied by the local authority upon the gross revenue from energy generated within, or passing through, or sold in, the district controlled by the authority. In effect, this would be a tax on the business of the undertaking, and would resemble in general principle the royalty required of the National Telephone Co. by the Post Office. By adopting this second plan, local authorities would be able to protect their ratepayers completely from all financial risks, while at the same time securing to them a source of revenue, the tendency of which would be to lower the local rates. Electric supply companies, on the other hand, if the tax upon their revenue were not excessive, might accept the proposal rather than be compelled to terminate their existence; indeed, they might discover in it some guarantee of friendly encouragement and protection by the local authority.

OBITUARY.

PAUL JULIUS DE REUTER.

Baron Paul Julius de Reuter who died at Nice on Saturday morning last, at the advanced age of 82 years, was born at Hesse-Cassel in 1816. In his youth he became acquainted with the celebrated physicist, Professor Gauss, through whom he came into close touch with the early developments of telegraphy. The first practical telegraph line on the Continent was between Aix-la-Chapelle and Berlin, and the operation of this line commenced in 1849. When this line was opened, de Reuter started an office at Aix-la-Chapelle for the collection of news and its transmission over the new telegraph line, thus laying the foundation of that extensive telegraphic news agency which subsequently grew up under his direction, and with which his name is so intimately associated. But, although the germ of this modern commercial project was started on the Continent, the system itself was almost entirely developed to its present degree of intricacy and perfection in this country. Two factors decided de Reuter to remove from Germany to England, viz., the inquisitorial censorship of the press on the Continent, as compared with the freedom of the newspaper business in England, together with the laying of the Dover-Calais cable in 1851, which latter enabled him to live in England while remaining in telegraphic communication with the Continent. It was at first intended to deal principally with commercial intelligence, but the demand in the newspaper world, for prompt and accurate political foreign news, opened up an extensive field for de Reuter's activity in the direction of general telegraphic news, so that in 1858 he was supplying regularly some half-a-dozen London daily papers with foreign telegrams. At this time de Reuter lived in Finsbury-square, and his telegraphic apparatus was fitted up in the back garden of his house. The business was, of course, carried on at first in quite a small way, but, as its importance became recognised by an ever widening circle, it not only grew in bulk, but also in the importance of the individual messages, so that ere long even Government dispatches were received in cypher and transmitted to Downing-street from the little shed in his back garden. De Reuter himself used to be called up at all hours of the night to take these precious messages and forward them to the Cabinet Ministers. This was about the time of the Crimean War, and the urgency of Government telegraphic dispatches during that crisis gave to Baron de Reuter's unique business an ascendancy that it might otherwise have been very much longer in acquiring. In addition to so extensively using telegraph lines for his business, de Reuter was himself instrumental in laying new lines. In 1865 he obtained a concession from the Hanoverian Government for the construction of a submarine cable between England and Germany. He also obtained from the French Government a concession for laying a cable between France and the United States—a cable which was ultimately laid and worked in conjunction with the Anglo-American Co.'s system. Baron de Reuter's title was conferred upon him in 1871 by the then Duke of Saxe-Coburg and Gotha in recognition of his public services.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

A New Wave Indicator.—A. Neugschwender scratches a narrow gap into the coating of a silver-on glass mirror, and inserts the mirror in the circuit of a Daniell cell and a galvanometer. On breathing upon the mirror, the condensed vapour bridges over the gap, and the galvanometer shows a deflection. But this deflection is immediately annulled when electric waves impinge upon the mirror. When a piece of moistened cloth is fixed near the mirror, the action is rendered continuous. Every train of waves produces an infinite increase of resistance while it lasts, and on its cessation the normal current is re-established. The gap in the mirror must be so wide, of course, that no ordinary coherer action intervenes. A good width is 0·3mm. The experiment also

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succeeds with copper or tin as a mirror metal (though not with platinum), and with glass, mica, celluloid, caoutchouc, stearine, or pitch as a support. Ammonia, H Cl, and various salt solutions may be employed, but no effect is produced unless the liquid is so far evaporated that nothing can be seen of it with the naked eye. Sound vibrations, concussions, statical charges and simple heating are without effect, but every spark discharge is instantly responded to. The response is so rapid that the individual discharges of an induction coil are separately indicated, as may be proved by inserting a telephone in the detector circuit.

[NEUGSCHWENDER, *Wied. Ann.*, No. 2, 1899.]

Dark Light.—G. Le Bon has already proved that bodies exposed for a few seconds only to sunlight retain for several months the power of producing an impression upon a sensitive plate, and that the rays producing that impression, although altogether invisible to the eye, are propagated and refracted according to the same laws as ordinary light. He goes on to show that bodies enclosed in opaque boxes can be photographed in a few seconds by using, in the place of a sensitive plate, a screen of phosphorescent zinc sulphide. After exposure, this screen is put into contact with a photographic plate, which is then developed by the usual methods. The source of light is a lamp screened by black paper, which acts the part of a Röntgen tube when the object is photographed by transmission. But the object can also be photographed in its box by reflection, as in the case of ordinary light. To render the sulphide screen sensitive, it is exposed for a few seconds to sunlight. It is well known that the rays at the red end of the spectrum have the property of neutralising the phosphorescence produced by the more refrangible rays, and it is just the infra-red rays of a wave length of about 1·5 μ that are most capable of traversing opaque non-conductors such as ebonite, paper, and wood. These heat rays, which seem to play a very important part in nature, are a serious rival to X-rays in their practical applications.

[LE BON, *Comptes Rendus*, Jan. 30, 1899.]

Constitution of the Electric Spark.—When an electric spark passes between metallic electrodes, the spectrum of the metal appears, not only in immediate contact with the electrodes, but stretches often across, from pole to pole. It follows that during the short time of the duration of the spark, the metal vapours must be able to diffuse through measurable distances. In experiments made by A. Schuster and J. Hemsalech to measure the velocity of diffusion of various metals, the method consists in fixing a photographic film round the rim of a rotating wheel. All that is necessary for its success is to have sparks so powerful that each single one gives a good impression of its spectrum on the film. Were the sparks absolutely instantaneous, the images taken on the rotating wheel would be identical with those developed on a stationary plate, but on trial this is found not to be the case. The metal lines are found to be inclined and curved when the wheel rotates, and their inclination serves to measure the rate of diffusion of the metallic particles. The air lines, on the other hand, remain straight, though slightly widened. In the case of zinc, the velocity is about 1,000cm. per second for a sparking distance of 0·51cm. per second. The authors conclude that the initial discharge of the jar takes place through the air; it must do so because there is at first no metallic vapour present. The intense heat generated by the electric current volatilises the metal which then begins to diffuse away from the poles and is driven by its own pressure into the partial vacuum formed by the heated air; the subsequent oscillations of the discharge take place through the metallic vapours and not through the air. Bismuth, in spite of its atomic weight, shows a rate of diffusion considerably higher than that of zinc.

[SCHUSTER and HEMSALECH, *Proc. Roy. Soc.*, Feb. 2, 1899.]

Source of Becquerel Rays.—The theory of ultra-mundane particles advanced by Madame Curie to account for the supply of energy which maintains the radiation of uranium, thorium, polonium and radium compounds is converted by Sir W. Crookes into a theory analogous to that postulated, though in a purely hypothetical sense, by Maxwell with his famous "demon." Briefly, Crookes believes that the heavy metals mentioned have surfaces capable of sorting, like the "demon," the rapidly moving from the slowly moving molecules, and absorbing some of the energy of the former. Thus a feeble but constant radiation could be maintained, the energy of which would be derived from the kinetic energy of the gaseous particles at ordinary temperatures. The author points out that the energy stored in the air of an ordinary room is sufficient to maintain a 1 H.P. engine in motion for 15 hours per day. Of course, the air is cooled in the process, in direct violation of the second law of thermodynamics. But then that law only holds good until an exception to its universality is discovered. If such an exception is discovered, it will considerably modify our views of the structure and ultimate fate of the universe. It will be remembered that Keeley, with his quixotic "motor," proposed to derive his supply of energy from the air itself. It yet remains to be explained, however, why Becquerel rays are equally well given out in a vacuum.

[CROOKES, *Comptes Rendus*, Jan. 16, 1899.]

ELECTRICITY WORKS ACCOUNTS.

Kensington and Knightsbridge Electric Lighting Co. (Limited).

We are sorry to note the retrogression which the accounts for 1898 of the Kensington and Knightsbridge Electric Lighting Co. bear evidence of. The year analysed is the eleventh year of operation, supply having commenced in January, 1887.

During 1898 the capital has been increased by £18,980, the total amount received now standing at £248,435. The expended capital has risen from £252,162 to £263,481, though £977 has been written off the item of accumulators and switchboards from the renewal account, which stands at £25,615, £5,117 having been placed to it during the year. The item in capital expenditure showing the amount paid in purchase of the Kensington Court Co. has also been *credited* during the year with £2,430 at the expense of the premium account.

Turning to the business done during the year, we find that the connections to the mains have increased about 13 per cent. as compared with the 15 per cent. increase which took place during 1897. The output shows an increase over 1897 of only 9·6 per cent. as compared with 25 per cent. in 1897 over 1896. As in the case of the Westminster Company, some reason for this falling away in the progress is sought for in the absence of fogs. The year 1897 was also an exceptionally good one for the Kensington and Knightsbridge Company, and the fact that it was the jubilee year no doubt places it in unfair comparison with 1898.

The revenue per unit from supply has dropped from 5·28d. to 5·08d.; this and an increase in the costs from 2·65d. per unit to 3·04d. have combined to increase the ratio of costs to revenue from 47·6 to 57 per cent. Most of the items of cost show a rise, though the collective item of "management and property charges" is practically steady at 0·96d. The item of repairs and maintenance is apparently somewhat unfairly loaded with £500 cost of alterations to Chapel-place, £390 loss on engine and dynamos sold and £2,174 cost of replacing two sets of accumulators. These collectively represent 0·35d. per unit, and this, deducted from generating, works, and total costs, has the effect of making them look normal. The fuel item shows that the scarcity of coal has also had its share in increasing the costs. Then, again, in the special charges there is to be noted £303 "cost of conversion to 200 volts," and £100 increase in the insurance charge.

A working profit has been made of £19,949, representing 7·74 per cent of the mean capital. Out of this and the balance of £7,264 from the preceding year £5,408 has been carried to the depreciation and renewal funds, and £3,292 paid in interest. A sum of £12,715 is thus left available for distribution, out of which a 10 per cent. dividend for the year has again been paid, in addition to the dividends on the Preference shares.

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	KENSINGTON & KNIGHTSBRIDGE		LEEDS.	
Undertaking Worked by	The Kensington and Knightsbridge Electric	[Lighting Co., Ltd.	The Yorkshire House-to-House Electricity Co.,	[Limited.
Date of Commencement of Supply	January, 1887.		May, 1893.	
System of Supply	Three-wire, continuous-current, with batteries.		Alternate-current transformers.	
Chief Engineer	H. W. Miller.		Harold Dickinson.	

YEAR ENDED	DEC. 31, **1897.**		DEC. 31, **1898.**		DEC. 31, **1897.**		SEPT. 30, **1898.***	
QUANTITIES—								
Units generated	—		—		—		—	
„ **SOLD (TOTAL)**	1,898,362		2,081,074		833,280		695,718	
„ sold to consumers	1,898,362		2,081,074		833,280		—	
„ sold for public lighting, &c.	—		—		nil		—	
„ used on works	—		—		—		19,305	
UNITS SOLD PER 8 C.P. LAMP CAPACITY	27·1		34·1		13·9		—	
Maximum supply demanded	—		1,880 kilowatts		1,010 kilowatts		2,091 kilowatts	
Number of public lamps	—		—		—		1 arc	
Number of consumers	1,620		1,851		576		750	
Connections to mains in 8-c.p. lamps	137,953		156,158		49,150		65,328	
CAPACITY OF PLANT IN 8-C.P. LAMPS	70,000		61,000		60,000		75,000	
CAPACITY OF PLANT IN KILOWATTS	2,230		1,950		2,100		2,400	
CAPITAL—	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.	Total.	Per kilowatt capacity.
AUTHORISED (TOTAL)	£502,240	£225	£508,435	£26·1	£200,000	£95·2	£200,000	£83·4
Share	350,000	157	350,000	179	200,000	95·2	200,000	83·4
Loan (including Debenture charges)	152,240	68·3	158,435	81·3	nil	—	nil	—
RECEIVED (TOTAL)	229,455	103	248,435	127	131,992	62·9	169,244	70·6
Share	152,240	68·3	158,435	81·3	131,992	62·9	169,244	70·6
Loan (including Debenture charges)	77,215	34·6	90,000	46·1	nil	—	nil	—
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	272,785	122	260,000	133	68,008	32·4	30,756	12·8
Share (unissued)	197,760	88·6	191,565	98·3	12,130	5·78	12,130	5·06
Share (uncalled)	—	—	—	—	55,878	26·6	18,626	7·76
Loan (including Debentures)	75,025	33·6	68,435	35·1	nil	—	nil	—
REPAID (TOTAL)	—	—	—	—	—	—	—	—
RESERVE OR SINKING FUND	20,498[a]	9·20	25,615[a]	13·1	5,000	2·38	8,000	3·33
DEPRECIATION FUND	1,436	0·644	1,783	0·914	6,600	3·14	9,212[f]	3·84
EXPENDED (TOTAL)	252,162[b]	113	263,481[g]	135	161,009	76·6	226,633	94·4
Lands and buildings	52,522	23·5	52,851	27·1	64,332	30·6	—[g]	—
Plant	96,780	43·4	106,368[f]	54·6	61,191	29·2	—[g]	—
Mains	81,959	36·7	85,733	43·9	27,600	13·1	—[g]	—
Miscellaneous	20,902[b]	9·37	18,529[g]	9·50	7,886[a]	3·76	—[g]	—
BALANCE OF CAPITAL ACCOUNT	−22,707[c]	−10·2	−15,046[c]	−7·72	−29,017[b]	−13·8	−57,389[b]	−23·9
REVENUE—	Total.	Per unit sold.	Total.	Per unit sold.	Total.	Per unit sold.	Total.	Per unit sold.
TOTAL	£43,911	5·560d.	£46,332	5·342d.	£18,406	5·300d.	£13,901	4·799d.
Revenue from supply	41,681	5·280d.	44,067	5·083d.	17,127	4·940d.	12,720	4·390d.
„ meters, &c.	1,324	0·167d.	1,463	0·169d.				
„ public lighting	—	—	—	—	—	—	—	—
„ sale of lamps, &c.	10	0·001d.	44	0·005d.	—	—	—	—
„ miscellaneous sources	896	0·113d.	756	0·087d.	1,279[c]	0·368d.	1,181[h]	0·407d.
EXPENDITURE OUT OF REVENUE—								
TOTAL COSTS	£20,919	2·650d.	£26,383	3·043d.	£5,352	1·540d.	£4,983	1·718d.
WORKS COSTS	13,279	1·680d.	18,051	2·083d.	3,544	1·020d.	3,335	1·151d.
Generation of electricity	*11,970*	*1·510d.*	*16,517*	*1·906d.*	—	—	—	—
Fuel (including cartage, &c.)	5,463	0·692d.	6,587	0·760d.	876	0·252d.	703	0·243d.
Oil, waste, water, stores	910	0·115d.	807	0·093d.	184	0·053d.	162	0·056d.
Wages at station	2,744	0·347d.	3,186	0·368d.	2,041	0·589d.	1,855[i]	0·640d.
Repairs and maintenance at station	2,848	0·360d.	5,937[h]	0·685d.	444	0·128d.	615[i]	0·212d.
Distribution of electricity	*1,309*	*0·166d.*	*1,534*	*0·177d.*				
Wages, &c.	861	0·109d.	983	0·113d.	—[d]	—	—[d]	—
Repairs, renewals of mains, &c.	448	0·057d.	551	0·064d.				
Public lighting	—	—	—	—	—	—	—	—
Attendance	—	—	—	—	—	—	—	—
Renewals	—	—	—	—	—	—	—	—
MANAGEMENT AND PROPERTY CHARGES	7,640	0·966d.	8,330	0·961d.	1,808	0·520d.	1,648	0·569d.
Royalties	—	—	—	—	—	—	—	—
Rent, rates, taxes	*3,487*	*0·441d.*	*3,874*	*0·447d.*	*262*	*0·075d.*	*176*	*0·061d.*
Management	*4,153*	*0·525d.*	*4,456*	*0·514d.*	*1,546*	*0·445d.*	*1,472*	*0·508d.*
Salaries	2,686	0·340d.	2,717	0·314d.				
Stationery, &c.	263	0·033d.	318	0·037d.	1,546	0·445d.	1,472[j]	0·508d.
Establishment charges	323	0·041d.	377	0·044d.				
Law charges, &c.	881[d]	0·111d.	1,044[i]	0·120d.				
FINANCIAL RESULTS—	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded	Total.	% to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£22,992	9·53%	£19,949	7·74%	£13,054	9·80%	£8,918	4·60%
Sum carried to Depreciation Fund	8,351	3·46%	5,408	2·10%	2,300	1·72%	2,612	1·35%
Sum carried to Reserve or Sinking Fund					3,000	2·25%	—	—
Net interest on loans (incl. Debenture charges)	3,026	1·25%	3,292	1·28%	51	0·04%	3,105[k]	1·60%
BALANCE FROM LAST ACCOUNT	875	0·363%	7,264	2·82%	+393	0·30%	1,329	0·686%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	12,490	5·18%	12,715	4·93%	8,096	6·08%	10,740	5·54%
Deficit	—	—	—	—	—	—	—	—
ORDINARY DIVIDEND PAID	10%	—	10%	—	6%	—	6¾%	—
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	47·6%		57%		29·1%		35·8%	
Expenditure per kilowatt capacity	£9. 7s. 6d.		£13. 10s. 7d.		£2. 11s. 0d.		£2. 1s. 6d.	
REVENUE PER KILOWATT CAPACITY	£19. 13s. 7d.		£23. 14s. 10d.		£8. 15s. 4d.		£5. 15s. 10d.	
Expenditure per 8-c. lamp capacity	5s. 11¾d.		8s. 8d.		1s. 9½d.		1s. 4d.	
REVENUE PER 8-C.P. LAMP CAPACITY	12s. 6½d.		15s. 2d.		6s. 1½d.		3s. 8½d.	
REVENUE PER 8-C.P. LAMP CONNECTED	6s. 4½d.		5s. 11d.		7s. 5¾d.		4s. 3d.	
Price charged for lighting, per unit	6d. to 5d.[e]		6d. to 5d.[e]		6d.[e]		5d. to 4¾d.[e]	
Price charged for power, per unit	4d.		4d.		3d.		2d. less 5%	
Price charged for public lighting	—		—		—		—	

KENSINGTON AND KNIGHTSBRIDGE.—REMARKS—*a* Being balance to credit of renewal fund account. *b* Includes £11,473 to purchase of Kensington Court Co., Ltd. *c* Over-expended. *d* Includes £106 to auditing and £403 to insurance. *e* 6d. per unit at 100 volts and 5d. per unit at 200 volts, with rebates. *f* £977 has been *credited* during the year to the item of accumulators and switchboards from the renewal account. *g* Includes £7,346 to purchase of South Kensington Order and £9,049 to purchase of Kensington Court Co.; this latter item having been *credited* during the year with £2,430 transferred from premium account *h* Includes £500 cost of alterations to "Chapel Place," £390 loss on engine and dynamo sold and £2,174 to two sets of accumulators replaced. *i* Includes £112 to auditing, £506 to insurance and £303 cost of conversion to 200 volts.

LEEDS.—REMARKS—* The analysis of 1898 is that of the accounts for nine months' working only. *a* Includes £3,420 for meters and £937 cost of Provisional Order. *b* Over-expended. *c* Includes £1,251 rents receivable. *d* Not separately rendered in the accounts. *e* With discounts. *f* Being amount allowed for depreciation on sale of undertaking. *g* The items of capital expenditure are not given. *h* Includes £1,149 rents receivable. *i* Includes distribution charges. *j* Includes £375 directors' remuneration and £95 to insurance. *k* To *credit* of net revenue account; £3,663 being interest received and due from the Leeds Corporation.

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The following particulars indicate the history of the undertaking since 1890:—

Year.	No. of consumers.	No. of lamps connected (8 c.p.).	Output, (units).	Dividend (ordinary).
1890	291	25,535	...	...
1891	436	38,408	385,051	2%
1892	550	47,441	535,343	4%
1893	734	64,529	724,308	5%
1894	908	80,678	977,789	5%
1895	1,109	94,780	1,228,734	6%
1896	1,325	119,955	1,514,729	7%
1897	1,620	137,953	1,898,362	10%
1898	1,851	156,158	2,081,074	10%

The Yorkshire House-to-House Electricity Co. (Limited).

The accounts analysed in our table are those for the period, from January 1, 1897, to September 30, 1898, of working of the supply undertaking at Leeds. At the latter date the concern was, in effect, sold to the Leeds Corporation, the transfer being completed on December 15th last. The supply of electricity by the Company on its own account having ceased on September 30th, the revenue account dealt with shows the result of only nine months' trading, and excludes the most profitable quarter of the year.

The capital received during the above period was £37,252, making the total amount received £169,244. Of this has been expended £226,633, representing £91·4 per kilowatt of plant capacity. We are unable to set out the separate items of this expenditure, as the information is not available from the accounts supplied us. With an increase in the number of consumers from 576 to 750, the equivalent 8 c.p. lamp connections have risen from 49,150 to 65,328, or about 33 per cent.

Considering that the period of working is not representative of the normal average load there is little use in attempting a comparison between many of the values of interest for the two periods set out in the tables.

Owing to substantial reductions in the tariff both for lighting and power supply the revenue has fallen from 5·8d. to 4·8d. per unit. There is a rise in the costs of about 0·18d. This is not more than might be caused by the absence of the best portion of the winter load.

The working profit for the period was £8,918. The balance from the year 1897 of £1,329, together with £3,663 received and due from the Leeds Corporation as interest, has, with the working profit, enabled £10,740 to be available for distribution after carrying £2,612 to the depreciation fund and paying £559 in interest. Out of this balance an ordinary dividend of 6¾ per cent. has been declared.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	1899	Jan. 6	Kens'gton & Knightsbr'ge (Co.)		Sept. 30
Ayr (Municipal)	1898	Nov. 11	Kingston-upon-Hull (Mun.)	1898	Aug. 19
Bedford (Municipal)	,,	Mar. 4	Kingston-on-Thames (Mun.)	,,	Mar. 25
Belfast (Municipal)	,,	Sept. 23	Lancaster (Municipal)	,,	Oct. 21
Birmingham (Company)	,,	Dec. 16	Leeds (Company)	,,	April 8
Blackpool (Municipal)	,,	Oct. 7	Leicester (Municipal)	1899	Jan. 20
Bournemouth (Company)	,,	June 3	Leyton (Municipal)	1898	Sept. 23
Bolton (Municipal)	,,	Dec. 9	Liverpool (Municipal)	,,	Aug. 12
Bradford (Municipal)	,,	May 20	Manchester (Municipal)	,,	July 29
Brighton (Municipal)	,,	May 6	Newcastle and District (Co)	,,	Dec. 2
Bristol (Municipal)	,,	July 29	Newcastle-upon-Tyne (Co.)	,,	April 29
Burnley (Municipal)	,,	Sept. 16	Northampton (Company)	,,	April 15
Burton-upon-Trent (Mun.)	,,	April 15	Norwich (Company)	,,	Dec. 2
Bury (Municipal)	,,	Nov. 25	Notting Hill (Company)	,,	Mar. 11
Cambridge (Company)	,,	June 17	Nottingham (Municipal)	,,	Oct. 28
Cardiff (Municipal)	1899	Jan. 6	Oldham (Municipal)	,,	Nov. 18
Charing Cross (Company)	1898	April 22	Oxford (Company)	,,	April 1
Chelsea (Company)	,,	May 20	Portsmouth (Municipal)	,,	Nov. 4
Cheltenham (Municipal)	,,	Oct. 7	Preston (Company)	,,	Oct. 28
Chester (Municipal)	,,	Oct. 14	Reading (Company)	,,	Sept. 16
Clerkenwell (Company)	,,	Mar. 18	Richmond (Company)	,,	Mar. 4
Derby (Municipal)	,,	Dec. 9	Scarborough (Company)	,,	April 1
Dewsbury (Municipal)	,,	Nov. 25	St. James' & Pall Mall (Co.)	1899	Feb. 24
Dover (Company)	,,	Mar. 11	St. Pancras (Vestry)	1898	May 13
Dundee (Municipal)	,,	Nov. 4	Sheffield (Company)	,,	Dec. 16
Eastbourne (Company)	,,	July 22	Shoreditch (Vestry)	,,	May 27
Edinburgh (Municipal)	,,	Oct. 14	Southampton (Municipal)	,,	June 3
Exeter (Municipal)	,,	Aug. 5	Southport (Municipal)	,,	Dec. 23
Glasgow (Municipal)	,,	Aug. 12	Stafford (Municipal)	,,	Oct. 21
Guildford (Company)	,,	May 13	Sunderland (Municipal)	,,	Aug. 19
Halifax (Municipal)	,,	Nov. 18	Taunton (Municipal)	,,	Aug. 5
Hammersmith (Vestry)	,,	June 10	Tunbridge Wells (Mun.)	,,	July 22
Hampstead (Municipal)	,,	Sept. 9	Walsall (Municipal)	,,	Nov. 11
Hanley (Municipal)	,,	April 8	Wandsworth (Company)	,,	Mar. 18
Harrogate (Municipal)	,,	Dec. 30	Westminster (Company)	1899	Feb. 24
Harrow (Company)	,,	Sept. 9	Whitehaven (Municipal)	1898	Dec. 23
Hast'gs & St. Leonard's (Co.)	,,	April 29	Windsor (Company)	,,	Dec. 30
House-to-House Co. (K'ns'gt'n)	,,	Sept. 30	Wolverhampton (Municipal)	,,	July 15
Hove (Company)	,,	May 6	Woolwich (Company)	1899	Jan. 13
Huddersfield (Municipal)	,,	Mar. 25	Worcester (Municipal)	1898	May 13
Islington (Vestry)	,,	June 24	Yarmouth (Municipal)	,,	June 17

CARBONS FOR ELECTRIC LIGHTING AND OTHER PURPOSES.*

BY FRANCIS JEHL.

(Continued from page 614).

As has already been mentioned, the Aluminium Industrie Actiengesellschaft, in Neuhausen, manufacture their own electrodes, and as they need a large number of them, they employ a continuous type of furnace which the writer has not yet explained. The system used in Neuhausen consists of a stationary fire while the hearths are movable. The writer was informed, while in Switzerland some time ago, that the furnace was especially constructed for the Aluminium Company by Menheim, but he was unable to get any drawings or data concerning the same. This system of furnace is, however, not new, and Mr. Rogler informs the writer that one designed by Bock has been in operation for years at the large pottery works of Fikentscher, in Zwickau, Saxony. Other similar designs have been constructed by Siemens-Hess and also by Pernot, who constructed a furnace in which the bed is mounted on wheels so as to be moved in and out of the fire. The latter type is used in the manufacture of steel.

Some time ago the writer designed such a furnace for a firm that intended to build a carbon and electrode factory, but as the duty on carbons was increased in the United States the matter was dropped. Figs. 46, 47 and 48 represent the

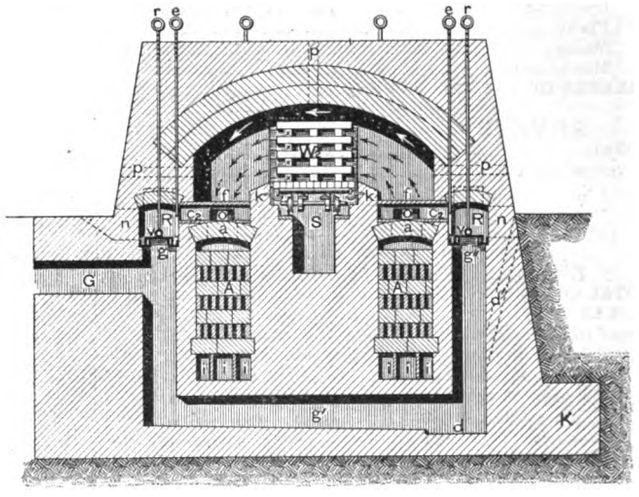

FIG. 46.—Jehl's Continuous Furnace with Tunnel and Regenerator. (Cross section view.)

writer's design; here G indicates the main gas passage connected with the generators. The latter are best built on the side of the furnace, as this gives us a minimum length for the passage—an advantage over the many metres necessary in the other continuous systems, as the gas arrives much hotter in the combustion chamber, for we have already seen that the temperature of the gas can sink as much as 50°C to 75°C per metre. From the passage G, the gas can be led to either side of the furnace by way of g, g', or g'', as shown, and can be permitted to pass into the reservoir chambers R R, by simply lifting the valves v or v', which are actuated by means of the rods r r. These rods can be held in any position by inserting pins in one of the holes at their upper ends. The section d in the passage g' acts as a drain for any condensed matter that may settle and which can be pumped up by inserting a pipe into the hole d' at the side of the furnace, as shown in Fig. 46. This opening is, of course, always closed up when not in use, as otherwise gas would escape. It is hardly probable, however, that any tarry matter will condense, as the gases only travel a short distance and are too hot to allow condensation. When a valve at R is raised, the gases enter the reservoir chamber which communicates with the branch passages c_1, c_2, c_3 that lead into the fire boxes f f. The flow of gas into each of

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these branches can be regulated or stopped by means of dampers that are connected to the rods *e e*.

As seen from the plan there are three such branches c_1, c_2, c_3 that lead from the reservoir chambers R into each fire box, while the gas flows out horizontally in the middle of the fire box at openings *o o* on each side of the branch passages, as shown in the cross section, Fig. 46. The air that is necessary for combustion enters at *b* or b_1, according to

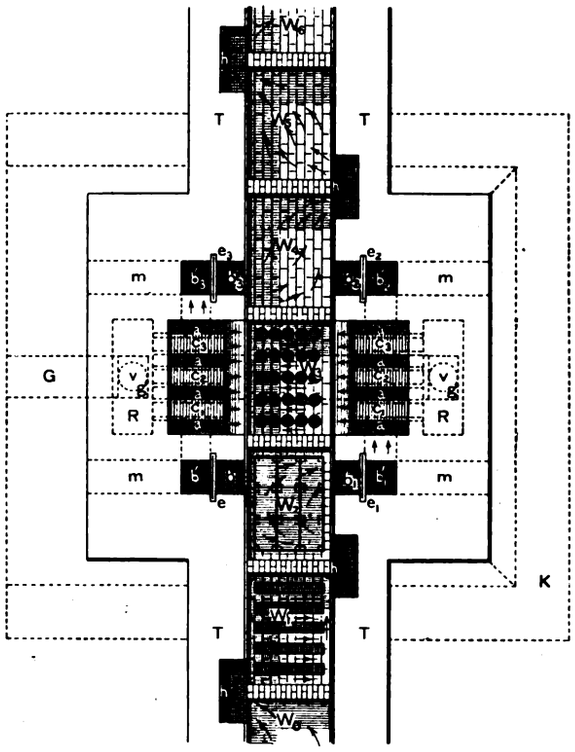

FIG. 47.—Jehl's Continuous Furnace with Tunnel and Regenerator. (Plan.)

which side of the furnace the gas is turned on, and from there it passes into the passage b' or b'_1 that leads into the regenerator A at *i*, *i*, *i*, Fig. 47, where it gets heated up to a high degree and then passes out at the openings *a a a a* in the fire box *f*, striking the gases at right angles, and thus getting well mixed up. The flames that result from the combustion have plenty of room over the fire box to expand, according to Siemens' theory, and then take an even and well-distributed path as shown by the arrows.

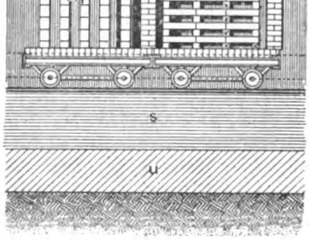

FIG. 48.—Jehl's Continuous Furnace with Tunnel and Regenerator. Longitudinal Section of Tunnel.

In Fig. 47 the passages b_3, b_3' and b_2, b_2' serve to conduct the burnt gases away, while *e*, e_1, e_2, e_3 are dampers by means of which the passage can either be closed or regulated; *m*, *m*, *m*, *m* are entrances which permit access in to the canals *b*, b_1, b_2, b_3 and the generators, but which are well sealed up with fire bricks when the furnace is in order. In Fig. 46 *n n* are similar entrances that lead into the reservoir chambers when inspection is necessary, but are also well sealed up when the furnace is working. The peep-holes are shown at *p p p*, and should be covered with mica so as to prevent cold air from entering.

On both sides of the furnace is a tunnel, T T T T (Fig. 47), a portion of the longitudinal section of which is shown in Fig. 48. Here *t* is the roof on which earth *w* is banked so as to prevent the heat from dissipating; *u* is the foundation, and through the centre runs a passage, *s*, the cross section of which is shown in Fig. 46. On steps of this passage rails are placed, on which waggons W_1, W_2 run as shown in all the figures. The waggons should only be constructed of wrought iron, while on the sides a projecting strip of iron dips into a U-formed rut that is filled with sand, as shown in Fig. 46 at *k*. This cuts off the heat and prevents it from getting into the lower passage *s*, and thus the lower part of the waggons are protected. It is better, however, to have the U-formed rut attached to the waggons and have the straight strip fixed in the wall of the tunnel, as then the rut can always be filled with fresh sand when a waggon is placed into the tunnel. In the waggons a layer of sand is placed, on which a good bed of the best fire bricks is laid, while at one end of each waggon a wall is built, as shown in Fig. 48, covering the cross section of the tunnel except for a reasonable clearance.

By this means we obtain a sort of chamber system, the number of which depends upon the number of waggons or the length of the tunnel, while communication between each compartment is effected by means of passages *h* (shown in Figs. 47 and 48) built in the sides of the tunnel. It will be seen from what has so far been explained that this system offers the same advantages as those given by the other continuous systems, and that the waste heat is just as economically employed, for here, too, the heat contained in the retorts, &c., that have been finished is utilised for warming up the air that is used for combustion, while the heat of the gases that result from combustion is used in warming up a regenerator and those waggons that contain carbons or electrodes not yet baked.

In order to render the working of the writer's furnace system clearer, the following example may be taken:—We will suppose that waggon W_3, Fig. 47, is in operation, and that W_4, W_5, W_n are waggons that contain carbons that have not yet been baked, while those in waggons W_2, W_1, have already been carbonised. The valves and dampers that control the gas and air passages at *g*, *e*, e_2 are closed, while those at *g''*, e_1, e_3 are opened. The air entering the tunnel on the side where the waggons W_0, W_1, W_2 are situated takes up the heat contained in these waggons as it circulates from one compartment to another by way of the passages *h*, until it arrives at b_1, where it enters and passes into the canal b'_1, that leads into the right hand generator A, shown in Fig. 46, where it is heated up to a very high temperature and then issues out at the openings *a a*, mixing well with the combustible gases that also issue out over these openings, so that a very good combustion takes place, the flames of which strike the retorts or fire-clay cases, passing between them, and leave at the other openings on the opposite side, as shown by the arrows in Fig. 46. These hot gases in passing the openings *a a*, circulate through the generator A on the left-hand side, which received a great part of the heat, while the rest is taken up in the waggons W_4, W_5, W_6, as the heat in leaving the generator enters the canal b'_3, and out at b_3, into the compartment W_4, &c., as shown by the arrows in Fig. 47. After the fire has been working for a few hours on one side, its direction is reversed by closing up the valves and dampers that are opened, and opening those that are closed. By this means the retorts, &c., are evenly heated, and are at all parts subjected to an even intensity of heat which is so important in carbonising. When the contents of a waggon have been finished, the whole series are pushed one space further, while at one end of the tunnel a waggon is taken away, and at the other end one is added, the rails being connected with a turntable at each end, so that the waggons can be pushed into the packing and receiving departments.

(To be continued.)

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MOTOR-CAR BUILDING.*

One of the oldest of the artistic trades and handicrafts is that of carriage building. It has grown up through many centuries, and has formed a separate industry with workmen, traditions and reputations of its own. Probably its prosperity was at the height during the stage coach days, but it is not unlikely that the growth of private wealth has maintained it on the whole plane of activity during the whole of the century now closing. Although the railroad companies did not long go to the coach builders for their cars, there was an enormous increase in the number of private vehicles of all classes, and thus the loss of the stage coach was not seriously felt by the carriage builders. At the present moment, however, as the century closes, an entirely new prospect opens up, and one is led to conjecture whether the changes in carriage building may not become so revolutionary as to cause the industry to pass into new hands, unless the former directors of it are alert enough to adapt themselves promptly to the latest conditions. It is the automobile that is the instrument of this new departure, and the outward sign of a change as great as that from bows and arrows to breech-loaders and machine guns.

To state the case broadly, the carriage builders of the past have all been, practically, workers in wood. Now, while it is possible that not a little wood enters into the composition of an automobile, it is easy to picture such vehicles, and good ones at that, into whose construction not a particle of wood enters. The modern automobile is a thing of steel and rubber tubes, while its body may preferably consist of aluminium, light sheet steel, and a few trimmings not necessarily of leather. The automobile embodies other problems than those of a vehicle that is hauled. It lifts itself into speed from a dead rest; it is steered within itself; its motive power is a matter of mechanism, and the questions that arise at each step are radically different from those relating to the carriages of our fathers. How many carriage builders are there to-day who have given any proof of their desire and intention to head the new procession, and to be the chief beneficiaries of the new tendencies? We are constrained to answer, not one so far as we know. Some of the carriage builders are making wooden bodies to fit the running gear of various automobiles, but, as we have suggested, that is a precarious tenure, with little promise of permanency in the new art. It does look, at this moment, as though a new crop of manufacturers must come to the front, recruited, perhaps, to some extent by the more enterprising of the old carriage builders, but consisting very largely of concerns trained in the fields of bicycle building and electricity.

ELECTRO-CAPILLARY PHENOMENA.†

BY S. W. J. SMITH, M.A.

The Lippmann-Helmholtz theory of the capillary electrometer contains two assumptions. The first assumption would apply to any electrolytic cell. A deduction from it, which would apply to any cell having a large and a small electrode, is that the variation of the potential difference at the capillary electrode of an electrometer is the same as that of the applied electromotive force. In order to trace the relation between surface tension and potential difference on the view that this first assumption is correct, it is necessary to eliminate the possible effect of depolarisation upon the form of the electro-capillary curve—*i.e.*, the curve which shows the relation between the surface tension and the applied electromotive force. A direct method of examining the depolarisation current is described and applied. An estimate of the magnitude of the depolarisation effect is given, and the circumstances under which the effect may become appreciable are discussed.

The second assumption of the Lippmann-Helmholtz theory, that the electro-capillary phenomena are controlled by a simple variation of the electrostatic surface energy, leads to two conclusions, each of which is beset with difficulties.

a. The form of the electro-capillary curve is remarkably dependent upon the nature and concentration of the electrolyte, and depolarisation is quite insufficient to account for the dependence.

b. The conclusion that the potential difference between the solution and the capillary electrode is zero, when the surface tension has its maximum value, leads to the necessity for assuming large potential differences between certain solutions.

The hypothesis that the potential difference between equally concentrated solutions of potassium chloride and iodide is negligible possesses a high degree of probability. It has been shown by previous observers that if this hypothesis be true the points of maximum surface tension on the electro-capillary curves for the above solutions cannot have the significance which Helmholtz's theory gives them. It is shown in the Paper that the first hypothesis of the Lippmann-Helmholtz theory is in striking accord with this hypothesis concerning the potential difference between KCl and KI, when the very definite "descending" branches of the electro-capillary curves are considered. If both the hypotheses just mentioned be true, we get the result that the surface tension of mercury (for a certain range of potential differences) in two solutions is the same for a given potential difference between the mercury and the respective solutions, if the solutions are equally concentrated and possess the same kation. An extension of this result shows that it is indifferent whether the kation be K, Na, or H.

The relation found for the KCl and KI curves can be extended to the other known cases in which the electrometer curves and liquid potential difference calculations seem to be contradictory, in such a way as to account for the apparent contradiction. Several of the cases are examined. The results in the previous paragraph would give a direct and accurate method of finding the potential differences between equally concentrated solutions, and could be extended to the case of solutions of different concentrations. The probability that the electro-capillary curves are never completely free from influences other than electrostatic is shown by an examination of the relations between the curves for unequally concentrated solutions of the same salt. In confirmation of results obtained by G. Meyer, in a slightly different way, it is shown that if the potential difference between KCl and KI is very small, the potential fall from a half normal solution of KI to a dropping electrode of the Paschen type is about a quarter of a volt greater than that from a half normal solution of KCl to the same electrode. In the same way the potential fall from KI to mercury when the surface tension is a maximum is about a quarter of a volt greater than that from KCl to mercury when the tension of the surface separating the solution from the mercury is a maximum. These results follow from direct observations with dropping electrodes, and give further support to the view that the first assumption of the Lippmann-Helmholtz theory is true and that the second is not.

THE REFLECTION OF CATHODE RAYS.*

BY A. A. CAMPBELL SWINTON.

The author has investigated the para-cathodic rays, so called by Prof. S. P. Thompson, which in a focus tube proceed from the front surface of the anti-cathode, and cause the green fluorescence of the glass. By means of a tube in which these rays cast the shadow of a wire upon the opposite end of a tubular annex he has studied their magnetic deflection, and finds it to be in a similar direction to that of cathode rays. By means of another tube containing a small Faraday cylinder, into which some of the para-cathodic rays were caused to pass, he has determined that the para-cathodic rays carry negative charges. The author has previously shown that para-cathodic rays produced Röntgen rays, where they strike the glass; they also produce green fluorescence, hence he concludes that para-cathodic rays are simply reflected cathode rays. The mechanical force exerted by these reflected cathode rays appears to be exceedingly small, and is insufficient to account for the inverse rotation of radiometer wheels, which, as described by the author in the *Phil. Mag.* for October, 1898, occurs when the wheels are placed just outside the cathode stream. Indeed, all experiments designed to produce rotation by the impact of reflected cathode rays failed, and in some cases the wheels were found to rotate most persistently in a contrary direction, showing that, whatever be the cause of such inverse rotation, it is more potent than the force of impact of the reflected rays.

The reflection of cathode rays is largely diffuse, but not altogether so; experiments with a polished concave platinum reflector, capable of rotation, gave, under certain conditions, distinct visual evidence of true specular reflection, with equal angles of incidence and reflection. In addition to the specularly reflected rays, the anti-cathode reflector was also found, under certain conditions, to give off a well-defined beam of other rays normal to its surface, which caused fluorescence of the glass. The exact nature of these normal anti-cathode rays calls for further investigation.

The author has studied and quantitatively measured the electric charges carried by reflected cathode rays for different angles of incidence and reflection by means of special apparatus. A tube was constructed for this purpose, in which a polished flat platinum reflector could be set at different angles to the incident cathode rays. This tube was fitted with a movable Faraday cylinder, which was capable of rotation round the reflector, so that throughout a single plane the whole field traversed by the reflected cathode rays could be explored. The amount of negative charge imparted to the movable Faraday cylinder at different positions, and with different angles for

* From the *Electrical Engineer* of New York.

† Abstract of a Paper "On the Nature of Electro-capillary Phenomena. 1. Their Relation to the Potential Differences between Solutions," read before the Royal Society, January 26 1899.

* Abstract of a Paper read before the Royal Society, Feb. 9, 1899.

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the reflector, were measured both by a reflecting galvanometer and also by a quadrant electrometer. Many complete series of observations for different positions both of reflector and cylinder were made, and all agree in showing that the field of reflected cathode rays is not uniform, but increases more or less gradually on both sides up to a maximum, which occurs almost exactly at the point that makes the angle of reflection equal to that of incidence. Further experiments show that the amount of charge carried by the reflected rays increases as the angle of incidence is made more slanting, and that the electrification of the reflector itself, which is strongly negative when the incidence of the primary cathode rays is normal, gradually falls to zero as the incidence is made more slanting, until with very slanting incidence the electrification becomes slightly positive. The author compares this result with that described by him in the *Roy. Soc. Proc.*, Vol. LXIII., pp. 434—435, viz., that cathode rays which strike the anti-cathode normally, are more efficient in producing Röntgen rays than those which impinge upon it very much on the slant.

The author points out that these results support the view that the Röntgen rays are actually due to the electric charges carried by the cathode ray particles being imparted to the anti-cathode.

EXPERIMENTS BEARING ON THE THEORY OF VOLTAIC ACTION.*

BY J. BROWN.

In former Papers on the "Theory of Voltaic Action,"† I have adduced evidence in support of the view that the difference of electric potential observed near the surface of two metals in contact is caused, or at all events mainly influenced, by the chemical activity of films condensed on their surfaces from the atmosphere (vapour or gas) in which the metals are immersed. From this view it would naturally follow that, if all chemically active films and all atmosphere competent to produce them could be removed, the difference of potential would disappear also. This inference has been pointed out and acted upon by previous experimenters, as is well known; but it appeared to me that no certain test of the theory could be obtained in the way they suggested without elaborate precautions as regards details; and experiments were undertaken in the hope that more definite results might follow greater care in the work. The method adopted was to enclose a copper-zinc volta condenser in a glass tube containing nitrogen at a small pressure, together with metallic potassium and sodium, the expectation being that these metals would absorb any remaining water vapour or other agents (compounds of oxygen, &c.) that could exert chemical action on the zinc.

Experiment I., started December 12, 1888.—The plates having been cleaned with fine glass paper, the condenser was slipped into its tube. A small porcelain cup of phosphorous pentoxide was introduced, in order to dry out the interior, and the tube was then temporarily closed. The difference of potential was then found to be 0·74 volt. The end of the main tube was then sealed at the blowpipe. The tube was exhausted through the side tube by a Sprengel pump, then filled with nitrogen, again exhausted, and then refilled with nitrogen. The condenser plates were now found to be in metallic contact, presumably due to the accidental sucking in of some minute globule of mercury from the pump. In three days this contact ceased. About 3 grammes of potassium and 1 gramme of sodium, in small pieces, were now inserted by the side tube. (My notes do not state that the capsule of phosphorus pentoxide was removed before closing the tube, but probably it was). The tube was again, December 17, exhausted to 3mm., and refilled with nitrogen, when the difference of potential was found to be about 0 64 volt. The tube was finally exhausted to 4·5mm., and the side tube was sealed off, the difference of potential being 0·61 volt. The following observations were then made at the intervals noted in days after thus starting the experiment:—

Days ...	13	25	27	30	61	106	173	181
Volts...	0·56	0·52	0 55	0·51	0·47	0·34	0·32	0 33

It remained to ascertain whether the fall in potential-difference was due to the gradual absorption of chemically active matters by the potassium and sodium, or to the well-known effect of gradual tarnishing of the zinc surface. If, on admitting air and moisture to the tube, the potential-difference increased, the former alternative would be indicated, and the absence of such increase would indicate the other alternative. Before testing this point, it was thought desirable to ascertain whether the pressure originally in the tube had changed. To measure the pressure, the sealed end of the leading tube was joined by a rubber tube and mercury seal to the Sprengel pump, which was worked till the pump gauge showed a pressure of about 2mm. The end of the leading tube was then broken off in the inside of this rubber tube, a notch having previously been filed to facilitate breaking. The pump gauge then fell, and ultimately stood at 90mm. pressure, showing that a considerable amount of gas had been evolved in the tube during its six months' trial. The leading tube was now removed from the pump, and air admitted; air was also blown in by the mouth, to introduce moisture. The difference of potential at once rose to 0·39 volt, and later to 0 48 volt. On taking out and examining the condenser, the zinc was found to be tarnished at the edges, but not much in the middle of its surface; the sodium was scarcely altered, but the potassium had a thick coat of, no doubt, oxide or hydrate, covering a core which burned on water.

Experiment II., started Dec. 9, 1889.—This was intended to be practically a repetition of Experiment I. In closing the end of the main tube, a considerable amount of fumes and moisture from the gas blowpipe was observed to get into it, which may have affected the condition of the zinc surface. The moisture was removed by warming the tube and washing out with air. Eight grammes of potassium were inserted, but no sodium. The nitrogen pressure before sealing off was 5mm. After sealing off, the difference of potential was found to be 0·70 volt, and fell thereafter more or less regularly for a year and a half, when, on June 9, 1891, it had diminished to 0 52 volt. On opening the tube this value did not sensibly change. The fall in difference of potential was, therefore, probably due to tarnishing of the zinc merely. The potassium in the tube was very little altered.

Experiment III., started June 15, 1891.—The arrangement was the same as in Experiment I, except that, after the tube had been exhausted and finally sealed off, the 9 grammes of potassium and 3 grammes of sodium which had been introduced, were fused together, forming the alloy that is liquid at ordinary temperatures. The difference of potential was at first about 0·75 volt. During the first year, the whole tube (except when being examined) was kept immersed in a bath of petroleum, to prevent leakage of air, in case of minute imperfections at the sealed in wires or elsewhere. The difference of potential on July 22, 1892, was about 0·67 volt. The tube, no longer kept in petroleum, was examined occasionally for the next six and a-half years, till November 4, 1898, when it was opened. The pressure had risen to about 59mm. of mercury. The difference of potential just before opening was about 0·49 volt; and after opening and blowing in there was little appreciable change in this value. If anything, it seemed rather lower; though the rapid tarnishing of the potassium-sodium alloy, when a new surface of it was exposed, indicated the presence of an ample amount of oxidising medium. The decrease of potential difference, in this case also, was, therefore, probably due to tarnishing of the zinc surface. The zinc was almost as bright as when enclosed seven and a-half years before; but polishing a small portion of its surface with glass paper showed that a slight film had formed.

Of the three experiments, the first is the only one that lends any support to the hypothesis they were designed to illustrate. The laboratory notes show no difference between the first experiment and the other two, beyond what may be gathered from the foregoing account. It seems unlikely that the three days of accidental metallic contact in the first experiment or the distance apart of the plates in intervals between observations can have affected the result; and I am unable to suggest any other explanation except the possibility that the phosphorus pentoxide was left in the tube as well as the potassium and sodium. I found on a previous occasion,* that when this substance was enclosed with a copper-zinc pair, so as to dry the air surrounding the pair, the difference of potential fell in 134 days by one-sixth of its first value, and rose to its original amount immediately on admission of the ordinary atmosphere. In No. III. certainly no phosphorus pentoxide was enclosed, and there is no mention of it in my notes of No. II.

Though the experiments cannot be quoted as confirming the chemical hypothesis, which I still think to be supported by an overwhelming weight of evidence, it has been thought worth while to describe them, if only to show the extreme difficulty of eliminating the last traces of active matter from the gas employed. That this is the real difficulty in the way of obtaining positive results is well illustrated by the ingenious experiments of C. Christiansen.† He found, among other things, that when the metal (of a pair) near which positive potential is usually observed is exposed, for a minute fraction of a second, to an inactive gas, such as hydrogen, the observed potential difference is very much smaller than when the exposure lasts for a considerable time. The metal exposed by Christiansen was a jet of liquid amalgam, flowing from a drawn out glass tube. Its surface was thus perfectly clean, and the time of exposure to the surrounding gas was merely the interval between the instant at which the amalgam left the nozzle and that at which it broke into drops. The difference of potential observed, when

* Abstract of a Paper read before the Royal Society, February 23, 1899.

† *Phil. Mag.*, Vol. VI. (1878), p. 142; *ibid.*, Vol. VII. (1879), p. 109; *Roy. Soc. Proc.*, Vol. XLI. (1886), p. 294.

* *Roy. Soc. Proc.*, Vol. XLI. (1886), p. 305.

† *Wied. Ann.*, Vol. LVI. (1895), p. 644.

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carbon was opposed to a jet of zinc amalgam in hydrogen in this manner, was only 0·15 volt; while in air it was 0·89 volt. If more time had been allowed, the impurities in the hydrogen would have diffused in larger quantity towards the zinc, and given a larger effect, similar in character to that observed in my experiments, where the metals are exposed to the gas for a period amply sufficient for all such action.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *February 3, 1899.*

Consolidations of Electrical Interests.—One of the most striking features of the many consolidations of the last year or two is the attention which has been devoted to companies whose work is founded on the electrical arts. Among the manufacturers of electrical apparatus as well as companies operating telephone, central station and street railway systems, the promoter of syndicates has been at work with a success that stimulates, and is in turn helped by the eagerness of the financial public to invest and speculate in electrical securities which are now the most prominent industrials dealt in. The general movement is the outcome of the demand for the production at the lowest possible cost. In the manufacture of electrical goods the company operating on a large scale has in this respect the same advantage over smaller competitors that exists in other lines. In another direction the industrial combinations present an important national advantage. The United States has been rather late to develop foreign markets for its manufactures. It has to contend in that quarter with countries that have occupied the field for scores of years, and that have the great advantage of low priced labour. What the so-called trust can accomplish in that line has been shown by the ability of a large concern such as the General Electric Co. to compete successfully for business in foreign countries, where, if the industry it represents were scattered among a dozen or so separate concerns, the ability to bring the American product to the front, or to sell at prices that make one competitor effective, would be materially smaller. The general opinion appears to be growing that consolidation is the inevitable tendency of the management of all industry and that public legislation against it is futile and should be given up in favour of regulation and control. There is now a noticeable tendency towards the consolidation of the small central stations scattered among the different country towns similar to the widespread consolidation of the gas interests of the last decade. The securities and the stock of the small companies are all bought up by bankers in the financial centres and often paid for entirely by the issue of bonds of the syndicate formed. The change is thus, as a rule, a beneficial one, although, like many other contemporaneous industrial changes, it takes the control out of the hands of local owners and put it into the hands of a few bankers in the large cities.

The Latest Progress in the Application of Storage Batteries.—Mr. Joseph Appleton read a Paper before the New York Electrical Society on January 12, and gave some interesting facts regarding the application of storage batteries, as exemplified in the most recent plants. The history of the storage battery in this country, he said, is curious and probably comprises more troubles and trials than any other branch of the electrical industry. Until 1894 the use of storage batteries in this country proved most disastrous to all concerned on account of their poor design and inattention to the mechanical features. Now the conditions are very different, and the business has been put on a proper and substantial basis. In 1894 the weight of plates alone in use was 349,000lbs., and in 1897 it was 3,807,300lbs. The figures for 1898 have not yet been tabulated. One of the most valuable features of a storage battery is that it will safely take care of any sudden or momentary overload in the system, such as grounds or short circuits, and, if operating in parallel with generators or rotary converters, will relieve them of such overloads and consequent strain. In case of batteries operating on railway loads it is a common thing to see an occasional momentary discharge at a rate equal to twice the one-hour rate of the battery. The modern storage battery is designed to stand such occasional extreme discharges, and to do so without injury. Mr. Appleton considered a few representative storage-battery installations to show the great flexibility of the battery as an adjunct to any scheme contemplating the generation and transmission of electrical energy. The storage-battery installation of the Chicago Edison Company was first considered. This battery carries about 11,000 amperes during the peak of the load or about 25 per cent. of the total load. The batteries, under these conditions, take care of the maximum load during the short time it occurs, and increase the load on the generators during the remainder of the time when they have to be charged. This battery is used in addition to carrying the peak of the load, for maintaining a constant pressure on the system, and considerably relieves the switchboard attendants. The application of storage batteries to stations such as this can be made in two ways, namely, at the power-house and in sub-stations. When batteries are placed in sub-stations they will relieve the generating plants of the maximum load, as just described, and also effect a large saving in the underground system of conductors, as at the time of maximum load the conductors between the main generating station and the sub-stations are relieved of that portion of the load which is carried by the batteries and distributed from the sub-stations. He cited the Niagara and other plants as illustrations of the uses of the storage battery. The power from such a plant is largely sold for manufacturing purposes, and is charged for at so much per horse-power per annum, the power being available 24 hours per day. Mills and factories using this power do not usually run more than 10 hours per day; therefore, a man who requires a maximum of 100 H.P. for 10 hours a day, or 1,000 H P. hours, really has to pay for 2,400 H.P. hours, while he uses only 1,000, or probably less. With a storage battery capable of supplying 50 H.P. for 10 hours, or 500 H.P. hours, he need only pay for one-half the amount, or 50 H.P. for 24 hours, as the battery will furnish the remainder, and can be charged during the 14 hours he is not using the power. In addition to this, the battery will take care of any fluctuations above the average, and enable the man to buy the average amount of power he requires instead of the maximum. Such an installation has been made for the Buffalo General Electric Co. Before the Company installed the battery they were only able to shut down their steam plant from 11:30 p.m. until 5 a.m., during which time the rotary converters carried the entire load, which averaged 600 H.P., but they were paying for 2,000 H.P. With the aid of the battery they are enabled to shut down their steam plant from 7 p.m. until 7 a.m., and about 18 hours on Sunday. An illustration of the second method of using the storage battery for railway work is the installation of the South Side Elevated Railway Co., of Chicago. This Company operates an elevated railroad about nine miles long, all its trains being equipped with the Sprague multiple-unit system. The power house is located approximately at the centre of, and the two storage batteries near each end of, the line, and are connected directly across the system without a booster. The charge and discharge of these batteries is controlled by the drop over the feeders from the power house to the batteries, this drop varying according to the load on the system, from 10 to 30 volts. When the load is light the drop in the feeders is small, and there is voltage enough to charge the battery. When the load becomes heavy the drop on the feeders is increased. This consequently causes the battery to discharge into the line. The method of operating is entirely automatic. In each of the battery rooms there are installed 248 cells, having a capacity of 1,000 H.P. when discharging at the hour rate. The battery installed at the end of the line in this way increases the capacity of the power house and saves the investment in copper by making it necessary to transmit over the feeders only the average amount of current required instead of the maximum and at the same time maintaining the proper voltage at the end of the line, thereby enabling the motors to run at the points of highest efficiency.

The Rapid Transit Problem.—On Jan. 24 the New York Rapid Transit Commission submitted a memorial to the State Senate. It reviewed the futile efforts of the commission

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to carry out the provisions of the rapid transit law and its consequent inability to proceed further in its work unless additional legislation is enacted. Owing to the financial affairs of the city it was impossible to borrow money required to construct the municipal railway as contemplated by the Act of 1894, and the commissioners have been compelled to consider what courses are now open to obtain the relief so long and urgently needed. Three courses suggest themselves: First, to wait until the borrowing capacity of the city is so enlarged by the reduction of its present debt, or by an increase of assessed valuations of real estate, or by both, so as to enable it to borrow the necessary funds; second, to obtain legislative authority to issue bonds for the county of New York for the construction of the proposed railway; and third, to obtain legislative authority to offer the franchise for building and operating the proposed railway to private enterprise.

CORRESPONDENCE.

THOMPSON-WALKER SURFACE-CONTACT SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I must apologise to Prof. Ayrton for an error in my reply upon surface contacts at the Institution of Electrical Engineers. I find that no mention is made in our printed British Association Paper of the method of picking up. So that Prof. Ayrton was right and I was wrong. I must, however, in justice to myself, say that the trade circular which was issued before our Paper, and circulated at Bristol, and which contained a much fuller description of the system, mention is made of the accumulators used for picking up. Moreover, Prof. Thompson, at Bristol, alluded to this method of regaining contact.

Your readers will also understand that a 500-volt accumulator is not at all a necessity, because the force operating the switch is normally 10 times greater than is necessary to close it slowly.

In a line for which we are tendering in the North of England we propose to put in a hand generator somewhat larger than that used in an Evershed testing set. One turn of the handle gets up speed *on open circuit*; the circuit is then closed, and the impetus of the armature picks up the switch.—Yours, &c., MILES WALKER.

London, Feb. 24.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: By this time you are doubtless aware that the leading article in your last week's issue contained many incorrect statements concerning myself. An examination of the description of the Thompson-Walker system, as it was actually given in the B.A. Paper, at Bristol, would have convinced you that that Paper contained no reference whatever, first, to any accumulators being used or being necessary on each of the cars; second, to any means being required for preventing the whole tramline becoming blocked, and remaining blocked, if the main circuit were broken even for a fraction of a minute.

Without any suggestion, or letter, from myself, Mr. Miles Walker now sends me his apologies for the error into which he has fallen, and adds:—"I find that no mention is made of the method of picking up in our B.A. Paper, so that you were right, and I was wrong."

To the mistaken statements made by Mr. Walker at the last meeting of the Institution, and to the unfounded conclusions drawn in your leader I have prepared my reply. Probably, however, you would prefer to remove the necessity of my publishing it by withdrawing that portion of the article which concerned myself.—Yours, &c.,

W. E. AYRTON.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As I was, unfortunately, unable to be present at the discussion on Mr. Walker's Paper, and your report of the discussion makes no allusion to the matter, may I be allowed to put to Mr. Walker the question which first occurred to me on reading his Paper in the columns of your journal? It is in connection with the use of oil in the boxes to keep out water from the switch, and to facilitate the working of the plunger.

My difficulty is: What becomes of the early morning service after a frosty night? It seems to me that the oil (which, as we know, freezes at a comparatively high temperature) will, in freezing, absolutely prevent the plunger moving or the switch closing.

In a severe winter the lines might thus be closed for days together.

I can hardly conceive that the designers have missed this difficulty, but I should be much interested to know how it is got over, if it exists.—Yours, &c., A. M. TAYLOR.

Old Charlton, Kent, Feb. 24.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Thanks to your courtesy, I am enabled, in Mr. Walker's absence, to at once reply to Mr. Taylor's letter, and to assure him that when the temperature falls to the freezing point of paraffin oil, the inventors do not propose to work the system.—Yours, &c., CHARLES E. HOLLAND.

Hampstead, March 1, 1899.

LEGAL INTELLIGENCE.

Castner-Kellner Alkali Co. (Limited) v. Commercial Development Corporation (Limited).

This case came before the Court of Appeal, composed of the Master of the Rolls and Lords Justices Rigby and Vaughan Williams, on Tuesday, on the appeal of the defendants from the order of Mr. Justice Bigham on Aug. 3 last. The action was brought by the plaintiffs, who are the registered owners of letters patent No. 20,259 of 1894, granted to Carl Kellner, for an invention of improvements in electrolytic apparatus for decomposing alkaline salts, and for an injunction restraining defendants from manufacturing or selling caustic soda or other alkali, in infringement of their letters patent. It will be remembered that the plaintiffs were the owners of two patents—one taken out by Mr. Castner and the other by Mr. Carl Kellner, both of which had reference to the manufacture of caustic soda by separating the sodium from the chloride by the action of electricity. The difficulty of the ordinary process was that owing to the strong affinity of sodium for oxygen, before the amalgam could be removed from the salt solution and treated with pure water, the sodium began to go back to combine with the oxygen of the water of the salt solution. The plaintiffs' patents sought to overcome the difficulty by the adoption of a continuous process. In the Castner patent a circular chamber was used divided into two halves by a diaphragm, or partition, which did not quite touch the bottom of the chamber. Enough mercury was placed in the chamber to seal the two halves one from the other. In the one half salt solution was placed, and in the other water. The mercury, when charged with sodium in the first half, was removed to the other half by means of a paddle. Kellner professed to improve on this process by allowing the mercury to remain stationary relative to its containing vessel, and his claim was for "an apparatus for the electrolysis of alkaline salts with the aid of a stationary mercury cathode." Instead of a chamber divided into two halves he used a large chamber, called the combining chamber, which contained water and mercury and a smaller chamber or series of chambers, called the decomposing chamber, containing the salt solution. These chambers were in the form of bells, and were so placed as to dip into the mercury, which thus sealed them, separating the water from the salt solution. The bells were moved to and fro slowly, so that the mercury should be exposed alternately to the action of the salt solution and the water. Notches were cut in the edges of the bells to let the mercury pass, or alternatively grooves were cut in the bottom of the outer vessel. This was the apparatus described in Figs. 1, 2, 3, 4 and 5 of the complete specification. In another form, described in Figs. 7 and 8, the bells were arranged radially, and either the bells or the outer or combining chamber rotated The apparatus the defendants proposed to use was patented by Mr. Rhodin in 1896, and consisted of two circular chambers, one inside the other. The outer chamber was the combining chamber and contained water and mercury. It was fitted with radial ribs at the bottom, and rotated. The inner or decomposing chamber, which contained the salt solution, had, at the bottom, projecting mouths, which dipped into the mercury, and it was said that by means of the rotary motion of the outer chamber the same result was obtained as in the Castner and Kellner patents, and it was alleged that defendants' apparatus was, in fact, identical with the rotating form of the Kellner patents. The plaintiffs' case was that the defendants had added nothing to the Kellner patent, which was the one sued upon. The defendants attacked the plaintiffs' patent on the ground of disconformity, and they also denied the infringement. Mr. Justice Bigham decided, after hearing a mass of expert evidence (fully reported in *The Electrician* for July 15 and 22, 1898), that plaintiffs' patent was not bad on account of disconformity, and that the defendants had infringed their patent, and he granted the injunction claimed. Hence the present appeal by the defendants.

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Mr. Thos. Terrell, Q.C., Mr. Astbury, Q.C., Mr. MacConky and Mr. J. H. Gray appeared for defendants (the appellants); and Mr. Fletcher Moulton, Q.C., Mr. Bousfield, Q.C., Mr. J. Graham, Mr. A. J. Walter and Lord Robert Cecil for plaintiffs (the respondents).

Mr. TERRELL said his clients were appealing from the judgment of Mr. Justice Bigham holding them liable for threatened infringement, and he thought infringement also of a patent taken out by Kellner in 1894, No. 20,259, for improvements in electrolytic apparatus for decomposing alkaline salts. The subject to which the patent applied was a very extensive trade in the manufacture of caustic soda. That was a combination of the metal sodium with oxygen used in the arts and soap making, many hundreds of thousands of tons being used in a year. Caustic soda had always been manufactured from common salt, which was a combination of chlorine and sodium, and the problem in the manufacture of caustic soda was to get rid of the chlorine which was combined with the metal sodium and common salt and to substitute for the chlorine oxygen. That was the problem to be solved. For many years that had been done, and was still done chemically. Many years ago it was ascertained that you could decompose metallic salts by an electric current. You passed a current through a cathode, through an electrolyte, and through an anode, with the result that the sodium was separated from the chlorine, the salt was decomposed, the metal was decomposed on the one side, and the acid of the salt or the chlorine or oxygen was evolved at the other end of the apparatus. In that way metals were produced from salts. That was used in the process of electro-plating. As soon as that was understood it was obvious that the same thing could be done with chloride of sodium You could, by passing an electric current through chloride of sodium, obtain metallic sodium at one end, and the evolution of chlorine at the other. But there was a difficulty, because the avidity the metallic sodium had for oxygen was so great that as soon as it was formed by the electric process it was decomposed again. Sir Humphrey Davy discovered a fact which was the foundation for all the electrolytic proposals for the decomposition of chloride of sodium, and that was that if you used a cathode which was composed of mercury the mercury absorbed the metallic sodium and protected it from the action of the water contained in the fluid for a certain time, so that by way of electrolysis you could obtain metallic sodium, but you obtained it alloyed by a large percentage of mercury. Subsequently to that discovery, a great many attempts were made to utilise this discovery in the arts, and he (counsel) would have to deal with those attempts at some length, because he wanted their lordships to exactly understand what it was that Kellner invented, why he said that patent was bad, and why he said that defendants had not infringed it.

Lord Justice RIGBY: You say both, do you?

Mr. TERRELL: Yes. I say his patent is bad from disconformity. Then I say the plaintiffs' patent is bad from want of subject matter, and, finally, that I have not infringed it. The learned counsel said that the first attempt at putting Sir Humphrey Davy's process into use was by a patent taken out by Atkins and Applegarth, with which it would be necessary to trouble their lordships. Atkins and Applegarth took out their patent in the year 1890—No. 20,768. Their lordships had before them an enlarged drawing of that patent—Atkins and Applegarth diagram, Fig. 1. This process was eminently calculated to waste mercury and eminently calculated to waste labour in the transference of the loaded mercury. This process, therefore, came to nothing, but it was illustrative of the first practical attempt made to utilise the process which had been described by Sir Humphrey Davy. The apparatus was also complicated and imperfect in its operation. The next process was that of Hermite and Dubose, 1891, No. 21,959. That also was eminently calculated to be wasteful in mercury, having regard to the value of the mercury used in comparison to the value of the product. It was also an intermittent process, the mercury being first charged and then discharged, and always kept in a state of flow. Then came Jensen's process of 1893. This was a continuous process, but involving the mechanical carrying of the mercury from one vessel to the other. He would next deal with Castner's process. In considering that process he would point out that the salt was decomposed by the electric current, pure and simple. There was nothing to arrest it, but when they got to the other side of the process the amalgam of mercury might be decomposed by water only, or arrested by an electric current. Now it was very essential in this process that the richness of the amalgam should be kept very nearly constant. If the amalgam was freed from mercury very much quicker than the taking up of mercury it was presented to the action of electrolysis at different stages of richness, which was undesirable and not economical to work. The mercury amalgam, if allowed to be decomposed by water alone, required a very much larger surface of water to discharge it from its sodium than it did the electrolyte to charge it with sodium. If, on the other hand, the current was employed through both sides of the process the discharging process was much quicker than the charging, so they again got their mercury presented with different richness to the process of electrolysis, and Castner appreciated that and Castner achieved what they had now got for the first time—a really continuous process. He used a circular chamber divided into two halves by a diaphragm or partition, which did not quite touch the bottom of the chamber. Enough mercury was placed in the bottom to seal the two halves one from the other. In the one half salt solution was placed, and in the other water. The mercury when charged with sodium in the first half was removed to the other half by means of a paddle, with a rotary motion constituting one continuous flow. But, inasmuch as the two chambers were of the same size, he found a difficulty in this, that if he passed an electric current entirely through both, he got discharge much quicker than charging, and if he passed it through one alone he got the discharging much slower than the charging, so he separated out his electric current. He got a dynamo giving 90 amperes, and a dynamo giving 10 amperes, and so arranged his currents that he balanced the thing. Their lordships would see that Castner had got essentially a continuous process, in which the mercury was continually passing from the one side of the apparatus to the other side by the movement of the paddles, and a process eminently calculated to maintain the mercury at one point of richness. There were two vessels, the mercury travelling from one to the other in one continuous flow, continually absorbing sodium and continually discharging it. Castner showed you at Fig. 3 that he might pump his mercury. The important figures, however, were Figs. 1 and 2. The next patent their lordships would have to consider was that of Sinding and Larson. There, there was a salt solution and a metal bath, A of peculiar shape, caused to be revolved by pulling at the top. As that revolved, the mercury amalgamating with the metal, the mercury was swished up on the surface of A and thrown down on the other side. A was a cup which was revolving, and as it revolved the mercury was taken from the inner side of the vessel, was switched up and passed over the amalgamated surface A and dropped down on the other side. This process could not be made into a commercial success, at least that was what the evidence showed. The evidence showed that none of these patents were practically used with the exception of Castner's, which was a practical apparatus, and which was bought by the plaintiff company. They did not, however, sue the defendants upon that, but sued them upon the Kellner patent, which they bought afterwards. The plaintiffs did not use Kellner's themselves, but some modification of Castner's. He had given their lordships, he considered, enough in the way of specifications to show what was the state of the art when Kellner filed his provisional specification. The state of the art was this:—It was well known that mercury would absorb sodium, and that sodium could be protected by the mercury from the too rapid action of water. It was well known that it could be done by a continuous process by pumping the mercury, or by revolving the mercury as Castner had done. It was well known that they could in that way maintain the mercury at a particular definite stage of richness. The question then arose whether Kellner knew anything about Castner when he filed his specification, and if he did, or even if he did not, what did he mean by his specification? Looking at the language of the specification, he thought it was probable he was aware of Castner at the time he filed it. Kellner professed to improve on the Castner process by allowing the mercury to remain stationary relative to its containing vessel, and his claim was for "an apparatus for the electrolysis of alkaline salts with the aid of a stationary mercury cathode." Instead of a chamber divided into two halves he used a large chamber, called the combining chamber, which contained water and mercury and a smaller chamber or series of chambers, called the decomposing chamber, containing the salt solution, These chambers were in the form of bells, and were so placed as to dip into the mercury which thus sealed them, separating the water from the salt solution. The bells were moved to and fro slowly so that the mercury should be exposed alternately to the action of the salt solution and the water. Notches were cut in the edges of the bells to let the mercury pass or, alternatively, grooves were cut in the bottom of the outer vessel. In another form the bells were arranged radially, and either the bells or the outer or combining chamber rotated. In Rhodin's patent they began by taking a containing vessel, which was the largest vessel of all. That vessel contained water, and in that was put a bottom with the ribs radiated, the object of those ribs being, that as the apparatus rotated, the mercury flowed from the inner side to the outside. It was to give a radial action. The next thing was a china vessel. There was a succession of bells. On the top of the bottom, which contained the mercury, was water. The mercury was supposed to cover the ribs. When this went down the ribs of the bells made a seal between the inside of the bells and the outside. They dipped into the mercury. There was a large extent of water compared with the surface of salt solution exposed to the operation. The salt solution could not get out, because the mercury was sealed. In the anode was a battery and carbon poles, through which an electric current was passing, the poles going into the salt solution. As they operated in the salt water, the mercury at the bottom got charged, and then a rotation was given to the top of the apparatus only, and that rotation being given, the mercury was first under the influence of the salt solution and then under the influence of the water solution, and a radial movement was given to the mercury, so that it flowed out. The mercury was in constant movement, first being operated upon by the electrical action in the salt solution, and then being pushed out by the radial movement all round where the water was, and there decomposed. The inventor in Rhodin's patent did not rely on an auxiliary current of electricity for the purpose of obtaining his electrolytic and decomposed action, but limited his area to water contact. It was not true to say that the mercury in Rhodin was stationary, because it was intentionally given a radial action, not only to enable it, so to speak, to expose a patch to the action of the electric current, and then a patch to the action of the water, but to cause a constant flow of mercury, and so as to expose a large quantity of mercury to the action and flow of water. Under all these influences you might have in one sense a stationary mercury, and in another sense movable mercury. What they had to inquire into was as to the substantial operation of the apparatus. In Castner the movement of the paddles was exceedingly slow. In Castner the mercury was pushed under the bells from place to place by the paddles. In Kellner, by Figs. 7 and 8, the mercury was carried from bell to bell by the friction of the bottom of the vessel which contained it. Kellner's aim was to get mercury from one bell to another. He (counsel) admitted that, if Kellner had been the first to do anything of that sort, it would have been difficult for him (counsel) to show that the variations did not involve infringement of Kellner. But Kellner was only doing that which a great many people did in another way. The essence of Rhodin's patent was the rapid moving of the mercury outwards, but the essence of the Kellner invention was to have it rich and then impoverished, then made rich again and impoverished again. What Rhodin said was, "Move your mercury as rapidly as possible and you will find that you will maintain that definite

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point of richness at which the operation is best conducted." Mr. Terrell said that the substance of Mr. Justice Bingham's judgment was on the words "stationary mercury cathode" in the Kellner specification.

The MASTER of the ROLLS: As I understand it your mercury is as stationary as theirs.

Lord Justice RIGBY: Your cathode, you know, is in one sense stationary and in one sense it is not.

Mr. TERRELL: Yes; although it is stationary in space it is mercury, the particles of which are constantly changing their relation to each other. When your lordships come to hear the evidence of Lord Kelvin you will come to the conclusion that their case is, and the statement in the specification is, that the mercury is practically—I do not say absolutely—in their Fig. 1, stationary in so far as the particles of mercury have reference to each other.

Lord Justice RIGBY: I understand that you have not used your patent?

Mr. TERRELL: We have erected enormous plant, but the working of the patent is in suspension during the present proceedings. We have done enough to prove a commercial value to the thing, and then we stopped until our rights have been decided in the Courts. Counsel then read the evidence given in the Court below.

Referring to the testimony of Mr. Swinburne, the MASTER OF THE ROLLS said he understood from him that the action of the ribs would be to stop the rotary motion of the mercury, and drive it inwards. The defendants were, he believed, at issue with Mr. Swinburne there.

Mr. TERRELL said in one sense, but they were not at issue in another sense.

The MASTER OF THE ROLLS: You want to make out that the mercury moves, but you say it does not matter which way?

Mr. TERRELL: Yes; that it must move in order to get from one place to another seems obvious.

Lord Justice RIGBY: That is part of your case, and an important one.

Mr. TERRELL: Yes, and Mr. Swinburne says there is a stirring and a movement, and if there is a stirring there must be movement. Whether produced by centrifugal action driving the mercury outwards, or whether it was produced by the mercury re-attaining its level after being driven inwards did not matter. The whole object of the apparatus was to change the position of the mercury.

Lord Justice WILLIAMS: Whether you take Kellner's or Rhodin's system, it is not really true to say that there is no motion of the mercury whatsoever?

Mr. TERRELL: I agree. We say there must be a motion of the mercury, but we say Kellner places his mercury under each bell by the movement of the bells, and we change the mercury by the movement of the mercury.

Counsel, continuing, remarked that the evidence showed that all that was required to make Castner do exactly what Kellner did was to make Castner's paddles work faster.

Mr. TERRELL asked if their lordships would like to see Rhodin's machine work.

The MASTER OF THE ROLLS said that they would, and the model was then charged with mercury and set to work.

Lord Justice VAUGHAN WILLIAMS: Is mercury a difficult thing to mix?

Mr. TERRELL: No.

Lord Justice VAUGHAN WILLIAMS: More difficult than water. If you have got a glass of water, and you introduce a spoon or glass vessel into the glass of water, you will mix together the particles of which the water consists considerably. If you were to put the same spoon or the same glass into the glass of mercury, although you could displace the particles the moment you withdrew your spoon, to a large extent the particles would go back to the same place as they had been displaced from.

Mr. TERRELL: I can quite understand your lordship thinking that, but quite the opposite takes place. Mercury was exceedingly mobile. Mercury was much easier to mix than water.

Yesterday (Thursday) Mr. TERRELL, Q.C., continued the reading of the evidence, at the conclusion of which he asked their lordships to take particular notice of the fact that Lord Kelvin had stated that the great disadvantage in Kellner's process was the fact that the mercury was undisturbed. Kellner aimed at a steady pool. Lord Kelvin was not referring to "steadiness" with regard to the mercury, but to the steadiness of the mercury *per se*. The object was to get the mercury quiet and unagitated. Lord Kelvin had said that the less the mercury was stirred and agitated, the better, and that was his view of Kellner's patent. Having regard to his view of Kellner when he drew that specification, one must agree with Lord Kelvin; but when you came to Rhodin, Rhodin said he was going to drive his apparatus at high pressure. He said, "I am not going to have an alternating system which would necessitate that I should have richer mercury at one moment than at another." Rhodin said, "I am going to have a good churn up." How, then, could it be said that Rhodin, who professed, intended and did—as the evidence showed—aim at stirring up the whole of the mercury, could infringe a patent which, it was admitted, had for its object the keeping of the mercury as quiet as possible? He submitted that it could not be said, on the evidence of the plaintiffs' witnesses even, that the defendants had infringed the plaintiffs' patent for that reason. The defendants, however, said that even if they did infringe the plaintiffs' patent, that patent was bad for disconformity, because if defendants had infringed this patent they infringed figures 7 and 8, and if they infringed those figures those figures decribed the same thing as Rhodin did, viz., agitation of the mercury and the transference of the mercury in that way from one cell to another, which was opposed to what Kellner did in his provisional specification. The defendants also said that there was no subject matter.

Mr. ASTBURY followed on the same side, and said that Kellner's was simply a paper patent. It had never been worked and nobody knew whether it would work. The plaintiffs who owned it did not even run the risk of experimenting with it, either in or out of Court, and there was no evidence of utility in any way. The defendants' case was that the Kellner patent was useless unless they did that which Castner did. Castner was the first to show how this perfectly well-known process of electrolysis could be carried on in one machine instead of two.

The further hearing was adjourned to this day (Friday).

Postmaster-General v. Edinburgh Corporation.

Sheriff Rutherfurd has delivered judgment on the application of the Postmaster-General for an order upon the Lord Provost, Magistrates and Council of Edinburgh requiring them to consent to the placing and maintaining of a line or lines of underground telegraphs in certain streets in Edinburgh.

His LORDSHIP remarked that the questions raised in this case were of some novelty and dificulty, and involved the consideration of numerous statutory enactments. It appeared that the Corporation of Edinburgh, as the authority having control of the streets and public roads within the burgh, had declined to give consent to an application by the Postmaster-General for permission to lay underground telegraphs in specified places, and a difference had arisen between the parties within the meaning of the Telegraphs Act, 1878, which he was called upon to determine by a notice at the instance of the Lord Advocate, representing the Postmaster-General. It was maintained by the Corporation that the averments in the note were irrelevant, inasmuch as they did not specify the grounds upon which the Postmaster-General asked the consent of the Corporation to lay down the telegraph wires in question. In his opinion that was not necessary. Under the Telegraph Acts the Postmaster-General had power to place and maintain telegraphs under any street or public road, and it was nowhere stated that he must assign the reasons which for the purposes of his department rendered it expedient or necessary to do so. In their second objection the Corporation contended that all the parties interested were not called in respect that, in addition to their consent as the body having control of the streets and roads, the Postmaster-General, before executing the works proposed, must have their consent and that of the governors of George Heriot's Trust and other persons not named as the owners of the solum under some of these streets and roads. The only section of the Telegraph Acts founded on by the Corporation was the 13th, which enacted that, where any landowner or other person was liable for the repair of any street or public road, their consent should be obtained in addition to that of the body having control of the streets or public roads. In the present instance that liability rested upon the Corporation, and the duty was imposed upon them of making, managing, and repairing the streets, and for that purpose of assessing the owners and occupiers of lands and heritages within the City. On the whole he was of opinion there was not sufficient ground for the averment that all parties interested had not been called. His Lordship did not think it necessary to discuss at any length the objection of the Corporation to the effect that consent should not be given to the execution of the works specified on the ground that the wires which it was proposed to lay were intended to be used by the National Telephone Co. He referred to the case of the City of London dealt with by Mr. Commissioner Kerr and afterwards by the Railway Commissioners, and concurred in the opinion of Mr. Justice Wright that the objection was not of a class which it was intended that road authorities should be entitled to make. The fourth objection was that Section 137 of the Edinburgh Municipal and Police Act, 1879, conferred upon the Corporation an absolute right of veto against any opening of the streets by the Postmaster-General for the purpose of laying telegraph wires. That seemed to him an extravagant proposition. If the Corporation were right, no difference, in the sense of the Telegraph Act of 1878, would have arisen between them and the Postmaster-General. Holding the views he did, he was of opinion that no relevant or sufficient reasons had been stated by the Corporation for declining to give the consent required, and he therefore awarded, ordered, and consented that the Postmaster-General should be at liberty to place and maintain the line or lines of underground telegraphs in or under the streets or public roads mentioned in the notice dated May 31, 1898, and along the route therein specified.

Lammer and Geertz v. Clemenci.

On Monday, in the Westminster (London) County Court, a case which caused much amusement was heard. A firm of electricians sought to recover £3. 6s. 4d. for work done in connection with an electric table, supplied to defendant, and for which he paid 32s. It was made so that when defendant's performing bear was placed on it electric currents caused him to dance. When the table was tried it was found that the shock was not strong enough. Defendant then ordered the extra work now sued for to make the shocks stronger. Extra batteries and wires were applied to the table, but then the bear would not dance.

Judge LUMLEY SMITH: Is the bear here?

Mr. BAMFORD (for plaintiffs): I have given notice to produce it and the table.

Mr. MERTON (defendant's solicitor) said the table was produced, but it was thought advisable not to produce the bear—it attacked someone once.

Mr. LAMMER said he agreed to make an electrical table—not to make a bear dance. The currents were not made so strong at first, as defendant said the bear had such fine feelings. He said its feet were more tender than a man's. He was prepared to alter the table, by putting copper plates in place of the wires under the cloth.

Mons. CLEMENCI said he was proprietor of a performing bear, and he considered plaintiffs had failed to provide what they had agreed to—a table upon which a bear would dance.

In the end judgment was given for plaintiffs for £2. 2s. with costs.

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TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

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"Practical Telephony."—By Dane Sinclair and F. C. Raphael.

"'The Electrician' Wireman's Pocket-book."

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The "Big Blue Book" for 1899 is Now Ready. The Directory Division has been corrected up to Feb. 8, 1899, and all the latest new names, changes of address, &c., will be found included. The Handbook Division has been much extended, many valuable tables having been added. The volume contains, also, the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways, finally corrected to Feb. 9, 1899. The price of the Directory and Handbook remains the same—10s., post free 10s. 9d.; abroad, post free, 12s. (United States 13s. 6d.)

TENDERS INVITED.

As announced in our advertisement columns, the *Great Central Railway Co.* invite tenders for the supply of stores and materials during the twelve months ending April 30, 1900, including electric light and telegraph materials, asbestos packing, crucibles, india-rubber, screws, signal materials, tools, wire, &c. Applications regarding patterns to Mr. A. W. Longden, storekeeper, Junction-street Mills, off Ducie-street, London-road, Manchester. Specifications and forms of tender may be obtained from the secretary (Mr. Oliver S. Holt), with whom tenders must be lodged by 10 a.m. of Tuesday, the 14th inst.

The Guardians of the *Poplar* (London) Union invite tenders for the supply and erection of (*a*) steam turbines and dynamos (direct coupled), (*b*) electric motors, (*c*) accumulators, (*d*) electric cables, wiring, and fittings, and (*e*) main switchboard and distribution boards. Conditions, &c., may be obtained at the offices of the consulting engineer (Mr. F. J. Warden Stevens), Connaught-mansions, 34, Victoria-street, London, S.W., and tenders must be sent in to the clerk to the Guardians (Mr. G. H. Lough), before 6 p.m. of Wednesday, 22nd inst. Further particulars are given in an advertisement.

The committee of the *Stockport* Sunday School require tenders for the electric lighting of their premises. Some particulars are given in an advertisement, and applications for permission to view the premises should be made to the secretary not later than March 24.

As announced in an advertisement, the *Dundee* Gas Commissioners invite tenders for the supply and erection of four Lancashire boilers, two 450 H.P. steam engines and dynamos and one 700 H.P. steam engine and dynamo. Specifications, &c., can be obtained from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope Crescent-road, Dundee, and tenders must be sent to the town clerk (Sir Thos. Thornton), City Chambers, Dundee, not later than March 15.

The *Greenock* Board of Police invite tenders for the supply of low-tension mains, including the erection of arc lamp poles, &c. Further particulars are given in an advertisement, and specifications, &c., can be obtained from the burgh electrical engineer (Mr. S. E. Fedden), Municipal-buildings, Greenock. Tenders to the town clerk (Mr. G. MacCulloch), on or before March 16.

The Electric Lighting committee of the city of *Aberdeen* invite tenders for the supply of copper strip. Particulars and forms of tender may be had from the city electrical engineer (Mr. J. A. Bell), Electricity Works, Cotton-street Tenders to the Town clerk (Mr. W. Gordon), Town House, Aberdeen, by 10 a.m. of March 10. See advertisement.

The *Glasgow* Corporation invite tenders for the reconstruction of tramways. Specifications, &c., can be obtained on application to Mr. John Young, general manager, 88, Renfield-street, Glasgow. Further particulars are set out in an advertisement, and tenders must be lodged with the town clerk (Sir J. D. Marwick), City Chambers, Glasgow, by 10 a.m. of Wednesday, March 15.

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The Electric committee of the County Borough of *Belfast* invite tenders for the supply and erection of switchboard extension. Specifications, &c., may be obtained from the city electrical engineer (Mr. Victor A. H. McCowen). Further particulars are given in an advertisement, and tenders must be lodged at the office of the town clerk (Sir Samuel Black) by noon of March 16.

The *Ambleside* Council invite tenders for the supply of gas engines, generators, boosters, switchboard and battery, and mains. Particulars from Messrs. Hopkinsons and Talbot, 29, Princess-street, Manchester, or 26, Victoria-street, London, S.W. See also advertisement.

The *Brighton* Corporation require tenders for a 20-ton travelling crane. Tenders to town clerk (Mr. F. J. Tillstone), before 10 a.m. March 6.

The Vestry of *Hammersmith* (London) invite tenders for the supply and erection of three water-tube boilers, two 1,000 H.P. slow-speed engines, coupled direct to two 600 kilowatt alternators, underground feeders and cast-iron pipes. Tenders to Town Hall, Hammersmith, before 5 p.m. March 15.

The Lighting committee of the *Canterbury* Corporation require tenders for the supply and erection of :—(*a*) Boiler-house plant, (*b*) engine-house plant, (*c*) extension of switchboard, (*d*) extensions to mains. Tenders by March 14.

Stockport Corporation require tenders for two 140-kilowatt shunt-wound dynamos. Tenders by March 9.

The *Harwich* Corporation invite offers for the transfer of their provisional order. Tenders by May 17.

The *Edinburgh* Town Council invite tenders for condensing plant, with water-cooling tower, feed-water tanks and filters, for their Macdonald-road electric lighting station. Tenders by March 6.

The *Edinburgh* Corporation invite tenders for the supply of electric lighting materials for the Powderhall destructor, and also for the upholding of electric light installations and supplies and other works for the departments of the resident electrical engineer, burgh engineer and road surveyor. Tenders to town clerk by 11th inst.

The *Southend* Corporation invite tenders for the temporary transfer of their provisional order. Tenders to town clerk by April 6.

The *Lewes* Corporation invite offers for the erection of electricity supply works. Tenders by March 24.

Tenders are invited for the electric lighting of a portion of the *Winchester* public offices, public library and art school. Tenders to town clerk by 7th inst.

The *West Hartlepool* Corporation invite tenders for the erection of an electric lighting station. Tenders to town clerk by 13th inst.

Tenders are invited for the supply of stores for the *Southampton* Corporation's electrical department. Tenders to deputy town clerk by 6th inst.

Tenders are invited for the construction of electric tramways in *Moscow*, and application for forms of tender should be made to the Moscow City Council by April 12. Tenders by Oct. 1, 1899.

The municipal authorities of *Villarrubia de los Ojos* (Ciudad Real), Spain, invite tenders until the 15th inst. for the electric lighting concession for 15 years. Tenders to El Secretario del Ayuntamiento.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been received by the Leyton Council for the supply of a motor generator and switch gear for charging backward cells of a secondary battery :—

General Electric Co. (*accepted*)	£90	10	0
Electric Construction Co.	161	10	0
John Fowler and Co.	127	0	0
Fuller-Wenstrom Electrical Manufacturing Co.	105	0	0
Brush Co.	96	0	0

The Lowestoft Town Council have accepted the following tenders for the supply of electric lighting plant :—

Babcock and Wilcox (boilers, economisers, feed pumps, pipe work, &c.)	£2,421	0	
Musgrave and Co. (steam dynamos and motor boosters)	2,833	0	
Chloride Electrical Storage Syndicate (batteries)	1,531	0	
Laurence, Scott and Co. (main switchboard and connections)	875	0	
Carrick and Ritchie (overhead travelling crane)	265	0	
Callender's Cable and Construction Co. (mains and conduits, road work, &c.)	8,162	10	
J. W. Brooke and Co. (arc lamps and posts, &c.)	802	0	

The following tenders are recommended for acceptance by the Electric Lighting committee of the Edinburgh Town Council :—

James Kinnear (mason and joiner work)	£25,000
Pritchetts and Gold (storage batteries)	6,665
Carrick and Ritchie (overhead travelling crane)	545

The Leeds City Council have accepted the tender of Messrs. John Fowler and Co. for the supply of steam pipes and connections for the tramway generating station, at £1,390.

The Derby Town Council have accepted the tender of Babcock and Wilcox (Limited) for the supply of two boilers and accessories for the electricity works at £2,340.

The West Hartlepool Corporation have accepted the tender of Callender's Cable and Construction Co. for the supply of feeders, mains, arc light leads and roadwork in connection with their electricity supply undertaking, at £8,770. 2s. 4d. Messrs. Siemens Bros. and Co., W. T. Henley's Telegraph Works Co., W. T. Glover and Co., the Western Electric Co., and the British Insulated Wire Co., also submitted tenders.

The Fulham (London) Vestry have accepted the tender of Messrs. Wilkinson Bros. for the erection of an electricity generating station and refuse destructor buildings, at £22,755. 5s. 1d.

The Electric committee of the Belfast Corporation have accepted the tender of the Reason Manufacturing Co. for the supply of incandescent electric fittings for street lamps.

APPOINTMENTS VACANT AND FILLED.

As will be seen from an advertisement, the Salford Corporation require an assistant electrical engineer. Applications, addressed to chairman of Electric Light committee, must be lodged with the town clerk (Mr. Samuel Brown), Town Hall, Salford, before 9 a.m. of 10th inst.

The Tramways committee of the Manchester Corporation invite applications for the position of manager for their car building and repairing works. Particulars from the secretary of the tramways department (Mr. J. M. McElroy), Town Hall, Manchester. Applications to the chairman of the Tramways committee by 13th inst. An advertisement gives additional information.

There is a vacancy for an improver at the Barrow-in-Furness Electricity Works. Applications to the borough electrical engineer, Mr. H. R. Burnett. See advertisement.

A mechanical draughtsman is required for three months at the Bristol Electricity Works. Application to the city electrical engineer, Mr. H. Faraday Proctor. See advertisement.

The National Electric Free Wiring Co. (Limited) require a manager for their Bradford and Yorkshire branch. See advertisement.

There is a vacancy for an assistant in the Physics and Electrical Engineering Department of the Blackburn Municipal Technical School. Salary £110. Applications to secretary by March 13.

Mr. W. C. Pinn has been appointed second assistant engineer at the Derby Electricity Works, in place of Mr. A. S. Black, resigned.

BUSINESS NOTICES.

Messrs. W. Kingsland, J. H. Elwards and E. H. Armstrong, trading as Kingsland and Edwards, electrical and general engineers, Llandudno, have dissolved partnership. Debts by Messrs. Elwards and Armstrong, who continue.

Mr. A. P. Lundberg informs us that, pending construction of new works at Islington, additional premises have been taken at Culford-road, London, N.

Mr. Sydney Morse notifies that, on and after Tuesday, 7th inst., he will occupy more commodious offices at 37, Norfolk-street, Strand, London, W.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

At a meeting of Binko, Ridsdale and Co. (Limited), on Feb. 4, it was resolved that, for the purposes of reconstruction, the company be wound up voluntarily, and that Mr. W. B. Peat, of 3, Lothbury, E.C., be appointed liquidator.

A meeting of the B. C. Electric Syndicate (Limited) is to be held at 1 and 2, Great Winchester-street, London, E.C., on April 11, to receive an account of the winding up.

A meeting of the City of Bath Electric Lighting and Engineering Company will be held at 2, Northumberland-buildings, Bath, on March 25, to receive an account of the winding up.

Claims against the Standard Dynamo and Motor Manufacturing Co. (Limited) are to be sent by March 15 to the liquidator (Mr. W. Beanland), 35, Hustler-gate, Bradford.

Claims against the Carbon Syndicate, Limited (old company), must be sent by March 25 to the liquidator (Mr. G. Pepper), Pier-chambers, Chatham. A meeting of the members is to be held at 524, Mansion House-chambers, London, E.C., on March 25, to receive an account of the winding up.

Thomas Ford, electrical fittings manufacturer, &c., Emily-street, Birmingham, was publicly examined at the local County Court on Thursday last. Particulars of this failure were given in our issue of Feb. 17. The statement of affairs showed liabilities £5,653, assets £460. Bankrupt attributed his failure to bad debts, law charges, heavy interest and loss on patents. Examination concluded.

The affairs of John Alfred Edmondson, Globe Electrical Works, Kirkstall-road, Leeds, have been placed in the hands of Messrs. W. H. Steward and Son, 2, Upper Fountaine-street, Leeds. A

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meeting of creditors was convened for yesterday (Thursday), when a statement of affairs was submitted. On account of several pending actions and in order to protect the estate, a deed of assignment has been executed.

For Sale.—As announced in an advertisement Messrs. Fuller, Horsey, Sons and Cassell have been instructed by the receiver for the debenture holders (pursuant to order of Mr. Justice Wright) to sell by tender in one lot the valuable leasehold engineering works, lately occupied by the London Stamping Co. (Limited), and known as the Castle, Barnsbury-street, Islington, London, N. The plant and machinery are practically new, and the works may be viewed by order. Particulars, with forms of tender, may be had of the receiver (Mr. Robertson Lawson), 34, Old Broad-street, E.C., Messrs. Dale, Newman and Hood, solicitors, 75 and 76, Cornhill, E.C., and of the auctioneers, 11, Billiter-square, E.C. Tenders must be sent before noon of Thursday, March 23, to the registrar of companies (winding up), Bankruptcy-buildings, Carey-street, London, W.C.

Messrs. Alexander, Daniel and Co., Bank-chambers, Corn-street, Bristol, announce in an advertisement that they will sell by auction, on the premises at Kingswood, on Tuesday next, 7th inst., the whole of the local electric lighting installation, machinery, plant, &c., used in the lighting of Kingswood.

Mr. A. J. Mather, Bowling Iron Works, Bradford, has for disposal a complete electric welding plant. See advertisement.

Electric Launches.—In reference to the paragraph which appeared in our last issue, we are informed that the Vril launch which has been on exhibition at the Royal Aquarium, Westminster, has created considerable interest, and it has, therefore, been decided to keep it on show at Stand 23 during the month of March, a competent person being present to explain its working to inquirers.

Chloride Batteries.—A further section of the catalogue of the Chloride Electrical Storage Syndicate (Limited) is now available, dealing with "Renewals." The company state that owing to the great demand for their plates they have found it necessary to issue a special catalogue for this class of work. This section (F) is nicely printed, and contains useful particulars relating to this well-known type of accumulator, and the accessories and sundries used therewith.

Enamelled Steel Tubing Interior Conduit.—The Conduit and Insulation Co. (Limited) have selected a second string to their bow in the form of a seamless enamelled steel tubing, which their customers may use alternatively with the insulation-lined tubing, hitherto the sole system of wiring adopted by this company. It is claimed that by lining the steel tubing with a coating of enamel the prevention of oxidation renders more durable the insulation on the wire itself, as when bare tube is used rust is liable to gradually destroy the insulation. A pamphlet to hand gives particulars of this modification of the interior conduit system, and it is claimed that the prices compare favourably with other steel tube systems.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Feb. 22 to Feb. 28, with the ports of destination:—

Argentina—Buenos Ayres, £321 (telegraph material). ***Australasia***—Auckland, £686; Fremantle, £279; Hobart, £728; Newcastle, £600; Perth, £50; Sydney, £2,831 (including £266 telegraph material); Wellington, £2,747 (including £2,090 telegraph material). *Belgium*—Ostend, £119. *Canada*—Montreal, £61. *Ceylon*—Colombo, £185. *France*—Boulogne, £61. *Germany*—Hamburg, £500. *Holland*—Amsterdam, £100; Rotterdam, £27 (telegraph material). *Hong Kong*—£13. *India*—Bombay, £55; Calcutta, £1,186. *Italy*—Genoa, £125. *Japan*—Yokohama, £475. *Malta*—£60. *Mexico*—Vera Cruz, £13; *Norway*—Christiania, £90. *Russia*—Libau, £60; St. Petersburg, £334 (including £323 telegraph material). ***South Africa***—Cape Town, £828; Delagoa Bay, £358 (including £338 telegraph material); Durban, £779 (including £717 telegraph material); East London, £77; Port Elizabeth, £40. *Spain*—Malaga £45. *Straits Settlements*—Penang, £13. *Sweden*—Gothenburg, £21; Stockholm, £130 (telegraph material). *West Indies*—Trinidad, £180. Total £13,977, against £48,584 in the corresponding week last year (Feb. 16 to Feb. 22).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Aberdeen.—The accounts of the electric lighting department for the year ended Dec. 31, 1898, shows total receipts from sale of current for public and private lighting £7,635. 15s. 4d. After providing for interest, depreciation and sinking fund there was a deficiency of £126. 10s. 8d.

Alleged Fraudulent Bankruptcy.—Claude Theodore James Vautin, electro-chemist, was brought up at the Guildhall, London, last week on a charge of fraudulent bankruptcy and of having quitted the country with intent to defraud his creditors. Mr. Vautin had been arrested at Rome on an extradition warrant.

Asylum Lighting.—The Inverness Lunacy Board are advised to introduce the electric light at their Asylum. A report has been obtained from Dr. J. T. Bottomley, who strongly advises the adoption of electric lighting. The total capital expenditure involved is about £4,000, and the annual working expenses, after making allowance for interest and sinking fund, £480.

Brighton.—The Lighting committee recommend the appointment of Mr. Cecil C. Fowler, the present superintendent of mains, as assistant manager of the electricity department for three years at a salary of £250 per annum, rising by £50 annually to £350.

Bristol.—The latest information to hand shows that there is at present the equivalent of 67,144·8 c.p. lamps connected. After authorising some extensions of the electric lighting mains the report of the electrical engineer (Mr. H. Faraday Proctor), as to the best mode of extending the electric lighting station, has been considered by the Electric Light committee, and will be again discussed at its next meeting.

Buckingham Palace.—Extensions of the electric lighting installation are being carried out. Hitherto the light has been limited to a small portion of the palace, but the whole of the edifice is now to be lighted electrically.

Burnley.—As soon as the Burnley and District tramways come into possession of the local authorities electric traction is to be introduced, and the gauge will be reduced from 4ft. 8½in. to 3ft. 6in.

Burton-on-Trent.—The annual report of the Electric Lighting Department of the Corporation has just been completed for the period to Dec. 31, 1898, and shows the total capital expenditure to that date to be £31,851. 13s. 10d., comparing with £30,992. 17s. at the corresponding period of 1897. Generating expenses for the year have amounted to £3,551. 13s., against £3,236. 9s. 9d. for 1897. Sale of current has realised £2,496. 8s. 3d., meter rents £93. 15s. 7d. There is a deficiency on the year's working of £961. 9s. 2d. The revenue for 1897 was £2,073, and the deficit £1,164, showing an improvement for 1898 of £203 on the last-named item.

Buxton.—An inquiry was held here last week into the application of the Council to borrow £25,000 for electric lighting purposes. Prof. Kennedy, the Council's consulting engineer, submitted technical details of the scheme.

City of London.—The Common Council have intimated to the Board of Trade that they cannot consent to the applications of the Charing Cross and Strand Electricity Supply Corporation, the Metropolitan Electric Supply Co., or the Smithfield Markets Electric Supply Co.

Dublin.—An inquiry was held on Wednesday into the application of the City Corporation to borrow £7,000 for electric lighting purposes. Mr. Spencer Harty, borough engineer, said the loan was necessary in order to carry out certain alterations in connection with the increased pressure at which current was to be supplied.

Dundee.—A preliminary report on the electric lighting of the harbour has been presented to the Harbour Trust by the engineer (Mr. G. C. Buchanan). The cost of a complete electric lighting installation is put at £6,000.

Electric Lighting Acts.—Mr. Ritchie has introduced a Bill into the House of Commons for incorporating in one Act certain provisions usually contained in provisional orders under the Electric Lighting Acts, 1882 and 1888. In giving notice of this he said that 70 or 80 clauses were incorporated in the bill, those clauses being almost identical with every one of the electric lighting orders made. This practice entailed great expense and delay in connection with the orders, and it also created a considerable liability to mistakes. The present bill provided that, instead of setting out in every electric lighting order, as was now done, the 70 or 80 clauses, these might be incorporated as was the practice now with regard to clauses of other Acts. They would not be stereotyped, but the Board of Trade would have the power to vary them if necessary in respect of any particular order.

Exhibitions.—The prospectus of the 1901 Glasgow exhibition has been issued. The site will be the same as that of the 1888 exhibition. The guarantee fund now exceeds £450,000. The exhibition will be divided into various sections, but particular attention will be paid to those devoted to electricity, labour-saving machinery, marine engineering and locomotive and transport. The buildings will cover about 13 acres in addition to the permanent art galleries. At a meeting in London under the presidency of the Lord Mayor, yesterday, a London committee was formed to co-operate with the executive committee at Glasgow. It was announced that the Marquis of Tweeddale, Prof. Dewar, Mr. W. H. Preece, and a large number of noblemen and gentlemen had already expressed their willingness to join the London committee.

An exhibition dealing with the domestic applications of electricity will be held at Brussels in June next. The exhibition is being organised by the Société Belge d'Electriciens and will be open for thirty days. Section I. will be devoted to electric lighting, heating and motive power, primary batteries and accumulators; and Section II. to telegraphic and telephonic apparatus, electric clocks,

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bells and alarms, electro-medical apparatus, &c. Foreign firms having branch depôts or representatives in Belgium will be allowed to exhibit. The president is M. Banneux, engineer-in-chief of the telegraph department, and Messrs. Courtoy and Charlier are secretaries. Communications should be addressed to the secretaries at 18, Rue Melsens, Brussels.

Farnborough.—The Council have decided to transfer their electric lighting order to Power and Traction (Limited).

Glasgow.—A conference was held on Monday between sub-committees of the Electricity and Tramways committees as to which department shall supply the power required for the new electric tramways. Mr. H. F. Parshall has been consulted, and he recommends that the Tramways committee should construct a large central power station, and put down four slow-speed engines with an aggregate capacity of 17,500 H.P. Current would be supplied on the high-tension system at a voltage of 6,500, and the depôts could be utilised as stations for transforming the current to 550 volts at the present voltage. Of the 17,500 H P., three-fourths would be effective to drive 575 electric cars. At present there are 385 horse and 27 electric cars in use. The matter is to be discussed at a future meeting.

Grantown (N.B.)—A scheme is being formulated for the electric lighting of this town. It is proposed to utilise the water power of the river Spey for the generation of current.

Hackney (London).—A special meeting of the Vestry was held on Wedneeday evening to consider a report of the Electric Lighting committee, which stated that the committee had considered the electric lighting question, and that Mr. Robert Hammond, the consulting electrical engineer, had submitted his report. The committee unanimously recommended the Vestry to adopt the scheme marked B in that report, and to refer the same back to the committee with power to consider as to sites, and to engage Mr. Hammond to carry the scheme into effect. Mr. Ogan (chairman of the committee) moved the adoption of the recommendations comprised in the committee's report, and explained that scheme B comprised the laying at the outset of feeder mains, and the construction of 17 feeder boxes in various parts of the district, from which lighter mains would be laid for distributing current, and the erection of 130 arc lamps inside and 120 outside the compulsory area, replacing 292 gas lamps, each lamp post to be fitted with two 32 c.p. incandescents, to be lighted when the arcs were turned out, and that 300 additional existing gas lamp posts should be fitted with two 16 c.p. lamps, each with reflectors. The plant would comprise two 1,000 H P. and two 500 H.P. engines (one 500 set to serve as a stand-by), and six boilers, and the buildings would be sufficiently large to allow of additional plant being put in as extensions became necessary. The scheme provided for a demand for 75,000 8 c.p. lights by private consumers. With regard to the dust destructor, Mr. Ogan said the quantity of dust to be treated each year was 38,000 tons, and it was, in the opinion of the committee, the best way, from a sanitary point of view, to destroy it by fire. Mr. Hammond's estimate included £57,862 for distributing mains, £38,354 for feeder mains, £21,000 for public lighting, £40,200 for generating plant, £21,000 for buildings, £36,220 for meters, house connections, and general charges, and a margin of £10,731 for contingencies, making a total of £225,367. The capital expenditure for the dust destructor was put at £22,000, but it was estimated that, by uniting the electric lighting and dust destructor schemes, a saving of £5,000 will be effected, bringing the total expenditure to £242,367. Mr. Ogan urged the advantages of engaging Mr. Hammond, as his advice would be of great value in deciding upon the acceptance of tenders, and other matters. Mr. Hammond having answered various questions as to the technical details of the scheme, the analogy between Hackney and other districts where electric light and power are being supplied cheaply and profitably, and the safety of electric compared with other lighting, the chairman of the Vestry (Mr. Tom Hoswood) put the motion to approve the recommendation of the committee to adopt Scheme B, which was carried by 62 to 32. The recommendation of the committee that the report be referred back to them, with power to consider as to sites, was duly carried. Finally, in the early hours of Thursday morning, the recommendation as to the engagement of Mr. Hammond to carry out the scheme was also approved, the whole proceedings having been interspersed with motions for adjournment and many irrelevant and personal remarks, the chief object of which appeared to be to waste time and defer indefinitely the settlement of the electric lighting question in Hackney. This, it is gratifying to record, marks an advance in the development of electricity supply in one of the most important divisions of the metropolis. It is little to the credit of Hackney that it has taken so long to reach the present stage, and it is to be hoped sincerely that no further waste of time will be allowed in completing a scheme which thousands of residents in the district consider should have been established many years ago.

Hanwell.—The Council have asked the Ealing Council the terms upon which a supply of electric current can be given in the Hanwell district from the Ealing works.

Hastings.—The Council have decided to sanction the scheme of the Hastings, Bexhill and District Light Railway Co., for the construction of a light electric railway between the Fountain Hotel, West Marina and Bexhill, the right of purchase of so much of the railway as lies within the borough at the end of 25 years, and other conditions being, however, imposed.

Hawaiian Cable.—A Washington telegram states that the bill before the Washington House of Representatives includes provision of half-a-million dollars towards the cost of construction by the Navy Department of a submarine telegraph cable to Hawaii, which, when completed, is to be transferred to the Post Office, which will have discretionary power as to the commercial use of the cable.

Huddersfield.—The borough engineer and surveyor (Mr. R. F. Campbell) has now reported on the question of adopting electric traction on the local tramways. Reports have previously been submitted by the borough electrical engineer (Mr. A. B. Mountain) and the tramway manager (Mr. Pogson). Mr. Campbell strongly advises electric traction, and advocates the overhead trolley system. He estimates the cost of equipping the Lindley, Edgerton and Outlane section (allowing £6,000 for ten double deck cars with 2 H.P. motor trucks) would be £30,127, against the borough electrical engineer's estimate of £37,500. Mr. Campbell estimates the cost of working the section at £7,467, and the revenue at £9,000 for a year of 310 days, which would give a profit of £1,533 a year. To equip the whole tramway system he estimates £99,605 would be required. The committee have adopted the report, and the necessary borrowing powers are to be applied for.

Hull.—The electrical engineer (Mr. A. S. Barnard) has submitted estimates for the ensuing year. The total expenditure is put at £14,025, including £3,775 for generation of current, £450 for distribution, £1,650 for repairs and maintenance, £1,250 for management expenses, and £6,900 for insurance, interest, sinking fund, &c. The receipts were estimated at £15,570, leaving an estimated profit of £1,545. An inquiry was held here on Tuesday, into the application of the City Council to borrow £16,000 for electric lighting purposes. The chairman of the Electric Lighting committee (Councillor Skinner) and the borough electrical engineer (Mr. A. S. Barnard) supported the application. Mr. Barnard said the capacity of the present stations was—Dagger-lane, 22,000 8 c p. lamps; Sculcoates-lane, 29,666 8 c.p. lamps; total, 51,666. There was an equivalent of 69,350 lamps connected and applications had been received for about 5,800 additional. The present plant was entirely inadequate to meet the demand, and, consequently, extensions were immediately necessary. There was no opposition.

Ingleton.—A company has been registered, with a capital of £2,000, to establish electricity works. Nearly the whole of the capital has been subscribed locally, and it is hoped the station will be in operation by next winter.

Kingston-upon-Thames.—The borough electrical engineer (Mr. J. E. Edgcome) has issued his fifth annual report, which covers the year ended Dec. 31, 1898. Various extensions of the plant and mains have been carried out during the year. The number of consumers has increased from 163 in 1897 to 211, and the equivalent number of 8 c.p. lamps connected has risen to 11,856, an increase of 2,656. The number of units supplied to private consumers was 164,413, and for private lighting 67,957, a total of 232,370 against 194,268 in 1897. The total receipts were £4,700. 18s. 10d., representing 4 855d. per unit, compared with £3,929. 0s. 6d. and 4·853d. in the previous year. The total works expenditure amounted to £3,479. 11s. 8d. (against £3,061. 0s. 9d. in 1897), the gross profit amounting to £1,221. 7s. 2d. (against £867. 19s. 9d. in the previous year). After paying interest (£1,102. 4s. 2d.) and allowing for sinking fund instalment, there was a total deficit on the year of £1,112. 0s. 9d., the amount in 1897 being £791. 18s. 10d. Interest and sinking fund instalment in 1897 absorbed £824. 7s. 8d. and £835. 10s. 11d. respectively.

Lancaster.—The Council have been authorised to borrow a further £10,000 for electric lighting extensions.

Lee.—Mr. A. T. Snell has been appointed consulting engineer to the District Board of Works for one year, at a remuneration of £100, while the Blackheath, Greenwich and District Electric Lighting Co. are laying mains in the district.

Light Railways.—An effort is being made to revive the Finchley-Hendon light railway scheme in a slightly modified form.

The Board of Trade have confirmed the order of the Light Railway Commissioners authorising the construction of light railways between Barking Town and the Beckton Gas Works.

Littleborough.—The District Council have appointed Mr. W. C. C. Hawtayne, consulting engineer, to prepare a report as to the most suitable system of electricity supply for the district, and

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also as to the advisability of introducing electric traction on the olcal tramways.

Liverpcol.—The Corporation, on Wednesday, authorised the Estates committee to transfer to the Electric Lighting committee 66,000 square yards of land adjoining Lister Drive for the erection of an electricity generating station.

Messrs. Robey and Co.'s Works.—Mr. Justice Bucknill, who was recently at Lincoln as a Judge of Assize for the first time, takes a great interest in engineering and industrial matters, and availed himself of the opportunity of seeing the well-known engineering works of Messrs. Robey and Co. The learned judge, who was shown over the various departments by Mr. T. Bell, one of the managing directors, took a real technical interest in the various processes of manufacture shown to him, and expressed himself pleased with his visit.

Morecambe.—The District Council have entered into an arrangement with Messrs. Stoddart and Co. for the "free" wiring of premises in the district.

Municipal Trading.—In the House of Commons last evening Mr. Bartley asked the First Lord of the Treasury whether he would consent to the appointment of a Select Committee of the House to consider the clauses which appeared in so many private bills this session authorising municipalities to enter into trading enterprises, and the resolutions of the various chambers of commerce on the subject. Mr. A. J. Balfour said the Government were of opinion that the proper method for the further investigation of this matter would be a Joint Committee of the two Houses. The reference would, no doubt, be sufficiently wide to include all the points involved.

National Telephone Co's. Bills.—At a conference of delegates from the Corporation of London, the London County Council, the Vestries and District Boards of the metropolis, held at the Guildhall on Wednesday, resolutions to petition Parliament against the bills presented by the National Telephone Co. were adopted.

Newcastle-on-Tyne.—The Tramway committee have decided to consult Prof. A. B. W. Kennedy, in conjunction with Mr. Charles Hopkinson, as to the advisibility of adopting some system other than the overhead system of traction for the tramways in the centre of the town.

Oldham.—The Town Council have increased the salary of their electrical engineer (Mr. S. Wilmott Newington) from £220 to £250 per annum.

Port Adelaide.—The electricity supply works of the South Australian Electric Light and Motive Power Co. were opened on the 2nd January. The plant, which was supplied by Messrs. Johnson and Phillips, was erected under the supervision of Mr. W. Crawford.

Private Bill Legislation.—The examiners of Private Bills have decided that the Marylebone Vestry have not complied with the standing orders in connection with their Electric Lighting Bill, and the Standing Orders committee will have to decide whether compliance shall be dispensed with.

The Lancashire, the South Lancashire and Cheshire, and the Leicestershire and Warwickshire Electric Power Bills have also been held not to have complied with the standing orders, and the committee on Standing Orders have decided that compliance cannot be dispensed with.

Provisional Order Transfer.—The Whiston District Council give notice that they propose to transfer their provisional order for the townships of Eccleston, Knowsley, Rainhill and Whiston to the British Insulated Wire Co. The Council retain the right to purchase at the end of 14 years upon six months' notice. The company agree to pay the cost of obtaining the order. The maximum charge for current is not to exceed 6d. per unit, and arrangements are to be made for the "free" wiring of customers' premises. Current for lighting the main roads is to be supplied at 4d. per unit.

Rhyl.—A deputation from the Council, which is making inquiries into the advisability of establishing electricity supply and refuse destructor works, visited Llandudno last week.

Saltburn.—The Cleveland and South Durham Assets Co. are making good progress with their electric lighting scheme. The contract is being carried out under the supervision of Cox Walkers, of Darlington, who have already commenced to lay cables supplied by the British Insulated Wire Co.

Seaham Harbour.—Owing to differences with the local gas company, the Council have decided to apply for a provisional order.

Sevenoaks.—A local syndicate has applied to the Council for sanction to a proposed application for a provisional order for the district. The communication is being considered by the Lighting committee.

South Shields.—At a meeting of the Electric Lighting committee, on the 22nd ult., Mr. J. A. Jeckell presented a report on the application of the Guardians for a supply of electric current to the workhouse, which is 150 yards outside the borough. It was decided, subject to approval by the Board of Trade, to lay cables and give a supply at the same price as is charged in the borough, provided the Guardians entered into a five years' agreement. The Guardians' annual gas bill is £300. Mr. Jeckell stated that he hoped to lay before the committee at their next meeting a large scheme for cable extensions, as it was most desirable to make extensions, especially in view of the increase in the price of gas from 2s. 6d. to 2s. 8d. per 1,000. A sub-committee have under consideration the reduction of the price of current from 7d. and 3d. to 7d. and 1½d. per unit, and the adoption of some system of "free" wiring, which, in view of the increase in the price of gas, the engineer is desirous of bringing about as soon as possible. Besides the workhouse, there are 2,000 lamps awaiting connection. An immunity from breakdowns and a price which many people find cheaper than gas is responsible for the rapid development of the demand for electric current.

On the 22nd ult. Col. Durnford, R E., held an inquiry into the application of the Corporation to borrow £20,000 for the extension of the electric light undertaking. The borough electrical engineer (Mr. Jeckell) described the plant it was proposed to put down. There was no opposition. The electric light undertaking has made rapid strides at South Shields within the last 12 months, as the following figures will show:—Max. load, Feb. 23, 1898, 125 kilowatts; Feb. 22, 1899, 292 kilowatts. Lamps connected, Feb. 23, 1898, 5,969; Feb. 22, 1899, 16,514. Output at station, week ending Feb. 23, 1898, 3,474 units; week ending Feb. 22, 1899, 11,177 units. Capacity of plant, Feb. 23, 1898, 200 kilowatts; Feb. 22, 1899, 600. Units sold to private consumers for the quarter to Dec. 31, 1897, 33,028; 1898, 79,272, an increase of 140 per cent. For the month of January, 1898, units sold amounted to 10,507; for 1899, to 28,349, an increase of 169 per cent.; and for the month of February, 1898, 8,254 units; for February, 1899, to 25,870, an increase of 213 per cent.

Stockton-on-Tees.—An inquiry has been held here into the application of the Council to borrow £30,000 for electric lighting purposes. Evidence in support of the claim was given by the town clerk, the manager of the gas works (Mr. William Ford), and the Council's consulting electrical engineer, Mr. C. S. Vesey Brown.

Stoke-on-Trent.—The Council have appointed a deputation to visit towns where electricity supply works are in operation, with a view to collecting information for the guidance of the Council in connection with their proposed electric lighting scheme.

Windsor.—The Council recently desired to erect some electric arc lamps in the principal thoroughfares, but upon this information coming to the knowledge of the local gas company, the Council was notified that if any arc lamp were erected the company would raise the price of street gas lamps 15s. per annum throughout the borough. This intimation, however, did not influence the Council, who instructed the Windsor Electric Supply Co. to tender for the whole public lighting of the borough. The company's engineer (Mr. A. L. Farrow) has prepared estimates of cost, &c., and the Council have unanimously agreed to accept the company's tender. The company have commenced the work of street lighting with 246 16 c.p. incandescents, and 10 2,000 c.p. and 8 500 c.p. arcs. Messrs. Lacey, Clirehugh and Sillar, in conjunction with Mr. Farrow, are advising the company.

A few years ago the Windsor Company commenced operations in a modest way, and mains were laid in the principal streets, and the chief shops and residences were wired for the electric light. Gradually the company have extended their works and mains. Windsor Castle is now illuminated, but until quite recently no public electric lighting had been installed. As will be seen by the above, the jealousy of the local gas company has precipitated matters. Immediately upon the erection of two experimental arc lamps at the Windsor Electric Lighting Co.'s own expense, the gas company refused to tender for lighting only a portion of the town, and on being asked to tender for a year's lighting raised the price to the full allowance under the Lighting Act. Under the contract above referred to the electric lighting company has nine months to complete the laying of mains, &c., for public lighting, but it is anticipated that current will be available in six months. The present contract for gas lighting terminates on March 25, and in the meantime Windsor will be lighted by oil lamps.

"Wireless Telegraphy."—Last evening, at the Institution of Civil Engineers, Mr. Marconi read a Paper on "The Latest Advances in Wireless Telegraphy" before the Institution of Electrical Engineers. The rush for admission proved so great that a crowd of about 300 persons were unable to obtain admission.

Workhouse Lighting—The Islington (London) Guardians have received a report from their consulting engineer (Mr. J. Enright) upon the electric lighting of the new Highgate Hill Infirmary. The report recommends an independent plant, estimated to cost £5,920. The report has been adopted, and steps are being taken to give effect to Mr. Enright's recommendation.

The Ecclesall (Sheffield) Guardians have received tenders for the electric lighting of their new hospitals, and a sub-committee is considering the tenders.

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PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application an asterisk is affixed.*

February 1, 1899.

2,246. J. F. BENNETT and W. APPLEYARD. Sheffield. Improvements in electrical gas lighting appliances.
2,268. F. BROWN. London. A new or improved cord grip for electric lamp holders, fittings and the like.
2,273. C. A. DAY. London. Improvements in electro-therapeutics. (H. G. O'Neill and J. Rooney, United States.)
2,280. E. FRISCHAUER and A. O. SIMONNIER. London. Improvements in electric arc lamps.
2,288. P. F. RIBBE. London. Improvements in or relating to accumulator plates.*
2,299. J. G. HATHAWAY. London. Improvements in the manufacture of electric accumulators or secondary batteries.*
2,303. W. A. PHILLIPS. London. Improvements in and relating to electrical conductors.

February 2, 1899.

2,325. C. FÜRER. Liverpool. Apparatus for closing and interrupting currents.*
2,341. W. P. MENDHAM. Bristol. Improved apparatus for branding by electricity.
2,350. F. G. BELL and M. BYNG. London. A new or improved method of connecting electric telephonic apparatus as a system.
2,358. M. DERI. London, Improved arrangement for exciting the magnets of dynamo electric machines.*
2,362. H. F. JOEL, Jun. Ilford. Improvements in apparatus for regulating vehicles propelled by electric motors.
2,369. W. M. McDOUGALL. London. Improvements in the manufacture of electrodes and division plates for secondary batteries.
2,377. H. B. REES. London. Improvements in electric igniting devices.
2,386. H. FLEISCHHACKER. London. Improvements in and relating to the fixing of insulators for carrying electric line wires.*

February 3, 1899.

2,422. J. LENNIE. Glasgow. An automatic guard or safety appliance for use on electric cable or other tram cars, motor cars and the like.
2,425. A. HARTLEY and J. RHODES. Halifax. Improvements in and connected with the trolleys of electric railways.
2,428. H. C. GOVER and J. M. HUISMAN. Glasgow. Improvements in electric switches.
2,454. D. CUNNINGHAM. London. A new or improved method and means for electrically connecting railway carriages, vans and locomotives for communication or signalling purposes.
2,482. C. STEVENS, C. C. VYLE and W. MILNER. London. Improvements in means or apparatus for recording and repeating and re-transmitting Morse characters for use with telegraphic instruments.
2,507. H. T. HARRISON. London. Improvements in and in connection with primary battery electric generators.

February 4, 1899.

2,525. J. L. DOBELL. London. Improvements in or connected with electric batteries.
2,527. O. MOON and J. A. LOUGHLIN. Manchester. Improvements in safety electric fuses for high-voltage circuits.

February 6, 1899.

2,610. G. E. HEYL-DIA. Manchester. Improvements in the manufacture of insulating material for electric cables.*
2,627. J. W. H. WENDT and K. L. KRAUSSE. Birmingham. Electrical central alarm.*
2,629. R. J. Yarnold. London. Improvements in the electrolysis or modification of gases and gaseous mixtures or compounds.
2,654. E. L. JOSEPH. London. Improvements in electric switches.*
2,656. W. P. THOMPSON. Liverpool. Improvements in electrolysis and in apparatus therefor. (Dubose and Bertin.)
2,657. W. P. THOMPSON. Liverpool. Improvements in the manufacture of aluminium calcium carbide and other substances by the electric furnace and in apparatus therefor.
2,660. C. S. LEMSTRÖM. Liverpool. Improvements in electrical influence machines.
2,665. W. W. ZWORIKIN and S. DE BLUMENTHAL. London. Automatic electrical apparatus for indicating leaks in ships.

February 7, 1899.

2,726. J. W. FLOWER and T. E. GAMBRELL. London. Improvements in electrical measuring instruments.*
2,741. J. S. G. KAY. London. Improvements in secondary battery plates, grids, and the like.
2,742. E. W. BOWLES. London. Improvements relating to electric floats for theatrical purposes.
2,745. E. H. CALLAWAY. London. Improvements in conduits for electric wires or cables.*
2,748. C. D. ABEL. London. Improvements in primary electric batteries. (La Société d'Etude des Piles Electriques, France.)
2,778. A. ELLIS. Liverpool. Improvements in jointing or connecting electric conductors.
2,780. J. W. MANLEY. London. A new or improved electric cut-out.*

February 8, 1899.

2,794. W. B. DAY. Dublin. Improvements in electric traction.
2,811. E. EDWARDS. Blackpool. Overhead electric trolley automatic cut-out.
2,815. R. WILBY. Yorkshire. Automatic machine for regulating the speed of steam engines and for controlling the voltage and amperes of electric circuits.
2,825. E. A. CLAREMONT and F. H. ROYCE, Manchester. Signals to indicate the approaching exhaustion of the carbons in electric arc lamps.*
2,845. W. A. CROWDUS. London. Improvements in secondary batteries and in means for combining electric lamps therewith.
2,849. E. KRAISER. London. Improvements in electromagnetic apparatus for separating ores.*
2,852. P. F. W. SIMON and H. H. BERRY. London. An improvement in holders for electric safety fuses.
2,872. J. JASINSKI. London. Improvements in telegraphy.

February 9, 1899.

2,906. C. H. COX. Liverpool. Improvements relating to switchboards.
2,916. V. G. LIRONI, O. MOON and J. A. O'LOUGHLIN. Manchester. Improvements in electric switches.
2,929. S. H. SMITH. Birmingbam. Improvements in or relating to insulating blocks connected with holders for incandescent electric lamps.
2,932. A. D. SETON and J. L. DOBELL. London. Improvements in or connected with electric batteries.
2,934. M. E. FULD. London. Improvements in or relating to induction coils.*
2,956. SIEMENS BROS. AND CO. (LIMITED) and J. G. WILSON. London. An improvement in apparatus for controlling electric motors.*

February 10, 1899.

2,971. H. J. BAGLEY. London. Improvements in arc lamps.*
2,994. P. RZEPKA. Manchester. Improvements in and relating to electric arc lamps.*
3,005. W. H. LANE. Staines. Improvements in and connected with electrical switches.
3,007. E. S. D'ODIARDI and W. J. BISHOP. Croydon. Improvements in apparatus for the detection of electrical leakage in surroundings in buildings or in the open air.
3,020. D. CUNNINGHAM. London. Improvements in electrical connections for railway trains.
3,028. H. H. LAKE. London. Improvements in combined automatic magnetic circuit-breakers and resistance-controlling switch. (H. B. Cutter, United States.)
3,032. THE TELESCRIPTOR SYNDICATE (LIMITED) and A. L. SHEPARD. London. Improvements in printing telegraph machines.
3,047. A. O. BERRY. London. Improvements in continuous current dynamo electric machines.
3,051. S. BAUER. London. Electric illuminating apparatus.*

February 11, 1899.

3,087. W. M. HADDOW and J. S. HUTCHISON. Glasgow. An improved electric fitting for ships' lanterns.
3,090. T. MARSHALL. Shrewsbury. Improvements in electrical top switch holders.
3,180. A. C. BROWN. London. Improvements in electric lamps.

SPECIFICATIONS PUBLISHED.

NOTE.—**All Specifications can now be obtained at the uniform price of 8d. each.**

1898.

1,301. HERZOG. Electric signalling apparatus.
1,535. VON WELSBACH. Incandescence electric lamps and processes for the production thereof.
3,198. SAUNDERS. Manufacture of carbons for electrical purposes.
4,624. HEIBLING. Electrolytic manufacture of alkaline bichromates.
4,635. EDMUNDS and HOWARD. Apparatus for travelling through pipes or conduits more especially intended for use in threading through electric conductors.
6,147. RIECKEN. Electrolytical treatment of ores and slimes for the recovery of precious metals therefrom and apparatus therefor.
6,350. WADDINGTON. Manufacture of carbons for electric arc lamps.
14,599. GREENFIELD. Anodes employed in connection with the electro-deposition of metals.
19,855. LAKE (La Société Roger and Rathier). Manufacture of electrodes for electric accumulators.
21,755. MILLS (White). Electric meters.
22,449. WILD. Combined brake-pipe and electrical coupling for railway trains.
23,503. LAKE. (See). Devices for controlling the operation of electric motors.
23,532. THE BRITISH THOMSON-HOUSTON CO. (LIMITED) (Case). Electric brakes for electric railway cars and other electrically-operated mechanisms.
23,534. THE BRITISH THOMSON-HOUSTON CO. (LIMITED). (Libby and Potter). Governors for air compressors driven by electric motors.
23,988. THOMPSON. (Kahrs). Coin-controlled telephones.
24,196. KAHRS. Electrically heating plates, dishes, and the like.
24,641. EDGERTON and MASTERS. Secondary batteries.
24,655. GREENFIELD. Electric cables.

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COMPANIES' MEETINGS AND REPORTS.

City of London Electric Lighting Company (Limited).

The ordinary general meeting of this Company was held at Winchester House, Old Broad street, on Wednesday, under the presidency of Sir DAVID L. SALOMONS, Bart.

The MANAGER and SECRETARY (Mr. J. Cecil Bull) read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN, after referring to the lamented death of Lord Suffolk and Berkshire, said: My remarks to-day will, no doubt, be followed with a considerable amount of interest, as we propose to declare a dividend 4 per cent. less than at this time last year, and some shareholders who are faint-hearted might imagine that a kind of crisis had, therefore, taken place in the history of the Company. I trust, however, that, after I have given you all the facts in the frankest possible manner, you will see that that is not really the case; and after you have heard them and what I shall have to say about the future of the Company, I hope you will go away re-assured—those of you who feel a little down-hearted. It must still be fresh in your minds that powers were given by you to the Board to increase the Ordinary share capital, and this was done to the extent of £200,000. It is evident that this capital during last year was not bringing in a return to any extent, and that its effect on the profit we propose to distribute was absolutely inappreciable. Up to the end of 1897 it was the custom—and fairly so, and you approved of it—to charge capital with a proportion of the management expenses, but last year we considered that that practice should come to an end, and the whole of the management has been debited to revenue account. The board also considered, from the peculiar circumstances of the case, and the conditions which surrounded us at the beginning of last year, that the maximum price of the current should be reduced from 8d. to 7d. per unit for electricity within the City area, and nothing has occurred to alter our views in this respect. The applications have in no way fallen off, but have even increased in number considerably over 1897, proving that the public fully appreciate the boon which we offered them by the reduction in price. You must also remember that in the first year's working, when a reduced scale comes about—and it is a radically reduced scale in this particular case—it works very much harder against the concern than it is likely to do in any future year. You will also remember—especially those who visit the City almost daily, and who live in London—what bright weather we had in the autumn of last year as compared with previous years. This has naturally been against the year so far as we are concerned. Fogs and dark weather, although poison to many, form food for the City of London Electric Lighting Co. Coal, you also know from your own private experience, rose considerably in price last year. It may be interesting to you if I point out that if the dividend for last year had been the same as for the year before—namely, 6 per cent. on the Ordinary shares—a sum of nearly £22,000, less the tax, would have been necessary. Also, had the Ordinary capital remained the same last year as it was in 1897, the dividend, instead of being 6 per cent., for 1898 would have been 7½ per cent. These last figures may appear to you academical, but you will see their bearing by the following remarks. The greatest novice at business knows perfectly well that during the time capital is being expended, no return can be expected unless you are supplied with Parliamentary powers to pay interest out of capital—a method which does not apply to us. Consequently, the spending of this money last year, which we trust will bring in profit in the future, formed a load to us rather than an advantage as regards increasing your revenue. Having now told you briefly the reasons why the dividend must be less than it was in 1897, without going into a great many figures—which, however, you can get from the accounts, while I can answer any particular question on them which you may wish to put, it is desirable for us to see what our prospects are. On many occasions I have told you that the time would arrive when the Wool Quay site—which we were compelled to take over with the Eastern Order, and which is of great value to those who can make use of it, has proved for your Company to be the possession of a "white elephant"—would be turned to good account. This moment has now arrived. I may say that the ground rent of this site is £4,000 a year, and the bulk of this will be taken off our shoulders from this day, as well as the larger portion of the rates and taxes upon the property; and, therefore, for the year 1899 our revenue will be assisted by a sum very close on £4,000 a year. Various little alterations and details are being made at the works with the view of effecting certain economies in the cost of producing electrical energy, but I think I might point out—not in defence of our engineer, but in his favour—that if an expert were to compare the cost of production at our works with that of other companies in London, he would find that there is scarcely a detail in which improvement could be effected, as the cost of producing the energy is as low or lower than that of any other company in London. That fact is greatly owing to the experience of our engineer in dealing with electrical matters in the past. For the information of those who take particular interest in figures, I may state that in 1898 the generation and distribution cost 1·6558d. per unit, while for 1897 the cost was 1·6407d., the slight increase being due to the increased price of coal. The cost per unit of generation, distribution, rent, rates, taxes and management was 3·3011d. for 1897, and for 1898 it was 2·6293d. These figures exclude repairs and renewals. Of course, this reduction is due to the larger number of units sold in 1898—not in consequence of dark weather, but of the greater number of lamps joined to the circuit. It is in this direction—although there are many others also—that we must look for considerable improvement in the future for an increase in our revenue. The repairs and renewals per unit for 1897 worked out at 0·433 and for 1898 at 0·3921. It may interest you to know the number of lamps we have connected to our circuits this day. The information is given in the report up to the end of last year. The total number of lamps now on circuits is 365,560, and the applications are 382,750. Therefore, the balance awaiting connection is a little over 17,000 lamps. This latter number is very large, but it is due to customers not being wired yet, or not being ready for the connections to be made; and if you were to test these figures with any that might be given to you in the future, you might find that 17,000 odd lamps now awaiting connection might not exactly tally, because it is our frequent experience, whenever an installation is made, that the customer alters the number of lamps by increasing or decreasing them. However, we start the year with 365,560 lamps joined to our mains, on which revenue is to be earned. It is common to human nature for every man to think that his own grievances are worse than those which fall to others, and the same rule applies with equal force to corporations or public bodies. We believe that our Company has the most difficult district in London, if not in the world, to cope with. [The Chairman then referred to some curves which had been prepared illustrating the excessive provision which had to be made of possible demands in time of heavy loads such as fogs, &c.] These curves (continued the speaker) will bring home to you better than anything else how difficult it is to earn money in the City except in that short period, and what a difference it makes to the earning powers of the concern if you get a dark or a bright period. You must not, however, gather from these remarks that, at the present time, we have reached in the City that maximum point, for the capital which has been expended in the past year and which is still being expended is a long way off the maximum point of supply. We have yet a very large reserve, which will enable us to connect a great many more lamps to the system. This reserve has been idle last year owing to the machinery not having been completed, and it is awaiting this year's lamp applications, which are coming in from week to week. It is evident, however, that you must get your machinery ready always a year in advance, as it cannot be erected at a moment's notice, and we have been preparing in 1898 the machinery that is to come into use for lamps that are being put on this year, and that were put on in the latter part of last year. There is no evidence yet of a falling off, and we, therefore, trust that the advantages we have given to the citizens will cause the applications to come in this year, and for many years to come, as they have done in the past. In 1897 the net return per unit was 7·1d., when the maximum charge was 8d.; and last year it was 6·2d., with the maximum charge at 7d. The Board are fully alive to the value of a progressive policy, and they have, therefore, put in hand work which will be available almost immediately for giving to the citizens direct current for motive power, or any other purpose they may think fit. They have also inaugurated a wiring scheme, by which customers can, if they please, have their premises installed for them by the Company simply by paying a moderate rental to us. On page 4 of the report you will observe that in 1893 the generation and distribution absorbed 54·2 per cent. of the total receipts, and this figure diminished year by year until in 1897 it was 31·3 per cent., showing economical progress. For last year this figure rose to 36·1 per cent., and it might thus appear that the efficiency under this head had considerably decreased, but that is really not the case, for it is purely a percentage, and must increase as the receipts go back. To put this matter in its ultimate form, if we gave away the current to the citizens for nothing, the generating and distribution expenses would be 100 per cent., however economically the current had been produced. Respecting the issue of fresh capital for continuing the work still uncompleted, it is not the intention of the board to issue this until the very last moment, in order that as small a charge as possible shall fall on the revenue of this year in regard to such issue. The most absurd rumours have appeared in various directions, and are believed by many who, one would have thought, would be better advised. I particularly refer to the statements which have been made that the capital of your Company has been "watered." All such statements are absolutely untrue, but in order to confirm this point I will give you one or two figures showing how we stand. It is perfectly true that the Pioneer Company, which enabled the City of London to have the electric light earlier than otherwise would have proved to be the case, received, as the price of their surrender, £25,000. The other moneys they received were for work actually done, and on which there was no profit. Our Company has a total subscribed capital to-day of £1,400,000, and all preliminary expenses, registration fees, and expenses of subsequent issues, amounted to £46,686, including the £25,000 referred to; against which the Company received premiums to the extent of £221,924, upon which no interest or dividend is payable. Consequently, instead of the capital of the Company being "watered," it actually possesses a net sum of £175,238, against which no dividend ranks. I think, therefore, that you cannot be dissatisfied with what has been done, and I do not think it is possible for any fair man to make the slightest charge against this Company that any unfair proceeding has been taken on the part of this board or those who were connected with this concern previous to the formation of this Company. Your board intend to oppose by every means in their power the threat to invade your district by other companies. We regard their attempts not only in an unfriendly light, but as an exceedingly unfair step. It is an attempt on their part to rob us of a portion or the whole of our property, which we have built up by hard work, industry, and very heavy expenditure. Your Directors have

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already set forth their case for the consideration of the Board of Trade, before whom these applications now lie for their consideration; and they have made out a very strong case against the entry of those companies into this area. I will not take up your time by reading you the document, but I can assure you that there is not a single line of exaggeration in it, although it has been drawn in very forcible terms. It appears to your Directors inconceivable that the Board of Trade, which has acted so fairly in dealing with the assignment of areas to the different London companies in the past, should now depart from their previous course, and we believe that they will without hesitation refuse the demand which outside companies are making to invade our area. Last year I addressed you at some length respecting our position in the City of London and the action of the Corporation in regard to the Company, and I must again to-day refer to our relations with those authorities. The Corporation have made important contracts with this Company, and to reasonable men the natural conclusion would be that when two parties make a contract, each believing that such contract was made at the time for their mutual advantage, they would, instead of distrusting one another, do their utmost loyally to protect the contract and work together in harmony. The Corporation may be regarded as an individual with an everlasting life; in point of fact, however, the breath of life within that body is for ever changing. It is not surprising, therefore, to find that there are not to be seen to-day all the same representatives who were in authority when the contracts were made, and there are now those who do not regard with favour what their predecessors carried out, since they are prone to judge all they see by the present, rather than by going back and seeing how matters stood when the contracts were entered into. From a purely business point of view the more the City authorities uphold this Company and the stronger its position can be made, the better it will be for the City of London. Whatever may be their intention in the future—if the City has no desire to purchase the undertaking by mutual consent or under the various conditions named in the contracts—it is evident that a successful company can serve the citizens and give them more concessions than a company which is weak; and if, on the other hand, it is within the minds of the City authorities to purchase the undertaking, it is common sense that it will be cheaper to buy a successful concern, even at a higher price, than one which is sick and which would require an enormous expenditure on their part to set in order. In addition to this they would have to deal with other companies besides, if competition entered into our area. The Directors, therefore, trust that, even if sentiment is set aside, the City authorities in the end must and will support this Company by enforcing the contracts made, in their entirety, including such parts as may favour the City and those parts which may favour the Company. Sentiment in commerce is no empty word to Englishmen, who accept all agreements as religiously binding, and do their utmost to carry them out, whether for or against their interests at the time being. It is these sentiments, confirmed by deeds, which have placed Englishmen so high in the esteem of all foreign nations, and it would be deplorable to think that the authorities of the capital of the British Empire should depart from the principle which is so dear to Englishmen, and your Board cannot believe that such a result is possible. Any friction which has arisen between the Corporation and this Company is traceable to the regret of many of their members that their predecessors ever entered into the contracts which we have heard so much of during the past few years; but I fail personally to see why there should be any soreness, because our shareholders, at their own risk, have built up a splendid business within the City boundaries, which, in due course, the municipality may purchase or not, as they please; and if it should come about that competition should enter the City area it will be a step which they will deplore far more bitterly in the future than the regret already expressed. The Company has been far more liberal to the citizens than was ever anticipated when the agreements were drawn; and the continued increase in the number of our customers, of whom by far the larger number joined the Company before any idea of competition started, is, perhaps, the best proof that the undertaking has been conducted honestly and in the interests of both consumer and shareholder. It must be borne in mind that the City has the option of purchasing the Company's undertaking at the end of 21 years (that is, by mutual consent, not by a fixed figure) from the completion of the public lighting. The short life of electric lighting companies in general entitles their shareholders to a good return on their money during the existence of the companies; and for a local authority to permit private capital to be spent within its area (in any area, for I do not refer particularly to the City) with the view of giving advantages to the people within it, and afterwards to go and take steps to destroy this capital, is little short of confiscation. This year the two Directors who retire are Colonel Martindale, C.B., and Mr. Herring. They are both eligible for re-election, and place their services at your disposal. Colonel Martindale is too well known to need any comments. He is a late Royal Engineer, and has rendered good service to the nation in Australia in connection with railways, telegraphs, and the public works generally of that colony. He is, therefore, a gentleman of experience, in whom every confidence can be placed. Since his labours were completed in the colony he has given a great deal of attention to various dock matters in England and later to your affairs. Mr. Herring was elected to replace Lord Suffolk. He is known throughout the financial world as a gentleman of ability and integrity, and he has a very large stake in this Company. It is, therefore, to his interest to make the Company a success, and we find him a very valuable co-worker. I trust, therefore, that you will re elect these gentlemen as members of the Board. It has come to be regarded as a kind of wind-up to the speeches of all chairmen at annual meetings and elsewhere to say a few words about the staff, but with us this is no empty form. In this Company the members of the staff hold no sinecure position, and the advance we have made has been due largely to the energy and ability of our manager and secretary, Mr. Cecil Bull, and of our head engineer, Mr. Frank Bailey, who in turn have been rendered the greatest assistance by the second engineer, Mr. Jackson, Mr. Toy, the accountant, and many others, including the superintendents at the works and the head clerks, who have helped in every possible way to promote the welfare of the Company. The whole of the staff have worked throughout the year not only honestly but loyally in your interests. I will now move the first resolution, after which I shall be very pleased to answer any question you may desire to ask, if it is in my power to do so. I propose—

"That the report of the Directors and the statement of accounts for the year ended Dec. 31, 1898, with the appropriations to the reserve and depreciation funds, as shown therein, be and the same are hereby received and adopted."

Col. B. H. MARTINDALE, C.B., seconded the motion.

Mr. HAROLD YOUNG asked whether, owing to the non-delivery of heavy machinery, the Company had been unable to keep up the full pressure in the mains, and whether this had not caused them serious loss.

Mr. ROBERTS thought with regard to the threatened opposition against the Company, that the plain, blunt fact was that complaints as to the lighting were causing the dissatisfaction of which they heard.

Mr. PREVOST said he presumed that at the time the sliding scale arrangement was instituted, it was known it would affect their dividend. Did the Directors not think that the premium of £8 per share on the new shares that were issued was rather a large price to ask the shareholders to pay. The Directors proposed to issue further capital, and he thought it would be right that these should be issued to the shareholders at par as some compensation.

Mr. J. B. BRAITHWAITE, JUN., referring to the threatened competition, asked whether, if any other company got access to the City, their own Company would obtain relief from the onerous contract which they had at present with the City Corporation. The Company had spent £119,000 on the public lighting, and reference to the revenue account showed a profit on this capital outlay of less than ½ per cent. He understood also that the Company was compelled to put by a special reserve fund of 5 per cent., and a further 7½ per cent. on the whole of their plant and machinery—a very heavy item. They were also debarred from supplying current outside the City area. If, for instance, they could supply the Strand district it might improve their position. Moreover, the City authorities had powers to purchase this Company's undertaking in 21 years, whereas if a new company came in it would be untrammelled with such a condition.

The CHAIRMAN, in reply, said that Mr. Young had asked a question as to the possible loss sustained through the low pressure of the current. It was perfectly true that for some days an unfortunate state of things did exist, and might have produced some slight loss. The difficulties which arose were outside the Directors' control, but this source of complaint was speedily removed. As to whether it was a mistake on their part to lower the price of current it might appear to some that they lowered the price too soon, but everything at the moment indicated the advisability of an alteration and what was done the Directors considered was wisely done. It should not be forgotten that occupiers of large blocks of buildings in the City sometimes considered that it would be advantageous for them to have their own installation instead of taking their supply from the Company's mains, and it would not be policy on the Directors' part to permit this idea to spread, and, therefore, the reduction in the price was a matter of policy. Events had shown that the course adopted by the Directors was the right one, because applications had gone on increasing. With regard to the petition circulated in the City in favour of competition, they had to complain that those who were responsible for the petition did not keep strictly to the truth. A great many misrepresentations were made. As to dissatisfaction with the light supplied by the Company, there was no doubt that, during the few days when the low voltage previously referred to existed, complaints were made, but very little had been heard of any complaint since. Some of the complaints were undoubtedly due to the consumers themselves. The wiring contractor puts a minimum size wire and without consulting the Company the customer puts on more lamps than he should and so reduces his voltage. On the whole he considered the complaints against the Company were exceedingly few. As to the course the Directors would pursue when the fresh issue of capital was made, this point would be taken into consideration and the shareholders would be liberally dealt with as had been done in the past, but he could not say whether the new shares would be issued at par. With regard to Mr. Braithwaite's remarks as to the relations existing between the Corporation and the Company it might be advisable to say that a letter had been written, under date Feb. 24, by Sir John Monckton to the Board of Trade, with reference to the Provisional Orders asked for by parties desiring to compete in the City. This letter stated that "having regard to the terms of the agreement entered into for lighting the City by electricity the Corporation is unable to approve of the Orders in question." He (the Chairman) considered that this letter showed perfectly that it was not the intention of the City authorities to favour these competing Provisional Orders. The City authorities were men of business and they would not be likely to allow competitors to come into the City who would be free and unfettered by any agreement with the Corporation. There was no doubt that the position of the Company would be much improved if they were allowed to invade other districts, and they might obtain such powers if the Directors did not think it unfair, but by supplying direct current the Company hoped that much would be done towards satisfying those who were favourable to the introduction of competitive direct current supply.

The motion approving the report and accounts was then carried unanimously. The full dividend of 12s. per share on the Six per Cent. Preference shares, 7s. per share on Ordinary shares numbered 40,001 to 90,000 (making 12s., or 6 per cent. for the year), and 8s. 1d. on Ordinary shares numbered 90,001 to 100,000 (making 6 per cent. for the year, calculated from the dates of the instalments), were then unanimously approved.

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Col. Martindale and Mr. George Herring were re-elected Directors of the Company, and Messrs. W. K. Pannell and Co. were re-appointed auditors. A cordial vote of thanks to the Chairman, Directors and staff terminated the proceedings.

House-to-House Electric Light Supply Co. (Limited).

The Directors' report for the year to Dec. 31st states that the revenue account shows a credit balance of £14,066. 3s., which, with £226. 5s. 10d. brought forward, and £742. 15s. 7d. balance of interest received, makes a total of £15,035. 4s. 5d. After deducting £2,250 for interest on Debenture Stock paid and accrued, £1,767. 10s. for interim dividend paid on the 7 per cent cumulative Preference shares, and £1,982. 12s. 6d. for interim dividend at the rate of 5 per cent. per annum for the half-year to June 30th, on the Ordinary shares, the Directors recommend that the balance (£9,035. 1s. 11d.) be dealt with as follows: £4,000 to depreciation account; payment of remainder of dividend to Dec. 31st on the cumulative Preference shares, £2,100; payment of a dividend on the Ordinary shares for the half-year, at 7 per cent. per annum (making 6 per cent. for year). £2,775. 13s. 6d.; balance forward, £159. 8s. 5d. Additions and alterations to the plant and mains have been made at a cost of £19,423. 8s. 2d. Certain of the plant having been superseded, has been sold at a loss. The Directors consider that the proportion of this loss chargeable to the current year has been adequately provided for by the increased sum placed to the credit of depreciation account.

London Electric Supply Corporation (Limited).

The ordinary general meeting was held yesterday (Thursday) at the Cannon-street Hotel, under the Presidency of the Right. Hon. Lord WANTAGE, V.C., K.C.B.

The SECRETARY (Mr. H. C. Carter) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN: My first duty, gentlemen, is to congratulate you on regaining possession of the undertaking, and consequently that the annual general meetings of the Corporation are again resumed. When I had the pleasure of meeting you in June last I gave you an account of the business during the year 1897, and I also informed you of the result of the workings to March 31, 1898. As this meeting is only asked to adopt the accounts for the half-year ending December last, it may be interesting to you to know the result of the workings for the half-year ending June, the date when the receivership expired. The profit for that half-year was £10,131, as compared with £6,113 for the corresponding half-year of 1897—a gain of £4,018, or about 66 per cent. Now that we have got rid of the condition which necessitated our being in the hands of a receiver, it may be interesting to give you the result of the receiver's workings during the time he was in possession. He was appointed in July, 1894, prior to which the Corporation was carrying on its business at a loss. The result of the first half-year's working thereafter, ending December, 1894, showed a profit of £1,300; for the year 1895 it increased to £6,900; for the year 1896 to £7,600; for the year 1897 to £16,586; and for the half-year ending June, 1898, the profit was £10,131, the four years thus showing a satisfactory and steady rate of progress. These profits, after deduction of interest on loans, were applied towards the reduction of the debt due by the Corporation, so that instead of there being a debt of £170,795 to pay off—this being the total amount advanced to the Corporation by the debenture holder in possession—the amount was reduced by means of these profits to £140,000. Now we shall go from the past to the present, and deal with the accounts under review. It will be seen from the capital account that effect has been given to the resolution passed at the extraordinary general meeting of the Company held in June last to reduce the Ordinary shares of the Corporation from £5 to £3, and the effect of this is that we have been able to write down works set forth in the capital account to the extent of £181,688, and in addition to write off the whole of the preliminary expenses account and an old account called the debenture discount account. We have thought it desirable to make a record of these reductions in the accounts to December, although they do not actually enter into the accounts for that half-year, but to the half-year ending June. We have done this in case we might wish to refer to these reductions on some future occasion. The effect of the writing down of these assets is to place our capital account on a much stronger basis. The items set forth therein now fairly represent their value. In addition to writing off the amounts just stated, you will notice that a sum of £5,565 has been written off certain other accounts for depreciation. I hope you will consider that a prudent course has been adopted in writing off these amounts. Another satisfactory feature is that having written off such large amounts we may reasonably expect to be relieved from setting aside large sums for depreciation out of future profits, and in this respect the financial position of the Corporation has been considerably strengthened. The Court readily granted our application for these reductions, and when we made our issue of £200,000 Four per Cent. Mortgage Debenture stock it was not necessary to ask the outside public to take any part of the issue, as it was applied for nearly twice over by our own shareholders. Having thus set our house in order the Stock Exchange Committee granted us official quotations for all classes of our capital. The result of this increased the value of the shares, while I hope it was of convenience to the shareholders. During the half-year, as you will see from the capital account, we spent £23,076. Nearly half of this—namely, £10,938—was for payments on account of the 2,000 H.P. plant which was supplied in October last, and which has worked satisfactorily during the winter. We spent £6,697 in extending our distributing mains in Bermondsey, Rotherhithe, and Greenwich. You will see from the map attached to the report (which the Board considered would be interesting and useful to the shareholders) the large area we cover. We have now 28 miles of trunk and 64 miles of distributing mains laid. These mains we must always be prepared to extend when new business presents itself. The expenditure on the next three items—namely, transformers, meters, and electrical instruments—is to meet the requirements of new customers. The next item of £285 is almost entirely represented by the cost we were put to in protecting ourselves in Parliament against the attack of the Bermondsey Vestry, who endeavoured in the last session of Parliament to obtain a Provisional Order to enable them to enter into competition with us for the supply of electric light in that parish. Although unsuccessful last session, they have given us notice of their intention to renew their attack in the present session. It is unjust that electric lighting companies who originally obtained their Order with the consent of the local authority (who have the power of purchasing the undertaking at the end of 42 years on very favourable terms) should be subjected to attacks of this kind. The local authorities declined to take the risk of putting down stations for the supply of electric light when they had the opportunity, and left the expenditure to companies who took that risk. Some of these local authorities—the parish of Bermondsey being one—now seek to enter into competition with those companies immediately there are signs that the profit-earning stage has been reached. They ignore the years of effort that have been made to reach this stage, and the large amount of capital which has been expended, and on which no dividends have been paid to the shareholders, and by aid of the rates seek to enter into competition with the existing supply authority. This is not competition, but confiscation. I believe that the public are alive to the fact that it is confiscation, and I hope that Parliament may be equally alive to it, and, in my opinion, it was not the intention of Parliament when the Orders were granted. I say this because the duration of the Order is only for 42 years from 1889, and at the expiry of that period the local authority may purchase the undertaking on terms exceptionally favourable to themselves. These local authorities, who are now applying for competitive powers, seek to anticipate this period of 42 years, and, by the aid of the rates, they will no doubt seek to oust the companies, and thus evade the guarantee given by Parliament to the companies of 42 years' tenure, and they will try to take away the business of the supply companies without the necessity of purchasing their undertakings, as intended by Parliament. The last item of the capital account is a balance of £36,728 of unspent capital. This, we believe, will meet our commitments for the current year. We have to keep adding to and improving our plant and machinery, and extending our system of mains, owing to the increase of business; and, like prudent men, we have to look a considerable way ahead. You will see by the report that we increased our lamp connection last year by 31,221 lights—an increase equal to 25 per cent. You will, no doubt, consider this satisfactory, and while it might be too sanguine to expect that such a large increase would be kept up in the future, I am glad to say that the new business shows no falling off since the accounts were closed; in fact, there has been an improvement. During the current year we have made arrangements for the supply of certain new plant and machinery as follows:—A new plant of 750 H.P., which will be an intermediate plant between our large and small units, and which will take the place of the old Grosvenor plant, now nearly 12 years old, and which, while it has done most excellent work in the past, is now becoming somewhat out of date for the present requirements. We are putting down six new boilers to supplement our present boiler power. These boilers are of the most modern pattern, and are specially designed for quick steaming and economy in the use of coal. We are increasing our means of discharging and conveying coal from the wharf to the boiler-room, and are putting in a new coal conveyer plant, which will be capable of dealing with 300 tons per day, and by means of this conveyer we estimate that we shall effect a saving of 4d. per ton in the handling of the coal. Economy, you will observe, has been the great principle we have been proceeding upon—economy with new and better appliances. I daresay, as I mentioned the fact, it struck you that we have a balance of £36,728 of unspent capital at our bankers ready to be used in making such economies as I have indicated. We have also arranged for the heightening of our two chimneys to a total height of 200ft. This latter work is rendered necessary on account of the agitation which has recently sprung up regarding smoke nuisances, the result of which we have also experienced by being fined on one or two occasions for the emission of black smoke, although we burn the best class of Welsh smokeless coal that can be bought. It appears that for a short period in the afternoon, between four and five o'clock, caused by the sudden rush of the load coming on, we make black smoke, and this, up to the present, we have been unable to get rid of. The heightening of the chimneys, together with the experiments we are now carrying out with smokeless furnaces, will, we believe, get rid of this, as well as giving us a much better draught up our boilers. These are the principal items of capital expenditure during the current year. In addition, we shall have the usual expenditure consequent upon increase of business and in the laying of new distributing mains (and here I may mention that we are gradually eliminating the old Ferranti trunk mains by new trunk mains, and using the old trunk mains as feeders and distributing mains), and in the purchase of new transformers, meters, &c. We shall now, if you please, turn to the revenue account. It will be seen from this that our gross revenue for the half-year was £37,226, while the gross revenue for the corresponding half-year of 1897 was £27,903, an increase in the later six months of £9,323, or about 33 per cent. The profit on the working is £13,535, as compared with £10,471 for the corresponding half-year of 1897, being an increase of £3,064, or about 30 per cent. This latter increase would have been greater but for the extra expenditure we were put to at the generating station, owing to the Welsh coal strike. Our supplies of Welsh coal were completely stopped for nearly six months, during which period we had to purchase North Country coal at an increased price, and in addition we burned a very much larger quantity of it. This additional consumption not only caused a larger expenditure in

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coal, but increased the expenses in every other direction at the station, as we required a larger number of men to handle the extra quantity consumed, as well in cleaning the larger number of boilers required, and the extra repairs in maintaining the same; but even with this increased expenditure I am glad to inform you that we have been able to reduce the cost per unit. We find that the competition for the supply of electric light grows keener every year. Our largest district is in the parishes south of the Thames. In that district we have to compete with gas, yet in spite of this we have nearly doubled the number of our customers in that district during the past year. Although we are entitled under our Act to charge 8d. per unit, the average price that we have received during the year has only been 4½d. per unit, this being about equal to gas at 2s. 6d. per 1,000 cubic feet. This reduction, however, has resulted in a large increase of customers in the poor parishes on the south side, as well as an increased profit, and has, therefore, been quite justified. While we are purveyors of light I think I ought also to mention that we are also willing purveyers of energy, which may be used for traction purposes; and if customers wish for a supply of energy we shall be quite ready to attend to their wants. At present we have supplied light, as you know, but energy for the purposes of traction work is also within our province, and the large extent of ground which is your property at Deptford—and which I wish some of you at your leisure would visit—will afford ample room for extending the premises for the purposes I have referred to. I desire to mention that, because we shall be very ready to deal with persons who may require energy for traction purposes. You will see that the Board have relinquished half of their fees. The present Board have agreed to do this until such time as a dividend is paid on the ordinary shares. The net revenue account and the balance sheet call for no comments, I think you will agree that the balance-sheet now presents a very satisfactory appearance, as every item of a doubtful nature has been eliminated from it. That is my story to you, gentlemen, and it is perfectly accurate, and I hope, is as satisfactory to you as it is to me. I have now to move

"*That the Report and accounts be received and adopted, and that a dividend at the rate of 6 per cent. per annum for the half-year ending December 31, 1898, as recommended therein, be declared and paid on the 3rd inst., and that the balance of £3,275 9s. 7d. be carried forward.*"

Mr. ROGER DE QUINCE QUINCEY seconded the motion.

Mr. CHARLES POND pointed out with regard to the installation of motors driven electrically that the initial outlay was the stumbling block, and in this respect the gas companies had a decided advantage over the electricity supply companies. About 18 months ago, a Bill was passed through Parliament for a deep-level electric railway from the Mansion House to Earl's Court, and it seemed to him that they were looking in the West End of London for what this Company had at Deptford—machinery which would provide all that could possibly be wanted in connection with power for that railway. This machinery, he understood, was idle for many hours a day. All opposition has now been withdrawn to the deep-level railway referred to, and he thought that this would give a prospect of utilising all the spare power of their machinery. He expressed his satisfaction at the progress made in the Company's affairs. With 30 years' experience he never remembered an instance of such a resuscitation as that afforded by their own Company. Four years ago they were £16,000 in arrear with their debenture interest, and had debts amounting to £100,000. The smaller shareholders were certainly under a great debt of gratitude to the management, because they did not avail themselves of reconstruction. If such a course had been pursued the shareholders would only have received a very few shillings for their shares. The receivership had resulted in such a properous state of things being brought about that the Ordinary shareholders were in sight of a dividend.

The CHAIRMAN replied, that what Mr. Pond had referred to as to the utilisation of their machinery for supplying power had been under the consideration of the Board.

The report and accounts were then unanimously adopted.

Mr. HENDERSON proposed the re-election of Lord Wantage as a Director of the Company. It was, he said, largely owing to his lordship's action, when the Company was in dire straits, that the Company was in its present prosperous condition. He had ventured to predict at the last meeting that this half-year the full dividend would be paid. This had been verified, and there was a considerable balance forward.

The motion was seconded by Mr. QUINCEY, who strongly supported Mr. Henderson's views as to the thanks due to Lord Wantage for his action in connection with the Company.

The motion was carried unanimously.

The CHAIRMAN, in acknowledging his re-election, said that there was no doubt the shareholders did a very wise thing two or three years ago when the Company was emerging from its difficulties in requiring that the debenture holder in possession should carry on the Company for another year. He readily acquiesced, and they had the advantage of the entire devotion to the work of Mr. Stewart Bain, whose attention, ability and assiduity put the Company in that one year on the firm basis on which it now stood.

The auditors were then reappointed, and a cordial vote of thanks to the Chairman and Directors having been unanimously carried, the proceedings terminated.

Imperial Tramways Co. (Limited).

The general meeting of this Company was held on Wednesday, at Bristol. The Chairman (Mr. George White), in moving the adoption of the report and accounts, said that the London United Tramways had obtained power to employ electric traction on eight miles of their existing system, and, in addition, had authority to build another 13 miles of electric tramway route. The London United report explained the position of the new works and the progress already made, and he hoped that in about twelve months hence the whole electric system of tramways would be in operation. In addition, powers were being sought to extend the lines from Brentford, through Twickenham, Teddington, and Hampton Wick, to Hampton Court. If the Light Railway Commissioners granted the necessary powers they would have a route length of about 35 miles of electric lines in the attractive suburbs of West London. The line to Hounslow, and also that to Uxbridge Town *vid* Hanwell and Southall, would prove of great convenience to the public, and would add to the dividend-earning capacity of the Company, and the Imperial Company would participate as shareholders in the additional profit thus earned. The Acton Urban Council last week requested them to tender for the supply of electricity for lighting their district. Turning to the Middlesbrough, Stockton and Thornaby electric tramways system, he said the lines were opened for public traffic on July 16 last, and nearly four millions of passengers were carried, and £21,092 earned up to December 31st. In the first half-year they managed to earn a net 7 per cent. upon their outlay. At the request of the local authorities they were promoting about six miles of extensions of their electric tramways under the Light Railways Act. They hoped to obtain the necessary powers within the next few months, and would lose no time in building the lines. If the local authorities continued to show the same businesslike spirit in dealing with them he could promise them no lack of enterprise on their part (hear, hear). In his opinion, it was vastly more important to a Corporation to secure the development of their territory, and the consequent increase in the ratable value of their town, than, as is often done, to intervene conditions of such an irritating character as to stifle a tramway company's enterprise almost before it is born. The Darlington Council had approached them to see if something could not be done to put Darlington on a similar footing to Stockton and Middlesbro'. The Council had approved their proposal to apply to the Light Railway Commissioners for the requisite authority to lay down a system of about eight miles of electric lines in and around Darlington. He would conclude by expressing the obligations they were under to their Managing Director and Engineer, Mr. Clifton Robinson, to whose indefatigable energy and masterful grasp of the thousand and one details connected with the management of their various undertakings the success of the Company was largely attributable. The report was adopted, and dividends on the Preference shares at 6 per cent. per annum, and on the Ordinary shares at 7½ per cent. per annum, for the half-year ended Dec. 31 last, were declared.

A special meeting was afterwards held when a draft Order which is being promoted by the Company before the Light Railway Commissioners, for the construction of light railways in the counties of Durham and York, was approved. The Chairman announced that in the future interim dividends would be paid and the meetings of the Company would be held annually.

Notting Hill Electric Lighting Co. (Limited).

The twelfth ordinary general meeting of this Company was held on Wednesday, at the office of the Company, 140, High-street, Notting Hill Gate, Sir WILLIAM CROOKES, F.R.S. (Chairman) presiding.

The SECRETARY (Mr. R. G. Rawkins) read the notice convening the meeting.

The CHAIRMAN said: Gentlemen, once more I have the pleasure to preside at your annual general meeting, and present you with our report and accounts. Of these, you have no doubt received copies, so I presume you will allow them to be taken as read. They show the continued and increasing prosperity of the Company. As usual, I propose to go through the accounts *seriatim*, as there may be a few items on which you may like further information. The share capital account (No. 1) has undergone no change since last year, the whole of the present share capital having been issued and paid. The loan account (No. 2) shows that £31,000 of first Mortgage Debentures have been issued, of which £26,000 have been paid, bringing the total share and loan capital received to £126,000, and an additional £5,000 has been paid up since the close of the year, leaving £19,000 for future use. Tenders invited in October for the last issue of debentures, and the whole of the £10,000 issued was allotted at a little over £105 per cent., which is somewhat lower than the last year's price of £107. 10s. No doubt the reason for this was the unsettled state of financial circles at the time of issue. No. 3 is the general capital account, showing clearly the amount of capital received and expended, and giving the different items on which the money has been spent. The total capital received amounts to £126,000, and the expenditure to £128,003. 19s. 4d., or £2,003. 19s. 4d. more than the capital receipts. The largest item on the expenditure side is as usual for new mains; with regard to this item I may say that, in view of possible competition, the Directors felt justified in abandoning their usual policy of extending only to streets where a good return on the capital was practically assured, and extensions have been made in many streets, including the compulsory ones scheduled in our new Provisional Order, where the revenue derived an amount at present sufficient to pay interest on the amount of capital borrowed for the purpose of carrying out the work. Mains have been run in order to resist any opposing Provisional Order, and where any demand for current has arisen the streets have been wired immediately. Nevertheless our gross revenue is over 10 per cent. on the capital expenditure of £128,000 and we consider this rate amply justifies any extension, leaving future developments to bring us increased profits. The item of £3,671. 11s. 8d. for new machinery includes the cost of a new boiler, engine and dynamo, which practically fill the whole of the available space at these works; we must erect another station to cope with the increasing demand for electricity. The item of £4,060. 16s. 7d. for buildings is principally the cost of the freehold of the building in which

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we are holding this meeting; it was purchased at the almost unanimous wish of the shareholders at the last meeting, in consequence of the old offices being required for instruments and light machinery. This gives us a frontage on the main thoroughfare from which we expect to derive considerable benefit in the future, as it brings us into closer touch with the inhabitants of the district and greatly facilitates access to our offices. In consequence of this we receive a much larger number of inquiries from householders in the district, and this generally leads to their adopting the electric light. Since the erection of the Coronet Theatre, nearly opposite, lighted by the Company, this street is the most important in our district, and naturally these offices are a good advertisement. £1,324. 13s. has been paid for new meters; a large outlay on this item is always a matter for congratulation, as meters are only purchased as required by new customers. The only other item on the expenditure side I need refer to is the last, "Cost of Kensington and Notting Hill Bill, £65." This represents a part of the cost of the joint Bill promoted by the two Companies, to which I will refer again presently. You will gather from the credit side of this account that the sum of £16,000 was received during the year on the issue of debentures, but this sum does not include the premiums, which amounted to £1,308. 13s. 9d. Of this amount, £334 has been credited to the depreciation, reserve and renewal fund, and the remainder, amounting to £973, has been written off the preliminary expenses, bringing that item down to £1,000; it originally stood at £5,205. No. 4 is the revenue account, and dealing with the debit side of it first, I may say that the expenses have increased in one or two cases over the corresponding period of the previous year. The cost of coal naturally increases with a larger output, but there has been an exceptional increase in this item over last year owing to the Welsh coal strike. The cost of renewals to the accumulators is considerably increased, and amounts to £490, but the Directors thought it advisable to charge the whole of this to revenue account rather than take it out of the renewal fund. In fact, the whole of the buildings, plant and machinery has been maintained in an efficient state of repair entirely out of revenue account. There is also an item on this side of the account of £119 for law costs. These have been incurred in opposing applications to Parliament for powers which might have been competitive; and, further, the Company joined with several others in opposing the Marylebone and Bermondsey Vestries' application for powers to compete with the electric lighting companies already supplying current in their parishes. It was considered most advisable to give uncompromising opposition to these applications, as had Parliament granted the Orders it would have created a precedent enabling the local authorities to supply electricity in competition with companies to which they had practically given a lease, and it was on the moral understanding that no competition would be allowed that many shareholders were originally induced to invest their money in electric lighting undertakings. I am glad to say the Bills were thrown out by the Parliamentary Committee. Passing over to the credit side of this account it will be noticed that the receipts have increased over those of the previous year by nearly £2,000, and had it been possible to avoid a reduction in the price per unit, your Directors might now be in a position to recommend you to declare a much larger dividend. The pressure brought to bear by the local authority and the possibility of competition has made it necessary to keep the charge for current as low as possible, and the meter rents have also been reduced 50 per cent. It was not, however, so much the reduction in the price per unit which accounts for the small increase in the output as compared with the large increase in the number of customers. It is practically attributable to exceptionable circumstances: a very light season and an entire absence of the usual November fogs, combined with the fact that the contractor's account for current on the local electric railway was £650 less than in the previous year, mainly accounts for the comparatively small output. The profit on the year's working was £7,251, about £400 in excess of the previous year. The result is certainly not so good as your Directors expected, and is accounted for by the facts I have just mentioned. I may here add that I consider we are maintaining a much sounder position by reducing our charges, and we hope to derive considerable benefit from this policy in future by largely increasing the number of our customers and the quantity of current sold. Net revenue account, No. 5, follows, and you will gather from this that £825 has been set aside to the depreciation, renewal and reserve fund account, bringing that account to £4,500, after adding a portion of the premiums received from the issue of debentures. No. 7 account is the general balance sheet, which gives a summary of the state of affairs of the Company, and the certificate of the auditors certifying the correctness of the accounts will be found at the end.

Although the increase in the profit on the revenue account is small the number of houses and lamps connected during the last year created a record compared with any previous year of the Company's existence. Many of these, however, were not connected until late in the year, but we shall feel the full benefit of the increase during the current 12 months. Looking back for a moment before looking forward, I may remind you that we have had an exceptionally light season and the output during the summer months was no larger than the corresponding period of the previous year, although our customers had considerably increased. I had hoped that the founders would receive a dividend on this occasion. The result, unfortunately, made it impossible, but I hope, at our next annual meeting, I shall be able to propose the declaration of a good dividend on this class of shares, and this will necessarily mean a higher dividend for both Ordinary and Preference shares. Half the balance remaining after paying the full 6 per cent. dividend, belongs to the founders, and has been carried to a "Founders' Shares Undivided Profit Account." You see by this office that the Company is now in a good position in the district; mains are being extended in all directions, and new customers are being rapidly connected, so that the present outlook is most promising. More than two-thirds of our customers are already being supplied at the higher pressure of 200 volts, and as soon as they are all converted the saving in the cost of distribution will be very considerable and will allow us to connect a much larger number of customers to the present mains. I now beg formally to move—

"*That the Directors' report and accounts to Dec. 31, 1898, presented to this meeting be adopted, and that a dividend at the rate of 6 per cent. per annum less income tax on the Ordinary shares be and is hereby declared, payable forthwith.*"

Mr. JAMES THOMAS JERVIS seconded the resolution.

Mr. DAUBENEY said he did not quite understand the Chairman's remark to the effect that something had been put to the credit of the founders' shareholders.

The CHAIRMAN: Last year there was a trifle over the amount required to pay 6 per cent.—some £13—and this year the amount over 6 per cent. is £20. That makes together £33, which is placed to the account of the founders. I am told it is a little more—£37. When we give a dividend to the founders this will be included, but it is too trifling to distribute at present.

Mr. DAUBENEY remarked that he noticed a sum of £825 had been set aside for depreciation reserve. Speaking for three or four founders' shareholders besides himself, he thought that half of that sum should have been ear-marked and set aside for the founders. The articles plainly said that all that was available after paying 6 per cent. on the Ordinary shares should be divided between the two classes of shareholders. That was on page 11 of the articles.

Mr. ARTHUR ELLIS FRANKLIN (a Director) said the question was one of legal right, and the board had endeavoured to act on the advice that they had received as to the interpretation of the articles. Having read the article referred to, he said that he took it that, in passing the previous account, the shareholders had recognised the principle that the Directors had laid down of putting aside 1 per cent of capital expenditure every year to depreciation reserve, that was to say, not a reserve to meet depreciation in the license, but in order to provide against any sudden damage or injury to their property. They had about £4,000 or £5,000 set aside in case a boiler bursted or any other accident occurred.

Mr. FOX (Messrs. Fox, Sissons and Co., auditors) stated that, instead of writing anything for depreciation definitely off the machinery, the reserve which had been referred to had been created. The auditors could not pass the accounts unless some reasonable allowance was made in them for depreciation.

Mr. METCALFE (solicitor), said it was clear that the Directors had the power to carry part of the profits to the depreciation account. The founders' rights only came into operation in a year in which the profits of the Company exceeded a certain amount, and when they came to consider the profits available for distribution, it was clear, under article 99, that only those profits were, in the words of article 5, available for dividend which, in the opinion of the Board, remained after an adequate sum had been set aside for the purpose of a depreciation account. Therefore, until the Directors had made, if they came to the conclusion that it was their duty to do so, such appropriation to the reserve fund there were no profits available for dividend, and until profits were available for dividend, it was quite clear that the rights of the founders did not begin.

Mr. BALDWIN asked if the Directors intended to further reduce the price of the current. The Metropolitan Company had done so, and the consequence was that they paid a lower dividend—5 per cent. instead of 6 per cent. If the same should happen in this Company, the founders would be still further off getting any share of the profits.

The CHAIRMAN: It is proposed to reduce the price to those who take it from the 200-volt circuit from 6d. to 5d.

The resolution was then agreed to unanimously.

Sir William Crookes, F.R.S., and Mr. A. Howden were re-elected Directors, and the auditors were re-appointed.

An extraordinary meeting was then held to confirm the resolution passed on February 2nd, approving the Kensington and Notting Hill Electric Lighting Bill.

A motion was duly carried approving the Bill, and the proceedings terminated with a vote of thanks to the Chairman.

Telegraph Construction and Maintenance Co. (Limited).

The thirty-fifth ordinary general meeting of the members of this Company was held at the offices, 38, Old Broad-street, on Tuesday, under the presidency of Sir ROBERT G. W. HERBERT, G.C.B.

The MANAGING DIRECTOR (Mr. William Shuter) having read the notice convening the meeting, and the minutes of the last meeting,

The CHAIRMAN said: I conclude, gentlemen, that, as usual, it will be your pleasure that the report be taken as read, and I will proceed to move its adoption, making a few running comments on its several clauses. The Directors welcome with pleasure the opportunity afforded by this, our annual general meeting, of meeting face to face with the proprietors, because they are hopeful that you will consider the account, which they have to render of their stewardship for the past year, a satisfactory one. I will give you some comparative figures showing the differences between the chief heads of the accounts for 1898 and for 1897. The accounts this year show £71,593 net profits, against £61,131 in the previous year, and to this we add £33,841 brought down from last year, against £39,900 in the previous year, making a total of £105,435, against £101,071 for the year 1897. Having deducted the interim dividend of 5 per cent. there remains £83,025 to be dealt with against £78,660 in the previous year. We propose, as you have seen, to distribute the same dividend as last year—that is to say, a further 10 per cent. in addition to the 5 per cent. distributed in the middle of last year, and we shall have £38,205 to carry forward against £33,541 in the previous year. That is not quite so much as we should like to carry forward—it is, in fact, still a smaller sum than has been carried forward in most of the

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recent preceding years; but, having regard to the present condition of the Company, we hope that it will place us in a good position when this meeting recurs next year. We tell you that the Company's works have been fully employed in the manufacture of submarine telegraph cables and insulated land lines, and that our steamships also have been actively employed in the laying and repairing of cables in various parts of the world. That brings us to the important addition which we have made to our fleet in the steamship "Anglia," as to which reference was made at our half-yearly meeting. She is, as you see in the report, a very fine vessel of 6,514 tons, and the largest telegraph steamer afloat. In building her it has been the object of the Company to provide itself with a thoroughly efficient steamer, capable of carrying the longest lengths of cable that may have to be laid in any part of the world. Up to the present time, when a great length of cable has been laid, it has been necessary to employ two or more ships, but this fine vessel can carry out a very large job without any tender or assistance. She has the best machinery—triple-expansion engines, high-pressure boilers, and everything to give her the greatest efficiency and economy with good speed. She has now returned from a very successful trip as far as Alexandria, laying the cable from Gibraltar to Malta and Alexandria. She came back with a speed of over 11 knots without any pressure at all, and without the smallest hitch in connection with her machinery or any part of her works. We are extremely satisfied, therefore, for having got such a very fine ship for our purpose at a very moderate sum. We are, therefore, by possessing this economical and effective ship, naturally in a position to carry out works with greater promptitude and at a lower cost than we could before, or, indeed, than it is likely any other people will be able to rival us in. The factories at Wharf-road and at Greenwich and the steamships forming our fleet are in a thoroughly efficient condition. We have made considerable improvements at Wharf-road, which enable us to carry out our work more efficiently than we could do before; and at Greenwich also we have in hand, and are about to go on with, the ordinary considerable repairs and renovations which great works of the kind must, of course, require from time to time. The debentures of the Company, £150,000, we have been able to renew at 1 per cent. less—4 per cent. instead of 5 per cent. That is a little saving of £1,500 a year to the Company, which will come very usefully into our account. We next proceed to tell you that we are proposing to establish a pension fund for the benefit of the staff, and you will see in the accounts that we put down £5,000 to the debit of profit and loss as a nucleus for starting the fund. It is very desirable, as I am sure you will all agree, that we, like other great companies, should make provision for the staff which we employ. Our staff has been a very excellent one, and has always given us the highest satisfaction, and we should be very sorry to see any of them leave our employment to go to a company where security for them in their old age was provided which we did not do. This is not proposed as an annual sum of £5,000. Possibly, hereafter, when we are in good funds, there may be a proposal made to you to make a further donation to this fund, but it is desirable to place the fund on a footing, by the annual contributions of the staff, which will make it self-supporting. This bonus will tend to diminish the annual contributions from the staff, and it will be reduced rateably according to what they contribute. I am unable to unfold the scheme to you—it is in the hands of actuaries—but although we are a small company in point of the number of pensionable people we employ, we feel sure that we can organize a very satisfactory fund, which will be accepted very gratefully by our employés. The retiring directors are Admiral Sir Anthony H. Hoskins and Mr. Colin F. Campbell, who, I need not tell you, have both been very zealous in their attention to the interests of the Company, and who will offer themselves for re-election. Auditors have also to be appointed. I do not think I need detain you further, but if any gentleman in the room has any question to put we shall be glad to reply to it to the best of our ability.

Admiral Sir A. H. HOSKINS, G.C.B., seconded the resolution.

Mr. CROFT said he felt sure that the shareholders, present and absent, would be very gratified at the highly satisfactory report which had been presented to them, and the statement which had been made by the Chairman. He was sure that no better proof could be given of the prosperity of the Company than the fact that they had been able to renew the debentures at a smaller rate of interest than formerly. There were only one or two points on which he desired to ask information. He wished, in the first place, on his own behalf and on behalf of the shareholders, to express their great gratification that the Directors had established a pension fund for the benefit of the staff. He had been a shareholder in the Company for many years, and had always wondered why no such fund had been established. He was very glad to see Sir Robert Herbert's chairmanship signalized by the establishment of the fund, which he hoped that the Board would be able to carry through in a very satisfactory way. It was not stated whether it was intended for the benefit of the staff only, and he desired to know whether they meant it for the whole of the persons in the Company's employ. In connection with this point he might ask about the operation of the Workmen's Compensation Act, which, as they all knew, had affected all large manufacturing industries; and he would be glad to know if the Company had taken any steps with respect to this matter similar to those taken in the case of other large concerns. With reference to the expenses, although the matter was not referred to in the report, he presumed that they had suffered in common with other large companies who depended to a certain extent on coal from the increased price which had had to be paid for that article. He noticed the other day in the report of a meeting of what he supposed he might call a rival telegraph manufacturing company, that the chairman referred to the very high price which had had to be paid for the raw material of which electric submarine cables were composed. He did not wish the Chairman to enter into any details which he might not think it advisable to refer to; but, generally, he assumed they might take it that the Company had suffered both from the increased price of coal and the raw material of which their cables were composed.

General TREVOR thought it might be disappointing to some that when £83,000 had to be dealt with, only £44,800 was spent in dividend owing to a considerably larger sum being carried forward—£5,000 more than last year, and this in a year which they commenced with a profit of £1,500 arising from the reduction of interest on the debentures. They really carried forward £39,705. If an extra dividend of only 2½ per cent. had been granted there would still have remained £28,500 to carry forward; but he supposed that the Directors did not consider that this would be sufficient for their purpose, and they were the best judges in the matter. They had also a reserve fund of £50,000, which, of course, represented the accumulation of undivided profits. He did not know whether this sum was employed in their business, or whether it was invested in gilt-edged securities. For information on this point he had turned to the auditors' certificate, which stated: "We have also inspected the several securities held by the Company." That, however, might mean that the auditors had only inspected the gilt-edged securities in which this £50,000 was invested, if it was so invested, but they gave no information on the point. The Chairman was personally aware, being interested in another company in which he (the speaker) was a shareholder, that the way in which that company's reserve fund—he alluded to the Union Bank of Australia—was invested was always shown in the balance-sheet.

The CHAIRMAN, in reply, said: With respect to the first question that was asked—whether the pension fund is proposed to be made applicable to others than the staff—it is not at present in the purview of the scheme that it should extend to the mechanics and operatives at the works. Their position is a different one from those of the staff; they are, in fact, better treated relatively to their requirements than the staff. Moreover, as I am reminded, they come to us and go from us very much; they do not—like the staff of the office—make it their business to stop with us always. We take them on—a great many of them—according to the work we have to do. As to coal, we have had to pay more for it this year than in previous years, of course; and with reference to materials, no doubt their cost has been greater. It is well known to have been so all over the world. We have, therefore, been under the necessity of raising the prices somewhat of the manufactured work we supply. As the Company has always endeavoured to maintain a good large stock of materials, it is not so much affected by a temporary alteration of prices as if we had less well provided for our requirements a year or two in advance. I have been asked why, under the circumstances, a larger dividend has not been thought desirable, and why the carry forward is, in the opinion of the Directors, no greater than it should be. The £1,500 which will be saved in the debenture interest will, of course, come in to our benefit in the course of next year; but that, added to the amount we carry forward, is—as I said in my opening remarks—not an aggregate sum such as we should like to see carried forward. The amount carried forward in previous years has been £50,000, £60,000, &c.; and the uncertainty of our getting considerable orders is such that, with our great desire to maintain a steady dividend—not to have a slight increase one year, followed, perhaps, by a much greater fall next year, and making our stocks of a speculative character—we think it best to carry forward all we can within reasonable bounds. As to the auditors' certificate, it is the old form which we have adopted for many years. The reserve of £50,056. 12s. 6d. is an accumulation of interest that arose a good many years ago, and has always been left there; but, under our Articles of Association, the reserve fund must be maintained at £50,000, and if we took anything out of it we should have to put it back again.

Gen. TREVOR: Is it invested, sir?

The CHAIRMAN: I beg your pardon; it is not employed in the business at all, but is invested in securities of the highest class. In fact, this £50,000 is in Consols.

The report and accounts were then adopted, and a dividend of 24s. per share (in addition to the 12s. per share, interest or interim dividend paid to June 30, 1898) was declared, free of income tax.

The retiring directors were re-elected, and the retiring auditors re-appointed, and a cordial vote of thanks to the Chairman, Directors, and staff, for the able manner in which the business of the Company had been carried on during the past year, was unanimously approved, and the proceedings terminated.

W. T. Henley's Telegraph Works Co. (Limited).

The twentieth ordinary general meeting was held last Friday at the Cannon-street Hotel, Mr. SYDNEY GEDGE, M.P., in the chair.

The SECRETARY (Mr. A. E. Salmon) read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN: Gentlemen, my task is a very pleasant and easy one. I have to put before you this resolution:—

"*That the report and the balance sheet now presented to the meeting be and hereby are received and adopted.*"

I do not think that you will have any difficulty in accepting that resolution, and carrying it unanimously; but we who present the report to you are open to criticism, and although we gratify you, I hope, with a dividend and bonus amounting to 2 per cent. more than we paid last year—and, therefore, necessarily more than we have ever paid you before—we shall be very happy to accept any judicious criticisms you may kindly offer, especially if they lead to an improvement in our business, which may enable us to go on further in another year. There is very little, indeed, to remark upon in the report, because it is—I will not say rosy, but I think highly satisfactory. The Company has made steady progress. I am not going to take you many years back, but I thought it worth while to go back to the year 1895, and to trace the progress we have made in the Company in those four years from 1895 to 1898. I find that our share

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capital has been increased by 27 per cent., and that the value of our freehold land, buildings, machinery and plant has also increased by 27 per cent.; and you will see that, while the Ordinary share capital is £150,000; it is represented by freehold land, buildings, machinery and plant of the value of £150,809, so that there is ample property to represent the Ordinary share capital, merely looking at the freehold and fixtures alone. The stock-in-trade has very largely increased; it has increased by 166 per cent. in that time. Probably, you may think that a very large item. You see that £116,082 is the value of our stock-in-trade. Now, do not let any member suppose that that means just a lot of old stock-in-trade brought forward at full value, and making a very pleasant item in the balance-sheet, but which, if it had to be turned into cash, would not realise the amount. What it consists of is this: There is less than 4 per cent. of it which is what may be called old stock, and that has been written down every year lower and lower. We, therefore, have no doubt that that 4 per-cent., representing a sum a little above £4,000, is by no means an over valuation of that stock. The rest consists very largely of expenditure on orders in hand. You probably know that in this Company we never put down anything in our accounts in the shape of anticipated profit, or, in fact, earned profit on an order in course of manufacture. If we had done three-fourths of an order, we should only put down three-fourths of the cost, but we should not put down three-fourths of the profit, though it had been really earned. The stock-in-trade also consists of a considerable quantity of raw material, such as copper, gutta percha, and so forth, which have been bought as raw material for use in our trade. These are valued in this way: We look at two things—what we have paid and what the market price is, and the auditors look after us pretty carefully in order to ascertain the market price and to see that we are not over-valuing. We put down whichever is the lower amount – that is, if these things have risen in value since they were bought we put down what we paid for them, while, if they have fallen in value, we put down the market price. We are, therefore, very careful indeed not to make an over-estimate. Then a very considerable amount of this sum represents stock-in-trade for which there is a current demand, which has to be met immediately. We used in the old days, when we had not sufficient capital, to lose good orders because we could not supply the articles that were wanted until we had made them. We now keep a large stock—sufficient, but not more than sufficient—of articles of that kind to meet orders directly we get them. Then, as to orders and contracts, I am glad to tell you that we are this present year still continuing our progress with respect to these important matters. The orders up to this day are just 28 per cent. in value more than they were at this day last year, notwithstanding the fact that last year we received a very considerable order, amounting to about one-third of the whole, in the very week before the meeting. It was one very large order. This last year, however, we have not had the luck to get such an order. But, as a rule, large orders do not pay in proportion so good a profit as smaller orders. Little fish are very sweet, and I am glad to say that we have had very good orders, but they have been mostly made up of little fish. We have had very good orders, but they have been mostly running only to a few thousands, and they have been profitable orders. Looking to the other side of the account, I see that the first thing I have to point out is this—that we got £20,000 as a premium on the 2,500 Ordinary shares which we issued in 1898. You may remember that this time last year I told you that we had been able to put out the previous 2,500 shares, or £25,000, among the shareholders at a premium of £6 each—£16 for the £10 share—which brought in £15,000, which was then added to the reserve account. I told you at that meeting that we should be putting out the rest of the shares, and I said that you could not expect to get them so cheaply as you got the others; but I also said that we should sell them to the shareholders at a price that would pay them well, while at the same time a good price for the Company. They were offered at £18 and subscribed for at £18; and, therefore, £20,000 was made in the way of profit, as against £15,000 the year before on a similar issue; and that £20,000 has also been put to the reserve. We are also adding to it the ordinary £7,500, which, for the last three years, we have added to our reserve account, which now stands at the highly respectable figure of £62,500. I am glad to say that those new shares were put out without a single sixpence being paid to anyone by way of bonus or commission for placing them. They were taken up by the shareholders without any expense at all, and that is a point which should be particularly observed at a time when so much is being said about large commissions being improperly paid by directors of companies to get out their capital. The next item is the reserve under the cable repairing contract with respect to the Bahamas and Florida cable; the amount there is £5,352. That is increased automatically, as you know, by the subsidy which is paid to the repair fund by the Government of Bahamas, which, with the accumulated dividends, less anything spent in repairs, is invested half-yearly. Up to the present time on the cable, as cable, not a shilling has been laid out in the way of repair. The cable was laid in 1892, or seven years since, and altogether less than £30 has had to be spent on slight repairs to the cable huts and poles on shore; but, as I have said, the cable itself has not required a shilling to be laid out on it. I believe that I am right also in saying that the cable, which was laid the year before between Halifax and Bermuda—although that is not in our hands, and we are not answerable for repairs—has not required any expenditure, showing that our under-water work is exceedingly good. This time next year, unless any amount should be required to be spent on repairs, the insurance fund will amount to more than £6,000, and then under a provision in the contract to that effect, which we made with the Government of Bahamas for a subsidy, only half of it will be added to the fund and the rest will be paid direct into our pockets, and that will continue until, by expenditure on repairs, the amount is reduced—if it is reduced—to below £6,000. The next item I have to notice is this—that the net profits have risen by 45 per cent. since 1895, and the dividends and bonus have risen gradually from 8 per cent. to 14 per cent.—8 per cent., 10 per cent., 12 per cent., and 14 per cent. I am going to ask you to adopt the recommendation of the Directors to pay a dividend of 12 per cent. on the Ordinary shares and a bonus of 2 per cent. per annum. You may say: Why not make the dividend 14 per cent. at once—why make two bites of a cherry? Well, the reason is this: We consulted our brokers and other City people, and they say that while they think it perfectly right—and we think it right—that the shareholders should get the benefit of the very good business we did last year; yet, on the other hand, it is not certain, or it may not be possible, that we shall be able always to keep up a dividend of 14 per cent. If we go on as we are now, I shall hope to see a larger bonus than 2 per cent. over and above 12 per cent. We think that we shall always pay 12 per cent., and I hope that we shall never go below that rate, but we thought it better to pay a steady dividend of 12 per cent. and a bonus, because if we should not have such good business in a future year it would excite less remark if we did this than if we paid a dividend of 14 per cent., and it were afterwards to drop. It is the same thing all round, but on the Stock Exchange I hear that there is a good deal of sentiment, and they think more of a company that pays 12 per cent. and a bonus than of a company which has paid 14 per cent., and afterwards drops to 12 per cent. With respect to the steady increase of our business, there has been a great deal of talk about the payment of illicit commissions, and the Lord Chief Justice of England has been making severe comments on such commissions. I am happy to tell you that no illicit commission to the extent of a shilling has been paid by your Board to obtain contracts. We give proper commissions to our own agents, who, acting under our orders, represent us abroad and in the Colonies, and obtain business for us, but not a single shilling is ever paid by us to anyone who is an agent of anyone with whom we deal. Ours is all honest business. There is only one other matter for me to mention, with respect to the new works. On a recent visit to them I found—what I knew before—that the new offices and buildings are not yet completed. They have been very much delayed by the default of one manufacturer in not sending us material that was necessary for the works; but they are going on surely, if slowly. They will be very convenient, and as you pass them on the Thames you will see that they are very handsome works, which will do us credit, and the attention of all passers-by will be called to them. I may say that they are very substantial works. They are built on piles, and will be very expensive, but they are good. The contractors promise that they shall be completed, and I hope that they will be completed, so that they may be opened in July; and the Directors would like an expression from the shareholders as to whether we ought to celebrate the opening of these handsome new offices and warehouses at the works by something in the shape of a banquet, to which people in the commercial world and in the Government might, perhaps, be invited. We are disposed to think that it would be a very fair and proper occasion for the expenditure of a moderate sum, but we should very much like to hear your opinion as to whether you think anything of that kind is desirable. The principal shareholders would be invited; and we should be very glad to see the gentlemen who attend these meetings for the dry purpose of taking down notes of my speeches, and other speeches, present. If the suggestion is agreeable I think we might very well have an opening ceremony of that pleasant description. These are not all the works that we have to build. We have a great many shops for manufacturing purposes, not where the goods are sold. The shops are gradually getting into good order, able to turn out the work ordered, but more are required at a cost, which we have built up sufficient in the reserve account to pay. I only wish to add that our manager, Mr. Sutton, has been devoting himself to his duties in a way exceeding what he ought to have done. He has had an attack of influenza, and has been weakened by it, and he is not in good health. The Directors have, therefore, insisted on his going away, and he is departing for a few weeks to the Riviera, and I am sure when you come to give him a vote of thanks you will second us in our satisfaction that he is able to get away and in our hope that he will return completely restored to health and able to perform his duties with that zeal and ability that he has always shown. I do not think I have anything else to say beyond this—that Mr. Salmon and all the clerical staff in London and at the works, and Mr. Hatton, the engineer, and the various engineers under him, have all given complete satisfaction to the Board and done their work well, and deserve those proper increases of salary which the Directors were able to give them at the commencement of the new year. We feel as we are prospering that our prosperity is due, to a very large extent, to the energy, industry and fidelity of those in the employment of the Company, and that each of them ought, in his turn, to feel that as the Company prospers he prospers, and that as our dividend becomes larger his income follows suit. With these observations I now have the pleasure of proposing the resolution.

The Hon. RANDOLPH STEWART seconded the motion.

The resolution was carried unanimously and a dividend on the Preference shares and a dividend and bonus on the Ordinary shares were also approved.

Major-Gen. George Hutchinson, C.B., C.S.I., and the Hon. Randolph Stewart were re-elected Directors and Messrs. Ball, Baker, Deed, Cornish and Co. were re-appointed auditors.

The CHAIRMAN afterwards proposed a cordial vote of thanks to the Managing Director, the Secretary, and the staff in London and at the branches at home and abroad, and also to the chief engineer and his staff at the works for their valuable services during the past year.

Mr. GEORGE LAMONT seconded the motion, which was carried unanimously.

The MANAGING DIRECTOR (Mr. George Sutton), in acknowledging the vote, thanked the meeting for their sympathy with him in his sickness and for the cordial way in which he had been spoken of. The vote had been brought forward for many years in succession, but he could assure them that it lost none of its value by the repetition.

A vote of thanks to the Chairman and Directors brought the proceedings to a close.

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Charing Cross and Strand Electricity Supply Corporation (Limited).

The annual ordinary general meeting of the shareholders of this Corporation was held on Monday at the offices, 15, Maiden-lane, Covent Garden, Mr. W. F. FLADGATE (Chairman) presiding.

The SECRETARY (Mr. E. Wilmot Seale) read the notice convening the meeting, and the report of the Directors and the accounts were taken as read.

The CHAIRMAN: In submitting this report to you, the Directors feel that they are putting before you a report which shows a satisfactory progress, and a progress of which they do not think the shareholders have any need to be ashamed. I do not propose to detain you at any great length in discussing this report, but going generally through it, you will see that the second paragraph deals with the efficiency of the plant. Upon that the Directors never have the slightest hesitation in spending whatever may be considered necessary. That our plant should be kept in a high state of efficiency is one of the most important matters to consider in dealing with an electric lighting station. We have now at Lambeth an extensive installation. When we last met you we had to refer to the fact that certain boilers, which we had put in at the Lambeth station, were not working satisfactorily, and we feared that litigation might take place between us and the manufacturers of them. I am glad to say that the manufacturers, whose names I do not wish to give, have behaved in a perfect manner. They were content to depend on the report of an expert to be agreed upon between us, and that expert has given his decision that the boilers did not come up to the guarantee of the manufacturers, and they have agreed to take them back, and we have been saved the expense of them. The new ones are practically ready, however, and in a short time we shall have them installed. With regard to paragraph 3, that deals with the Provisional Orders which we had obtained, when we last saw you, from the Board of Trade, but which had not then been sanctioned by Parliament. The areas which we obtained were—the southern area of Holborn and the southern area of St. Giles. Up to the present time these areas have been unproductive, for the reason that it has not been possible to connect up our mains there, but we have laid down some 7½ miles of main in those areas, and we have no reason whatever to doubt that, when we are in a position to work them, they will be productive of great gain to the Corporation. We are still pushing forward, and we have applied, as we informed you last year, for a Provisional Order for lighting the City. In support of that we have obtained a memorial containing 5,000 signatures. Those signatures are the signatures of firms and corporations of the highest class, including 29 of the leading bankers, 81 of the leading insurance offices, and 82 newspaper proprietors, which, I think, is sufficient evidence that a very large class of people in the City think that competition should obtain in that district as in most other districts in London, and if we can secure from the Board of Trade and from Parliament the powers that we are asking, we have no hesitation in saying that it will be a good thing for us. During the last year we have added 26,694 lamps to the supply in the whole of our united districts, and that means an increase in our new customers of 374 persons, which, I think, is exceedingly satisfactory. I think that an increase of 43 per cent. is very gratifying. It is satisfactory also to note that, of the 26,000 new lamps which have been hung during the past year, 13,000 have been in our old district of St. Martin's, which shows that we have not exhausted our first area. The Strand district has contributed the bulk of the other 13,000, while St. Giles and Holborn have as yet contributed practically nothing. It is satisfactory to know that 20,000 lamps are now in process of negotiation, and we hope to be supplying them within a short time. During the year 18½ miles of main have been added to our system, of which seven miles are in the new districts. Of course, these seven miles are unproductive at present, because they are not yet connected with our supply. With regard to No. 6 paragraph, as to the output, I do not think I need trouble you, because, naturally, increased business means an increased output. Our output for the year was 3,246,231 units, and I might point out that, while in 1891 our output was, perhaps, the smallest of all the metropolitan companies, in 1898—last year—we stood fifth out of the thirteen, which shows the progress that this Company has made, notwithstanding competition and the efforts made by other companies to get that custom which we hope always, if possible, to keep to ourselves. Of course, the increase of our business has rendered necessary the enlarging of our buildings, and I may say that our buildings have had to be very greatly enlarged. We have also had to make arrangements for a new sub-station, and I am glad to say we have obtained an exceedingly satisfactory site in Drury Lane on a lease for 999 years, practically freehold. On that site we are erecting a sub-station, and also propose installing there a battery of accumulators, and that sub-station, linked with our two stations, the Lambeth one and the one here, will put us in the position to supply 250,000 lamps. We are now supplying 134,000; consequently, we shall have a balance of 116,000, which will enable us to meet the large amount of further demands which we expect will be made upon us. This, naturally, has been the cause of our being obliged to come to you for further capital. I will not detain you now with regard to that matter as I shall have to speak about it hereafter. The result of the year's working has been that our net earnings have amounted to £21,377, as against the net earnings in the previous year of £18,907. We think that is very satisfactory. We have heard from various sources that last year was not a particularly good one—too bright—because we did not have enough fog, but we do not feel that we have any great cause to complain of the results which we can bring before you. Our net earnings enable us, without straining our resources, to recommend the payment of a dividend on the Ordinary shares at the rate of 8 per cent. for 1898, and to carry forward £3,292 to future years, after making substantial reserve out of the money we have to deal with. Turning now to the accounts, account No. 1 is in the same shape as it was last year. That is our share capital account. With regard to No. 2 account—statement of the loan capital—I may remind you that we have powers at the present time to issue debentures to the extent of £150,000. Of these £70,000 has been already issued, and will mature on Jan. 1, 1900. They are running at 5 per cent., and, although we have power to buy them in at any time on giving six months' notice, the result would have been that we should have had to pay them off at the rate of 105, and we did not think it would have been wise to have incurred the cost of that premium. Instead of issuing any debentures until these debentures run out, we made arrangements with our bankers to lend us, as they did to the end of last year, £57,500 on the security of our unissued debentures. On that we paid ½ per cent. over bank rate. (a minimum of 3 per cent.) If you turn to the net revenue account, No. 5, you will see that the use of our borrowed capital, over and above debentures, has only cost us £1,100. It will be for us probably to meet you again in the course of the year to discuss how we should deal with the new issue of debentures. The only item on this account that we have to call your attention to, of any importance, is that we have, during the past year, expended £51,563 on capital account, and that is a considerable portion of the sum we now ask you to raise further capital for the purpose of meeting. Turning to No. 4 account, revenue account, the first item is the old item which I must at once say is not satisfactory, and that is the consumption of coals. It is very true that every electrical company during the past year has had, at any rate, some increase in their expenditure upon coals and, with regard to ourselves, we at once tell you that the expenditure of coals is receiving our careful attention, and that at the present time we are not satisfied with it. In the past year there have, of course, been special causes. In the first place there was a strike, and our calculations are that that strike has cost us a loss of £1,000 clear, over and above the contract price. The second difficulty that we had to deal with was the fact that there was no good coal during the strike to be got in the market, and so we were obliged to employ coal of a lower grade than usual. The result of that was that we used 7½ per cent. more coal, at least so our engineer reports, than we should have used if we had had the better coal. The next difficulty which arose was with regard to smoke. The fact of our having to use the bad coal brought us into conflict with the authorities, who summoned us for smoke nuisance, and on two occasions the magistrate felt bound to fine us. Our engineer has been, and is doing, all he can in this matter, but he points out that at present there is no destructor in the market which is practically efficacious, but he believes that an apparatus is now being constructed which will meet this difficulty, and we shall not hesitate to adopt it if we possibly can. At any rate, you can depend upon this, that the Directors will do as much as they possibly can to keep this item down in the future. In the same revenue account there is the item of accident compensation that we have had to pay, but we hope it will not appear again. We are now fully insured, and we do not think we shall have to trouble you again with that item. We have put £7,000 to the depreciation account, that being £1,750 in excess of last year. On turning to the next account, No. 7 account, you will observe that the large premium, which represents the premiums we received on the last issue of the Preference shares, has been carried to the reserve fund account. Consequently, if we add that to the total amount of depreciation account No. 6, you have a reserve amount standing at the respectable total of £29,609, or, in round figures, £30,000. Now, gentlemen, I think I have sufficiently gone through our report and accounts, and I will only detain you a few minutes longer in putting before you, as we have done before, our general position. We have done our utmost, I think, with a certain amount of success, to make this company one of the best, in the way of light supply, in the metropolis, and we do not ask you to come to us for that testimony; we think if you will look at the public prints and the diagrams showing the variation of electric pressure, which, I think, is in the hands of most of you, you will see that our line of pressure compares not only favourably, but exceedingly favourably, with that of any other London company. Having said this, I must come next to this point: Are we charging the public an undue amount for what we are giving them? When I remind you that our price is and has been the lowest in the metropolis, I do not think the Directors, when they can give you an 8 per cent. dividend on the Ordinary shares, can be considered as otherwise than having worked fairly in the interests of the Company in supplying a good article at a reasonable figure and giving a good return to shareholders. The average price in 1898 that we received for our light was 4·41d., and the only other company which has ever been less than 5d. in the metropolis is the St. James' Company, whose price last year was 4·78d., as against 5·32d. for the year 1897. I do not think that is a bad record for our company. One word with regard to the future. We are asking you to vote a large increase in our capital, an increase of £100,000, which we propose to issue at a considerable premium. That money is absolutely wanted for the present requirements of our district. Our position has been this: We started with St. Martin's district, and before endeavouring to enlarge our borders, we practically did all the work required by that district. We then, notwithstanding considerable opposition from various quarters, went to the Strand district, and practically did all the work there before we tackled the next district which came to us. We have now obtained St. Giles and Holborn, and, with the additional capital that we are asking you for power to raise, we have every reason to believe that we shall do satisfactorily the whole of the work necessary to supply these districts efficiently and well. If you look at the map on the wall, you will see what is the extent of our district. There are our old St. Martin's district, the Strand district, and the St. Giles and Holborn districts. The Northern districts we did not receive powers to supply. When we came before the Board of Trade last year we were given the southern part of the districts, the northern being given to the County of London Supply Co. You will see that the whole of our eastern border, from Holborn to the Thames, is co-terminus with the City, and we feel that, if we can get power to supply the City, we are in an exceedingly

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satisfactory position to supply it. It means simply extending our borders eastward in a straight line. We have no doubt that if we can get the powers for supplying the City, that we can do well with it. However, it will require that we should raise a large amount of capital. We are not purposing in any way to deal with the City until we have met you again and secured your authorisation for the very large amount of capital which it will be necessary to raise in order to tackle the City successfully and well. I do not think there is anything more to trouble the shareholders with, but, before I finish speaking, I should like to testify to the services rendered to us by our staff here. We, Directors, I think, all of us have honestly worked in the interests of the Corporation. We have had in the past the assistance of Mr. S. Gatti, who is the great pioneer of this Company, in conjunction with his late brother whose death many of us still regret, but we have now the benefit of the services of Mr. A. Gatti's son, Mr. J. M. Gatti, who gives to the affairs of this Company a large amount of time and attention. But, without our staff, we could do absolutely nothing, and I wish to testify in the strongest terms to the energy and ability with which both secretarial and engineers' departments are looked after by Mr. Seale, the secretary, and Mr. Patchell, our engineer. It is to them that you owe a very great deal indeed. We can only direct and help to foster the industry which has grown to be so successful, and which we hope will become more so in the years to come. With these words I will move—

"*That the report and accounts be received and adopted.*"

Mr. G. H. BROUGHAM GLASIER seconded the resolution, which was carried unanimously.

A vote of 1,000 guineas to the Directors for the year of 1898, and a similar sum for their services for 1899 was voted. The dividend at the rate of 4½ per cent. on the Preference shares, and a dividend at the rate of 10 per cent. per annum for the half year on the Ordinary shares (making 8 per cent for the year) was agreed to. The retiring Directors were re-elected and the auditors were re-appointed.

The CHAIRMAN then moved a resolution for increasing the capital, which he announced would be dealt with in the same way as in the case of the last issue of Preference shares—it would be offered to the shareholders entirely in the first instance at a premium. The capital would be increased by the creation of 20,000 new ordinary shares of £5 each, to rank equally with the existing Ordinary shares.

The resolution was carried unanimously and a vote of thanks to the Directors and staff terminated the proceedings.

Chelsea Electricity Supply Co. (Limited).

The Directors of this company, in their report just issued for the year ended December 31 last, states that in November, 1898, an issue of £40,000 debenture stock was made at 108½ per cent. The issue was fully paid up in January, and a Stock Exchange quotation has been applied for. The balance of premium received in 1898, after deducting expenses of issue and certain special law and incidental expenses, has been carried to reserve, which now stands at £46,818. 3s. 4d. The whole of the authorised share capital (£200,000) has now been issued, as has debenture stock to the amount of £100,000. It becomes necessary, therefore, to take powers to increase the share capital so that future issues may be made as required by the progress of the business.

The Bill for the compulsory purchase of certain properties required for the purposes of the business was successfully carried through Parliament, the Chelsea company being the first to obtain an Act for powers for compulsory purchase of land within the area of supply. The Act will enable the company to acquire at reasonable cost such lands and premises as it requires.

£2,500 has been added to renewals and depreciation out of net revenue. After deducting this amount, and paying interest on debenture stock (£2,822. 15s. 10d.) there remains £12,923. 3s. 6d., and the Directors recommend the payment of a dividend of 6 per cent. on the Preference shares for the half-year, and a dividend of 7 per cent. per annum on the Ordinary shares, making 6 per cent. for the year. This leaves to be carried forward £923. 3s. 6d.

The number of lamps connected on Dec. 31 was 112,587, an addition of 15,949 during the year.

NEW COMPANIES, STATUTORY RETURNS, &c.

BRITISH PIONEER ELECTRIC LIGHT AND POWER COMPANY OF INDIA (LIMITED).—This company was registered on Feb. 27, with a capital of £3,000, in £1 shares, to apply for or otherwise acquire and deal with, in the United Kingdom, India, Burmah, Ceylon and elsewhere, any right, privilege, concession or contract for generating, supplying, distributing and employing electricity or other power, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity and electrical apparatus manufacturers.

ELECTROMOTORS (LIMITED).—This company was registered on Feb. 24, with a capital of £50,000, in £1 shares, to enter into an agreement with Messrs. Claude W. Atkinson and W. H. Johnson, and to carry on the business of manufacturers of electric and other motors, dynamos and electrical apparatus, electricians, electrical, mechanical and general engineers, electric and other locomotive builders, crane, hoist, waggon and motor car builders, &c. The subscribers, each with one share, are:—W. H. Johnson, W. H. Stubbs, J. H. Stubbs, A. McDougall, F. Goodbehere, Claude W. Atkinson and P. Stubbs. The first directors are:—William H. Johnson, W. T. Stubbs, J. H. Stubbs and A. McDougall.

INGLETON ELECTRIC LIGHTING AND POWER CO. (LIMITED).—This company was registered on Feb. 22, with a capital of £4,000, in £1 shares, to carry on at Ingleton, Yorks, and elsewhere, the business of electricians, electrical and mechanical engineers, suppliers of electricity and manufacturers of and dealers in electrical apparatus. The first subscribers are:—W. Metcalfe, J. C. Watkin, J. Brookes, R. Atkinson, C. Ferguson, W. Mackay and W. Fisher.

MACROOM AND DISTRICT ELECTRIC LIGHTING SYNDICATE (LTD.).—This company was registered on Feb. 27, with a capital of £5,000, in £1 shares, to acquire the plant, machinery, cables and concessions relating to the lighting by electricity of Macroom (Cork), to enter into an agreement with Mr. W. P. Theerman, and to carry on the business of suppliers of electricity, electrical engineers, machinists, electrical apparatus manufacturers, &c. The first subscribers are:—H. Shaw, D. Ashton, C. A. Clark (electrical agent), L. H. Shaw, J. Johnson, J. McDermott (electrical engineer), and J. Crossley.

NERNST ELECTRIC LIGHT (LIMITED.)—This company was registered on Feb. 25, with a capital of £320,000, in £1 shares (140,000 Seven per Cent. Preference), to acquire certain rights in connection with an invention known as the Nernst Lamp, to enter into an agreement with the Nernst Lamp (Limited), and to carry on the business of electric lamp manufacturers and dealers, electricians, electrical and mechanical engineers, suppliers of electricity, and manufacturers of and dealers in electrical apparatus. The first subscribers (each with one share) are: John G. Fort, G. F. Honig, W. Andrew, F. W. White, C. M. Robertson, J. G. Forster, and E. Bois.

PIONEER ELECTRIC LIGHT AND POWER CO. FOR JAPAN (LIMITED).—This company was registered on Feb. 23, with a capital of £3,000, in £1 shares, to apply for, purchase, procure the grant of, or otherwise acquire and deal with any right, concession or contract for generating, supplying, distributing and employing electricity, gas or other light and power in Japan or elsewhere. The first subscribers (each with one share) are:—James A. Kelman, James A. Kelman, jun. (electrical engineer), C. S. Kelman, D. E. Kelman, A. McIntosh, E. A. King and G. C. Eedes.

PIONEER ELECTRIC LIGHT AND POWER CO. FOR CHINA (LIMITED).—This company was registered on Feb. 23, with a capital of £3,000, in £1 shares, to acquire and deal with any rights or concessions to supply electricity, gas and other light and power in the empire of China or elsewhere, and to carry on the business of electricians, electrical, mechanical and general engineers, suppliers of electricity, &c. The subscribers are the same as in the Pioneer Company for Japan above.

SURPRISE ARC LAMP SYNDICATE (LIMITED).—This company was registered on Feb. 24, with a capital of £2,000, in £1 shares, to acquire the business carried on under the style of Thomas and Co., to enter into an agreement with Messrs. Wallace J. L. Sandy and Thomas Geer, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity and electrical apparatus manufacturers. The subscribers, with one share each, are:—W. F. L. Frith, A. H. Parkes, H. A. Swepstone, F. Lloyd, G. C. Baldock, W. H. Butterfield, and H. Perry.

DIRECT UNITED STATES CABLE COMPANY (LIMITED).—The annual return, just filed, shows that 60,710 shares have been taken up out of a capital of £1,300,000 in £20 shares, and that all have been issued as fully paid.

NEW BRITISH INCANDESCENT ELECTRIC LAMP COMPANY (LIMITED).—The statutory return to Dec. 5th has been filed. The capital is £30,000, in £1 shares, of which 23,857 have been taken up, and all are considered as fully paid.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 2, 1899). Price of silver 27 7/8d. per oz. (March 2). Consols (2¾ per cent.) 110⅛—110⅝ for money, 110⅝—110⅞ for account; 2½ per cent. 103½—103½ xd. (March 2), Stock Exchange Settling Days: Consols, April 6; Stocks and Shares Continuation Days, March 8 and 27; Ticket Days, March 9 and 28; Pay Days, March 10 and 29; Mining Share Carry over Days, March 7 and 25.

BIRMINGHAM ELECTRIC SUPPLY CO. (LIMITED).—The Directors' report for the year 1898 states that the sale of the company's business to the Corporation on terms approved by the shareholders at the extraordinary general meeting in June, 1898, requires the confirmation of Parliament, the date for the completion of the purchase (subject to the right of the Corporation to anticipate) being fixed for Dec. 31, 1899. By virtue of the agreement with the Corporation, the company are entitled to declare and pay dividends at the rate of 6 per cent. per annum from Jan. 1, 1898, until the completion of the purchase. The amount of net profit, including £989. 3s. 9d. brought forward, is £18,516. 3s. 5d., of which £5,307. 13s. 10d. has been placed to credit of depreciation reserve fund. An interim dividend was paid for the half-year ended June 30 last, and it is now proposed to pay a dividend for the second half-year of 1898. These payments absorb £11,999. 7s. 5d., leaving £1,209. 2s. 2d. to be carried forward.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY CO. (LIMITED).—The Directors have declared a dividend on the Ordinary shares at the rate of 4 per cent. per annum (less tax) for the year 1898. The transfer books and register of members will be closed from 6th to 13th inst. inclusive.

BRAZILIAN SUBMARINE TELEGRAPH CO. (LIMITED).—The directors of this company have declared an interim dividend of 3s. per share (at the

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the rate of 6 per cent. per annum), free of tax; for the quarter ended Dec. 31 last. The dividend is payable on 24th inst., and the transfer books will be closed from March 17 to 23 inclusive.

BRUSH ELECTRICAL ENGINEERING CO. (LIMITED).—In their interim report for the half-year ended Dec. 31, 1898, the directors state that the works at Loughborough, including the new shops completed, have been well employed, and the volume of orders received during the half-year has been satisfactory. The further extensions at the Company's works at Loughborough, rendered necessary by the increasing demand for plant and rolling stock for electric traction purposes, are making satisfactory progress. Various important contracts in connection with electric lighting and electric traction undertakings have been secured and are in hand. An interim dividend for the half-year at the rate of 6 per cent. per annum has been declared on the Preference shares.

COMMERCIAL CABLE CO.—The transfer books of the Four per Cent. 500-year Debenture Stock will be closed from 23rd to 31st inst., inclusive.

DIRECT SPANISH TELEGRAPH CO. (LIMITED).—In addition to the dividend at the rate of 10 per cent. per annum on the Preference shares the directors of this company have declared an interim dividend at the rate of 4 per cent., free of tax, on the Ordinary shares for the half-year ended Dec. 31 last. Both dividends are payable on April 1.

GATESHEAD AND DISTRICT TRAMWAYS CO. (LIMITED).—The annual meeting was held on Wednesday. The Chairman said the new arrangement with the British Electric Traction Co. was working satisfactorily, and their Parliamentary Bill for electric powers and extensions would be unopposed. Mr. E. Garcke stated that as soon as the bill was passed the conversion of the tramways would be undertaken.

METROPOLITAN ELECTRIC SUPPLY CO.—The directors of this company recommend a final dividend of 5s. per share, making 10s. per share for the year 1898.

NORTHAMPTON ELECTRIC LIGHT AND POWER CO. (LIMITED).—The annual meeting of this company was held on Thursday last, Mr. F. H. Thornton presiding. The Chairman moved the adoption of the report, which was, he said, very satisfactory. The machinery was in excellent order, and no reasonable expense had been spared to maintain it so. During the year the mains had been extended to dwelling-houses, and the change over to the 3-wire system had been carried out without a hitch, much to the credit of their engineer. As to the purchase of the undertaking by the Corporation, if the corporation put a reasonable proposal before them, it would be considered. The 5 per cent debentures had been paid off, and future saving in that respect must follow. All that was needed to ensure the success of the company was the support of the public, which the directors were doing their utmost to get, by providing customers with slot machines, which enabled a consumer to obtain a shillingsworth of current. They had also entered into an agreement for wiring on "easy" terms. The report and accounts were adopted, and a prospectus was approved relating to the issue of 10,000 ordinary shares and a limited number of 4 per cent. debentures.

NORTHWICH ELECTRIC SUPPLY CO. (LIMITED).—The annual meeting was held on Monday. The chairman (Mr. T. Ward, J.P.) stated that although the company had only been actively working for a year, there was a satisfactory profit, which was carried forward. The equivalent of nearly 4,000 8 c.p. lamps have been connected up. It has been decided to extend the cables to Hartford which will be lighted electrically by June 1,

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has ordered the further issue of £150,000 4 per cent. debenture stock of the *Edison and Swan United Electric Light Co. (Limited)*, and 4,000 vendors' 6 per cent. £5 fully paid cumulative preference shares (Nos. 1 to 4,000) and 6,000 6 per cent £5 fully paid cumulative preference shares (numbers 4,001 to 10,000) of the *New General Traction Co. (Limited)* to be quoted in the Official List. Application has also been made to allow the further issue of £100,000 5 per cent. perpetual debenture stock of the *British Electric Traction Co. (Limited)* to be quoted in the List.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	AGGREGATE. Amount.	AGGREGATE. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Feb. 25	3,823	+ 491	7	30,027	+ 2,092
Blackpool Corporation...	,, 23	150	+ 39	47	17,330	+ 2,535
Blackpool—Fleetwood...	,, 25	207	...	8	1,267	...
*Bristol Trams & Carriage	,, 24	2,590	+ 299	8	19,841	+ 1,025
City & South London Ry.	,, 26	1,102	+ 37	9	9,997	+ 366
Dover Corporation	,, 25	142	+ 43	47	8,341	...
Dublin United (Southern)	,, 24	649	+ 298	8	4,786	+ 1,610
*Glasgow Corporation ...	,, 25	7,940	...	...	...	...
Liverpool Corporation						
Dingle Route	,, 18	45		14	7,521	...
Prince's Park Route...	,, 18	30		5	1,450	...
Liverpool Overhead Rly.	,, 26	1,280	− 20	9	11,624	− 506
*Sheffield Tramways....	,, 26	1,162	+ 245	8	9,651	+ 1,960
*South Staffs. Trams.....	,, 24	624	+ 73	8	4,715	+ 19

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

PRESENT AMOUNT.	AMOUNT OF SHARE.	LAST DIVIDEND.	NAME.	PREVIOUS WEEK'S PRICE FEB. 22.		Price Wednesday, March 1.		RATE PER CENT. YIELDED.	DIVIDENDS DUE.	BUSINESS DONE DURING WEEK ENDING MARCH 1.	
								£ s. d.			
			TELEGRAPHS.								
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	100	104	100	104	3 16 11	January and July	101	..
25,000	10	..	Amazon Telegraph	3	4	3	4	..	..	..	..
£125,000	100	5%	Do. 5 per Cent. Debentures	87	92	87	92	5 6 5	..	..	..
£905,560	Stock	24 0	Anglo-American	67	69	67	69	5 0 0	Feb., May, Aug., Nov.	..	..
3,047,220	Stock	80/0	Do. Preferred	119	120	119	120	5 0 0	,, ,,	119¾	119
3,047,220	Stock	18/1	Do. Deferred	15½	15¾	14½	15	6 0 0	.. ..	15	14⅝
205,151	10	3/0	Brazilian Submarine	16	16½	16	16½	4 4 11	Mar., June, Oct., Dec.	16½	16⅜
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	110	114	110	114	4 7 9	June and December	..	..
10,000,000	$100	$2¾	Commercial Cable Capital Stock	180	190	190	200	4 0 0	Jan., Apr., July, Oct.	..	..
£1,332,523	Stock	4%	* Do. 4 per Cent. Debenture Stock	105	107	105	107	3 15 2	,, ,,	106½	105½
16,000	10	8/0	Cuba Submarine Ordinary (Deferred)	9½	10½	9½	10½	6 13 4	February and August	..	..
6,000	10	10/0	Do. Preference 10 per Cent.	17½	18½	17½	18½	5 8 1	,, ,,	18⅜	..
12,931	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October	..	..
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	,, ,,	..	..
£50,000	50	4½%	Do. 4½ per Cent. Debentures	104⅞	107⅞	104⅞	107⅞	4 4 1	January and July	..	..
60,710	20	3/0	Direct United States Cable	12¼	12¾	12¼	12¾	5 2 0	Jan., Apr., July, Oct.	12⅝	12⅞
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	102	105	103	106	4 5 6	..	104½	..
£4,000,000	Stock	5%	Eastern Ordinary	179	184	180	185	3 16 1	Jan., Apr., July, Oct.	183	181
£1,295,000	Stock	3½%	Do. 3½ per Cent. Pref. Stock	104	107	104	107	3 5 7	,, ,,	106½	104
41,432,268	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	126	130	126	130	3 2 0	May and November	..	..
£89,900	100	5%	* Do. 5 per Cent. Debentures, 1899	99	102	99	102	4 18 0	February & August	..	..
£500,000	Stock	..	Do. Provisional Certificates (all paid)	103	106	104	107	..	..	..	..
250,000	10	2/6	Eastern Extension	17¾	18¼	18	18½	3 15 8	Jan., Apr., July, Oct.	18⅜	18¼
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	129	125	128	3 2 1	February & August	..	..
£16,200	100	5%	* Do. 5 p. c.(Austln.Gov. Sub.)Deb.1900(reg.)	99	103	99	103	4 17 1	January and July	..	..
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	,, ,,	..	..
£35,100	100	5%	*Eastern and S.African 5 p.c.Mor.Deb.,1900(reg.)	99	103	99	103	4 17 1	,, ,,	..	..
£46,500	100	5%	Do, (Bearer)	100	103	100	103	4 17 1	,, ,,	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures,1909	102	105	102	105	3 17 8	February & August	..	..
£200,000	25	4%	Do. 4% Mauritius Sub. Debs. (red.)	104⅞	107⅞	104⅞	107⅞	3 15 2	May and November	..	..
180,227	10	1/9	Globe Telegraph and Trust	12¾	13½	12¾	13½	3 17 4	Jan., Apr., July, Oct.	13	12⅞
180,042	10	6%	Do. 6 per Cent. Preference	17	17½	17	17½	3 8 7	,, ,,	17½	17
150,000	10	5/0	Great Northern of Copenhagen	29½	30½	30	31	3 4 6	January, April, July	30	..
£150,000	100	5%	* Do 5 per Cent. Debs., 1883 issue Series "B"	101	104	98	102	4 18 0	March & September	..	..
£97,800	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red)	99	102	100	103	4 8 0	June and December	..	..
17,000	25	12/6	Indo-European	58	61	58	61	4 2 0	May and November	..	..
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	109	112	107	110	5 9 1	March & September	..	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs.(red)	105	108	105	108	3 14 5	June and December	..	..
11,839	8	4/0	Reuter's	6½	7½	6½	7½	5 6 8	April and October	6¾	6⅝
8,881	£100 Cert.	6%	Submarine Cables Trust	138	143	139	144	4 4 8	,, ,,	142	141
15,609	10	..	West African Telegraph	..	..	..	..	..	..	..	..
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.) xd	101	103	97	101	5 0 0	March & September	..	..
30,008	2½	..	West Coast of America	¾	1	¾	1	..	..	..	..
£150,000	100	4%	* Do. 4 per Cent. Debentures	103	106	103	106	3 15 9	June and December	..	..
88,321	10	1/6	West India and Panama	1⅝	1¾	1¾	2⅛	..	May and November	2	..
34,563	10	6 0	Do. 6 per Cent. 1st Preference	10½	10⅝	10⅛	11	5 9 1	,, ,,	10¹³⁄₁₆	10⅝
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	8½	9½	9	10	6 0 0	,, ,,	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures	104	107	105	108	4 13 2	January and July	..	..
64,269	15	5/0	Western and Brazilian Ordinary	12⅛	13	12½	13	4 11 3	May and November	..	..
33,129	7½	3,9	Do. 5 per Cent. Preferred Ordinary	8¼	8⅝	8¼	8⅝	4 5 8	,, ,,	..	..
33,129	7½	1/3	Do. Deferred Ordinary	4	4½	4	4½	..	,, ,,	..	..
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	106	109	107	110	3 13 2	June and December	..	..
1,168,000	$1,000	7%	*Western Union 7% 1st Mort. (Building) Bonds 1902	..	..	..	..	..	Feb., May, Aug., Nov.	..	..
£158,100	100	6%	* Do. 6 per Cent. Sterling Bonds (red.) xd	98	103	98	103	5 16 6	March & September	..	..

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share	Last Dividend	Name	Previous Week's Price Feb. 22		Price Wednesday, March 1		Rate per Cent. Yielded £ s. d.	Dividend Due	Business Done During Week Ending March 1 — Highest	Lowest
			TELEPHONES.								
64,000	5	4/0	Chili Telephone (fully paid)	2¾	3¼	2¾	3¼	6 3 1	August	–	–
224,850	10/0	1½d.	Consolidated Telephone Const. & Manufacturing	1/16	3/16	1/16	3/16	6 7 0	July	–	–
28,000	5	4/0	Monte Video Telephone 6 per Cent. Preference	–		–		–	October	–	–
490,000	5	2/0	National xd	5½	6	5½	5¾	5 6 8	February & August	5⅝	5½
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref. xd	14	16	14	16	3 15 0	" "	14½	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref. xd	14	16	14	16	3 15 0	" "	–	–
280,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref xd	5½	5¾	5½	5¾	4 10 11	" "	5⅝	5 9/16
1,236,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	100	102	100	102	3 9 0	June and December	101½	100
171,504	1	0/4	Oriental	⅜	¾	⅜	¾	6 12 4	April and October	–	–
78,000	5	6/0	United River Plate	4½	5¼	4½	5¼	5 14 3	July	–	–
£151,720	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	104	107	104	107	4 13 11	June and December	–	–
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	–	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (10s pd.)	⅜	⅝	⅜	⅝	–	–	–	–
6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	13	13½	13	13½	–	–	–	–
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10½	11½	10½	11½	4 4 0	–	–	–
30,000	5	3/0	Charing Cross & Strand Electricity Supply Corp	11½	12½	11½	12½	3 4 0	February & August	12	11⅞
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6½	6	6½	3 9 3	" "	–	–
£24,000	5	2/6	Chelsea Electricity Supply Ordinary	8½	9½	8½	9½	3 3 2	March	..	–
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	114	116	114	116	3 18 1	June and December	–	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red)	103	105	103	105	4 15 3	–	..	–
50,000	10	5/0	City of London Elec. Lighting Ord. 40,001 to 90,000	18½	19½	19½	20½	2 18 6	February & August	21⅛	19½
10,000	10	1/9	Do. Ordinary 90,001 to 100,000	18½	19½	19	20	..	–	19½	–
40,000	10	6%	Do. 6% Cumulative Pref.	15	16	15	16	3 15 0	January and July	16	15⅝
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	124	129	124	129	3 17 10	June and December	126	..
30,000	10	–	County of London & Brush Prov. Ord. (1 to 30,000)	12½	13½	12½	13½	–	–	13	12⅞
10,000	10	..	Do. (30,001 to 40,000)	12½	13½	12½	13½	..	–	..	..
20,000	10	6/0	Do. 6% Cumulative Preference	14½	15½	14½	15½	4 0 0	March & September	15½	..
15,000	5	2/6	House-to-House Electric Lighting Supply Ord.	9	10	9	10	2 0 0	–	9½	9⅝
12,000	5	3/6	Do. 7 per Cent. Preference	9½	10½	9½	10½	3 6 8	March & September	9⅝	9 11/16
15,000	5	10%	Kensington and Knightsbridge Ord. xd	13	14	13	14	3 18 7	–	–	–
10,000	5	6%	Do. 6% 1st Pref.	7¾	8½	7¾	8½	3 12 9	January and July	–	–
110,000	3	–	London Electric Supply Ordinary	3½	4	3½	4	–	–	3⅝	–
48,050	5	–	Do. Preference	6½	7	6½	7	–	–	–	..
£100,000	Stock	..	Do. 4% 1st Mort. Deb.	104	106	104	106	3 15 6	Mch., June, Sept., Dec.	–	..
62,500	10	5/0	Metropolitan Electric Supply Ordinary	17	18	16½	17½	3 8 7	April and October	17⅜	17 13/16
22,500	10	–	Do. (£7 paid)	13½	14½	13½	14½	..	–	14 3/16	..
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	118	121	118	121	3 14 7	June and December	119	–
6,452	10	6/0	Notting Hill Electric Ordinary	17½	18½	16½	17½	3 8 7	March	17½	–
10,000	5	–	Oxford Electric Ordinary	6½	7½	6½	7½	–	–	–	..
275,000	1	–	Rand Electric	¾	1¼	¾	1¼	–	–	–	–
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb	88	93	88	93	5 8 1	–	91	–
150,000	$100	$8	Royal Electric Company of Montreal Shares	160	180	160	180	4 9 5	–	–	–
120,900	100	4½%	* Do. 4½% 1st Mort. Debs.	107	109	107	109	4 8 9	April and October	–	–
21,980	5	9/6	St. James and Pall Mall Electric Ordinary	15½	17½	16½	17½	4 2 9	February & August	17 1/16	16⅝
20,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	" "	9⅝	..
£50,000	Stock	4%	* Do. 4 per Cent. Debenture Stock (red.)	–		–		..	June and December	..	–
65,000	5	..	South London Electric Supply Ordinary (£3 paid)	3½	3¾	3½	3¾	..	..	3⅝	3 9/16
79,900	5	7/0	Westminster Electric Supply Ordinary xd	15½	16½	15½	16½	3 12 9	March & September	15⅞	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	2	1/2½	Brush Electrical Engineering	1¾	2¼	2	2¼	2 13 4	–	2 1/16	2
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative xd	2½	2¾	2½	2¾	5 1 1	–	2⅝	2½
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	111	115	110	114	3 19 2	February & August	–	–
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101	104	101	104	4 6 7	June and December	104	–
£20,000	5	5/0	Callender's Cable Construction	12½	13½	12½	13½	5 0 0	" "	13	12⅞
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	113	116	114	117	3 17 5	November and May	..	–
300,000	1	9¾	Castner-Kellner Alkali Co. (fully paid)	1¼	1⅝	1¼	1⅝	5 16 5	–	..	..
50,000	1	.	Chadburn's Ship Telegraph Ordinary	1⅛	1⅝	1⅛	1⅝	.	–	1 5/16	1¼
50,000	1	7½d	Do. 6 per Cent. Cumulative Pref.	1	1¼	1	1¼	4 16 0	–	–	–
32,098	3	1/6	Crompton and Co. (Nos. 1 to 32,098)	3½	3¾	3½	3¾	4 0 0	–	3⅝	3⅜
£82,850	100	5%	* Do. 5% First Mort. Deb. (red.)	98	101	98	101	4 19 8	January and July	–	..
98,261	5	1/9¾	Edison and Swan United ("A" Shares) (£3 paid) xd	2½	2¾	2½	2¾	7 1 8	February & August	2⅝	..
17,139	5	2/3¾	Do. (£5 paid) xd	4	5	4	5	6 19 0	" "	–	
£344,028	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	97	99	98	100	4 0 6	June and December	99½	98
17,400	5	5%	Edmundson's Electric Corporation Ord (fully pd)	5½	5¾	5½	5¾	4 6 11	Half-yearly	..	–
112,100	2	1/2½	Electric Construction Co. (Limited)	2½	2¾	2½	2¾	4 12 0	January & July	2 5/16	
25,000	2	2/9½	Do. 7 per Cent. Cumulative Pref.	3	3½	3	3¼	4 0 0	July	3½	–
£140,300	Stock	4%	Do. 4% First Mortgage Deb. (red.)	103	106	103	106	3 15 10	January and July	104	–
91,196	1	–	Elmore's Patent Copper Depositing	½	¾	½	¾	..	–	–	–
12,500	10	8/0	Henley's Telegraph Works Ordinary	25½	26½	26½	27½	4 14 6	February & August	27	–
8,000	10	7/0	Do. 7 per Cent. Preference	18½	19½	18½	19½	3 11 10	" "	–	–
£10,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	113	116	113	116	3 19 1	" "	–	..
50,000	10	15/0	India Rubber, Gutta Percha, &c., Works xd	23	24	22	23	4 6 11	" "	22⅞	22 7/16
300,000	100	4%	Do. 4% First Mortgage Debentures (red.)	102	106	102	106	3 15 6	March & September	103½	..
37,350	12	12/0	Telegraph Construction and Maintenance	38	42	40	44	4 1 10	March and July	41½	40½
£150,000	100	..	Do. 4 per Cent. Deb. Bonds	–		104	107	3 15 4	..	..	–
£13,400	5	–	Do. Manufacturing Ordinary	8¾	9½	9½	9¾	–	–	9½	9⅛
13,400	5	..	Do. 5% Cum. Pref.	5¾	6¼	5¾	6¼	4 0 0	–	–	–
£30,000	5	4/0	Willans and Robinson Ordinary	8½	8¾	8¾	9	4 8 11	April and October	8⅞	–
£30,000	5	3/0	Do. 6% Cumulative Preference	7	7½	7	7½	4 0 0	" "	–	–
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	106	108	106	108	3 18 8	May and November	–	–
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	8/0	Blackpool and Fleetwood Tramways xd	23	24	23	24	3 6 8	–	–	–
50,000	10	7%	Bristol Tramways and Carriage xd	24	24½	23¾	24½	2 13 1	–	21½	24
£90,410	Stock	4%	Do. 4% Debenture	120	121	120	121	3 6 2	–	–	–
80,000	10	..	British Electric Traction Ordinary	16½	17½	16½	17½	..	–	17⅜	17⅛
10,000	10	6/0	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm. pd.)	13½	13¾	13½	13¾	4 7 3	–	13 11/16	13½
£100,000	Stock	6/2·8	Do. 5% Perp. Deb.	121	123	125	127	3 19 4	–	126	125½
40,000	5	..	Buenos Ayres & Belgrano 6% Cum. Pref. (£3 paid)	3½	3¾	3½	3¾	..	..	3⅝	3½
27,500	5	..	Do. do. do. (fully paid)	4	4½	4¼	4¾	..	..	4½	4¼
£260,000	Stock	5%	Do. do. 5% Deb.	107	110	107	110	4 11 4	..	109½	109
£85,250	10	3/0	Central London Ordinary	9¾	10¼	9¾	10¼	2 18 6	June and December	10⅛	9⅞
178,308	10	1/9½	Do. (£8 paid)	7¾	8¼	7¾	8¼	2 19 2	" "	8 1/16	7 13/16
£530,000	Stock	2%	City and South London Railway Con. Ordy.	71	73	71	73	2 18 3	January and July	72	71
22,500	10	..	Do. Ordinary (£5 paid)	5	5½	4¾	5¼	..	..	..	..
9,251	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	3 5 7	January and July	–	–
£137,701	Stock	4%	Do. 4% Perpetual Debenture	133	135	133	135	2 19 7	May and November	..	–
20,000	10	6%	Imperial Tramways Ordinary	23	24	24	24½	2 9 0	March & September	24¼	23⅞
10,000	10	6%	Do. 6% Preference	16	16½	16	16½	3 12 9	" "	–	–
£70,000	Stock	4½%	Do. 4½% Debenture	118½	119½	119	120	3 15 0	..	120	118
37,500	10	4%	Liverpool Overhead Railway Ordinary xd	10 7/16	10 7/16	10¼	10½	3 8 4	February & August	–	–
10,000	10	5%	Do. 5% Preference xd	14½	15½	14½	15	3 6 8	" "	–	–
125,000	Stock	4%	Do 4% Debenture	106	108	106	108	3 14 1	January and July	-	.
30,000	5	3/3¾	New General Traction 6% Cumulative Pref	4¾	5¼	4¾	5¼	5 14 3	–	–	–
0,000	Stock	3%	Waterloo and City Ordinary	109	112	109	112	13 7	June and December	1 0	–

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

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CONTENTS OF THE CURRENT NUMBER.

NOTES	673	Wireless Telegraphy. By G. Marconi. Illustrated	690
Meetings of Scientific Societies	676	Correspondence	695
The Electric Construction Company's Works at Wolverhampton. Illustrated	677	Parliamentary Intelligence	695
Cloud and Fog Load at Bankside Station. Illustrated	683	Legal Intelligence	697
Electricity Works Accounts	686	Trade Notes and Notices	699
THE TELEPHONE QUESTION	688	Companies' Meetings and Reports	705
The "Premier" Carbide of Silicon Incandescent Lamp	690	New Companies, &c.	707
		City Notes	708
		Companies' Share List	710

NOTES.

OF the many objectionable features with which the scheme of telephone reform, as laid before the House of Commons on Monday evening, may be charged, perhaps the most serious is the manner of its introduction. By his gibes and innuendoes against the managers of the National Telephone Company, and his contemptuous treatment of their claims, the Secretary to the Treasury has made the task of the Post Office and that of the local authorities, far more formidable and more hazardous than it might have been had a more conciliatory tone been adopted. The battle which has been thrust upon the Company will be almost certainly embittered by the gratuitous affronts to its managers, not less than by the injustice done to its innocent shareholders. Mr. HANBURY will reply that they embarked their capital with their eyes open, but that is not the case; they had no inkling whatever that an eye-opener in the shape of a government official would ever appear upon the scene with a scheme for active hostilities against its own licensees. Say what he may about legal rights, it is impossible to get rid of the fact that the Government had never seriously asserted them; that they had become convinced that the exercise of them would be injurious to the public; and that, finally, they had abandoned them. Barely three years ago the Treasury, although clinging to its rights, distinctly deprecated competition in any shape or form—for the obvious reason that competitive telephony, like competitive telegraphy, would be a wasteful and vexatious mode of carrying on the business. What has happened meanwhile to reverse this policy? Nothing whatever that we can discover, except that the local authorities have been seized with a burning desire to further extend their municipal trading, and that a Conservative Government is disposed to humour their aspirations.

The following is the text of the interim report of the Committee of the Institution of Electrical Engineers appointed by the Council to consider the question of uniformity in electrical engineering practice:—

This Committee has given very careful consideration to the question of the adoption of a uniform standard of frequency or periodicity in alternate current working. It has collected information and has ascertained the opinions of a number of manufacturers and of consulting engineers on the Continent and in America, as well as in this country. It is unanimous in recommending the adoption, for general purposes, of a frequency of 50 periods per second as on the whole the best suited to ordinary cases of mixed distribution of alternating currents for glow-lamp, arc-lamp and power supply. For the exceptional purpose of transmission of power on the large scale it recommends the standard frequency of 25 periods per second. It also suggests for the exceptional cases of house-to-house transformer supply, as preferred in districts where the houses are scattered, a standard frequency of 100 periods per second.

Uniformity in frequency is certainly desirable, and the Institution of Electrical Engineers has done good service in laying down standards. The only objection we can find to them is that their number is three when two should have sufficed. When a supply station has commenced on a house-to-house transformer system, the latter has invariably developed into a sub-station system, and we think that the frequency of 100 ∿ per second might safely have been omitted from the list.

APPOINTING special committees of experts to examine and report on questions of current interest and importance is a practice to be commended, but we would observe that its conclusions would carry greater weight if the committee were appointed by the vote of the whole body of members and not merely by the nomination of the Council. Finally, before the reports of such committees are adopted by the Council, and circulated as if they represented the opinion of the Institution—the Institution Wiring Rules is a case in point—a draft of them should be laid before each member, and they should only be adopted at a meeting of which due notice has been given to every member of the Institution and at which it is in order to discuss and amend the reports. We hope that this latter suggestion at any rate will be adopted with regard to the final report of the Uniformity of Practice Committee.

WE regret to announce that the General Power Distributing Co.'s Bill has been rejected by the House of Commons. Our disappointment arises as much, if not more, from the indications of policy exhibited in the avowed motives for rejecting this measure, than from any regard for the particular scheme

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itself. Nottingham, Derby, Lincoln and their environs may be denied the benefits of wholesale electric power, with far less disastrous consequences than threaten the entire country if the policy of baiting capital enterprise is persisted in by the present amazing Government. Opponents of "electricity in bulk" companies have failed to show in what way cheap electrical power may otherwise be rendered available to the public. Nor have they even attempted to do so. The dog in the manger never appeared more brutally selfish than do now the municipalities, who are thwarting a public service they themselves are incompetent to supply.

A VOLUMINOUS report, embodying several alternative schemes, has been presented by Mr. ROBERT HAMMOND to the Hackney Vestry, on electric lighting and refuse destruction, and has been accepted by that local authority. In consequence it has been decided, as we announced in our issue last week, to expend £242,367 on a combined scheme embodied in the report, and Mr. HAMMOND has been retained as consulting engineer during the carrying out of the work. It now remains to discover a suitable site for the generating station, which, it appears, is to be equipped for the 3-wire continuous current battery system. For the initial works, two 1,000 H.P. generator sets are recommended, this size being adopted as the standard unit. Ample provisions are to be made for extensions.

A propos of the Nodon-Bretonneau electrical process of timber seasoning, referred to in a recent issue, a correspondent writes to call attention to the national importance of such a process. Considering that British timber imports in 1898 represented 15 millions sterling, while no less than 2½ millions were expended in processes for rendering imported timber fit for use, the value of a cheap and effective electrical process of seasoning can scarcely be exaggerated. We learn that a site has been secured beside the river at Charlton, and works are to be erected. Licenses are also being granted to timber merchants, &c. The process apparently accomplishes the total expulsion of the sap, and its replacement by insoluble and aseptic solid matter. Green timber is best treated, as the sap in it is most easily driven out. Woods previously useless, except for firewood, are, it is stated, now made saleable and workable.

IT must have been a true genius who designed the generator now being supplied by the Triumph Electric Co., of Cincinnati. Our esteemed contemporaries, the *Electrical World* and the *Electrical Engineer* of New York, each devote considerable space to an illustrated description of the machine. The generator is described as follows:—

> This dynamo will develop current for 50 per cent. more lights than the most modern and efficient machines, or, *vice versâ*, will develop current for the same number of lights with the expenditure of only 65 per cent. of the energy required with any other machine. This invention is analogous to that of Corliss in the steam engine field, the result being obtained by using the current expansively, so to speak. The generator is multipolar, the armature windings being divided into distinct and separate circuits connected through a special commutator to separate distributing circuits, with a common return, as shown in the diagram. The initial voltage generated in each circuit is 220 volts, this current being generated in each circuit for only one-third of the time, or, in other words, each coil on the armature is active for only one-third of a revolution, being entirely cut out of circuit for the remaining two-thirds. Actual test has demonstrated that, when a rate of 5,400 impulses per minute has been reached, the light is absolutely steady.

THEN comes a remarkable account of how a 300 light machine was tested by placing first two 55-watt 110 volt lamps on a Bunsen photometer, connecting one to an ordinary generator developing 115 volts and the other to the interrupted-current generator, and adjusting the regulation of the latter until the candle-powers were equal. Then "the apparent voltage of the interrupted current was observed, and the test began." The test seems merely to have been the connection of a number of lamps to the dynamo, and the taking of indicator cards with lamps connected corresponding to full load, half load and "fields open." The last mentioned gave 13·82 I.H.P. and the cards at half and full load 38·35 and 24·43 I.H.P. respectively, but how the enormous figure of 13·82 was contrived is not deemed worthy of mention. At all events this 13·82 is subtracted from the figures for half and full load, and the number of 16 c.p. lamps per horse power delivered is calculated coming out at 15·56 and 14·32 respectively.

THE makers of the machine are to be congratulated on their ingenuity: if not in the design of the machine, at any rate in their test of it. They offer to furnish a limited number of sizes of the machine on trial, and to let it "talk for itself." The power required to make the machine perform this acoustic feat is probably part of that mysterious 13·82 H.P. But, seriously, papers of such high standing as the two contemporaries we have mentioned should be more careful in the way they treat items of this kind. One of them, it is true, quotes the description as having been sent by the makers, but makes practically no comment; while the other prints it in the same type as its leading articles, and is content to adopt it *in toto*, adding only the words "the makers claim" after the second word of the first sentence quoted above. It will not occur to everyone to discredit tests when published without warning in a respectable technical paper.

Cable Interruptions.	Date of Interruption.
Dakar—Bathurst	Feb. 9, 1899
Paramaribo—Cayenne	Feb. 10, 1899

Royal Institution.—At a general monthly meeting on the 6th inst. his Grace the Duke of Northumberland was elected President of the Royal Institution in the place of the late Duke, his father.

Correspondence.—Owing to pressure on our space, we are obliged to hold over until next week an interesting letter received yesterday from Prof. S. P. Thompson, on "Automatic Liquid Interrupters."

Institution of Electrical Engineers.—Owing to the large number of members who had to be turned away from the Institution on the 2nd inst., Mr. Marconi has kindly promised, at the request of the Council, to repeat his lecture and demonstration on Thursday next, at the Lower Exeter Hall, Strand, *not* in the Examination Hall on the Embankment as originally intended. Admission will be by ticket only, obtainable from the Secretary of the Institution.——Mr. Marconi telegraphed from Boulogne last night that he was suffering from a bad cold, and was unable to be present at the meeting to reply verbally to the discussion on his paper.

Lincoln Corporation Electricity Works.—It has been pointed out to us that our description of these works last week would be liable to convey the impression that Dr. John Hopkinson

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had designed the works, whereas the extent of his services was to pronounce judgment for the Corporation as to the financial soundness of establishing electricity works. The electric supply scheme, as a matter of fact, was drawn up and the works were designed entirely by Mr. C. S. Vesey-Brown, acting as the Corporation's chief electrical engineer and consultant.

An American Municipal Electrical Association.—At a meeting of the Executive Committee of the Fire and Police Telegraph Superintendents Association, in Boston, on January 28, it was resolved to change the name to the "National Association for Municipal Electricians," and to render eligible for membership all officials engaged in the electrical departments of municipalities throughout America. The next annual convention of the Association will be held at Wilmington (Del.) on September 5 and 6. Several Papers are already announced, and there will be an exhibit of electrical and mechanical appliances used in the various departments of municipal work.

The Kaüffer Prize.—E. P. Kaüffer, a member of the Verein Deutscher Ingénieure, who died in 1897, left this society a legacy, from which a first prize of 3,000 marks, and a second of 1,500 marks (about £150 and £75 respectively) are to be awarded for the best essay in reply to the question :—"What practical and useful processes are available to transform heat directly (without motors) into electro-dynamical energy?" Herr Bissinger, Prof. Borchers, Prof. Dietrich, Herr Kapp and Dr. Kohlrausch have been chosen as judges. The competition is international, and is not confined to members of the Verein. Essays are to be written in German, and must be sent in before Dec. 31, 1899, to the Verein Deutscher Ingénieure, 43, Charlottenstrasse, Berlin, N.W., from whom further particulars may be obtained.

Journalistic Accuracy.—The following appeared in an American electrical paper last month :—

> It is reported from England that W. H. Preece, whose experiments in wireless telegraphy have been widely published, recently attempted under the most favourable circumstances to transmit messages by the "wireless" method and utterly failed. A wire from Carlisle to Haverfordwest and another from Belfast to Wexford were employed, with the expectation that messages sent through one wire would be heard through the other just as telephone messages are overheard on neighbouring wires by induction. The result obtained was nothing more than a strange babel of noises that seemed to have no relation to the messages transmitted. Mr. Preece was so dissatisfied that he has not tried the thing again. He considers the noises heard due to electrical effects not yet understood.

We may add that Mr. Preece's endeavour to transmit signals from England to Ireland between telegraph wires from Carlisle to Haverfordwest, and from Dublin to Wexford was made in June, 1895.

Electric Traction in Chicago.—The position taken up by the street railway companies of Chicago, which are seeking overhead trolley extensions in the central business district, that it is impossible to operate the underground system owing to poor drainage, bad pavements and the dirty condition of the streets, is strongly opposed by the city electrician and others. In a report made by the city electrician to the mayor, he refers to the fact that the telephone and electric lighting company, Edison companies, and the city authorities themselves have built hundreds of manholes in different parts of the city, varying in depth from 5ft. to 8ft. They do not make any other provision for draining them than to connect with the sewer, and at no time are they unable to do work in them on account of water. The cable conduits are not so deep, he says, as these manholes, and consequently less likely to be improperly drained if connected to the sewers.

Municipal Electrical Transmission Plant.—By a vote of 399 to 61, the property-holders of Orillia, Ontario, have decided in favour of erecting the first long distance electrical power transmission plant on the American continent, if not in the world, to be owned and operated by a municipality. The plant will cost about £15,000, and is intended to convey the current generated at the Ragged Rapids on the Severn River to Orillia, 19 miles distant. 800 H.P. will be delivered as a first instalment, but the system will have a capacity for delivering 1,000 H.P., and is so designed that its capacity can ultimately be increased to 3,000 H.P. at comparatively small additional expense. The *Canadian Electrical News* states that the contract for the entire equipment has been given to the Central Construction Co., of Buffalo. The electrical machinery is to consist of two 400 H.P. revolving field Westinghouse three-phase 60 cycle generators, able to sustain an overload of 60 per cent., with six step up 100 kilowatt stationary transformers to raise the voltage to 22,000 for the transmission line, while at the receiving station there will be six step down 100 kilowatt transformers of a similar type to reduce the pressure to 1,000 or 2,000 volts. The work is to be pushed to completion with the least possible delay, and the station is expected to be in operation before the end of next October.

Cost of Accumulator Traction.—Some interesting figures are included in the annual report of the Chicago Electric Traction Co. An increase in receipts of 50 per cent. is shown for 1898, as compared with 1897. The receipts per car-day were 67·3s.; expenses per car-day, 58·4s.; receipts per car-mile, 4·48d.; expenses per car-mile, 4·2d. The power-house record shows a total of 1,227,228 kilowatt-hours and a total operating and maintenance cost per kilowatt-hour of 0·465d. The cost of operating and maintaining the batteries was £925. The number of car-miles run was 609,767, so that the battery expense per car-mile was 0·36d. This battery expense was a trifle less than 9 per cent. of the total cost of operating and maintaining the line. The experience of the Company showed that the average mileage for each car battery of 72 cells is 23,000 miles. The test of service showed that one set of negative plates would outlast three sets of positive plates. With new batteries, the cars are run 22 miles on one charge, but, after the cells have been in use a short time, the battery is changed both on the up and down trips, making the run eleven miles for one charge. However, the cars have made as high as 40 miles on one battery charge. The schedule speed, including stops, is 12 miles an hour, but the cars are capable of a speed of 30 miles an hour. During January the record showed 1·65 kilowatt-hours at the power-house switchboard for each car-mile of service. This was about the average for the year.

Indian Wiring Rules.—We have received a copy of the rules for electric light and power installations, issued by the Calcutta Fire Insurance Agents' Association. One would naturally expect the variations necessitated by local conditions to be one of the most prominent features of this set of regulations, but, as a matter of fact, they do not differ to any radical extent from the rules issued by the English fire offices. A current density of 1,000 amperes per square inch is laid down as a superior limit (750 for high-tension currents), and a maximum actual temperature of 130°F. The insulation resistance of conductors is to be 750 megohms per mile—considerably higher than is usually exacted in this country—and 1,000 megohms per mile in damp places. No particular insulating material is prescribed so long as it is "of the best quality and thoroughly durable and efficient." Twin flexible may only be used for pendants and portable fittings, and on 220-volt circuits must have a radial thickness of insulation of at least 20 mils. Wood casing is to be of teak and varnished inside and out. Conductors passing through walls must be run in porcelain or other "approved" tubes, filled with dry sand or other suitable incombustible substance. Under certain conditions conductors may be run uncased on insulators and supported by "approved" cleats. Fuses *must* be calculated to melt at 50 per cent. above their normal current, and *should* not be placed in ceiling roses. Lampholders must be of an "approved type"; at pressures over 200 volts they must have a partition of porcelain "or other approved material" between the terminals, and switch lamp-holders, unless of special make, are not allowed at such pressures. Permission of the Association must be obtained before using floor-sockets. Lamps, it is stated, should be renewed when appreciably blackened—it is hard to see why blackened lamps occasion greater fire risk than new ones—and high candle-power lamps are forbidden where fluff, dust, or explosive gas is liable to accumulate. Arc lamps must have a cut-out on each pole, and motors and heating apparatus a switch and cut-out on each pole. The limit of pressure is fixed at 250 volts for continuous, and 125

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volts for alternating, current. The number representing the minimum allowable insulation resistance in megohms is obtained by dividing 10 by the maximum number of amperes required. If the supply is alternating, this number must be doubled.

Stroboscopic Methods of Testing Small Motors.—When testing very small motors, such as those driving ventilating fans, the friction of the speed counter or tachometer is not negligible compared with the useful load, and for such cases, Dr. G. Benischke, in a Paper recently read before the Berlin Elektrotechnischer Verein, describes some useful stroboscopic methods of speed testing. On the shaft of a small motor, independent of the one to be tested, is fitted a disc in which radial slits are cut. To the other end of the shaft is a worm wheel which gears into a toothed wheel connected to the speed counter when the latter is lifted against the worm by means of a lever. The auxiliary motor is placed with its disc parallel to the vane wheel of the motor to be tested, and its speed is adjusted by means of resistances until the vanes of the fan motor, looked at through the slits of the other, appear to stand still, when an observation of the speed of the auxiliary motor is made. The speed of the motor to be tested is then, of course, that of the auxiliary motor multiplied by n/m, where n is the number of slits in the disc of the latter motor, and m is the number of vanes of the motor which is to be tested. Of course, a cardboard disc can be used, instead of the vane wheel on motors other than fan motors. The same auxiliary motor can be employed for testing the frequency of an alternating current, more accurately it is said than by the method of measuring the speed of a synchronising motor. One way is to mount a flask on an iron rod in front of an electromagnet energised by the alternating current. From a tap in the latter a very thin stream of water falls, and this is broken up into a number of drops by the vibrations of the rod equal to twice the frequency. These are observed through the slits in the disc on the motor, and when they appear to stand still the frequency is calculated from the speed of the motor and the number of slits. Another method is to place an alternating arc behind the disc to observe the shadow on a white wall, and to adjust the speed until the disc appears not to revolve. The same apparatus can determine the slip in an alternating current motor. The disc is now fixed on the motor to be tested, and the shadow observed as before, when an arc lamp actuated from the same mains is placed behind it. If the shadow appears not to revolve, the motor is running synchronously. If there is a slip, on the other hand the shadow will appear to revolve backwards slowly, and by counting the number of revolutions the shadow makes per minute, the percentage slip can be calculated from the number of poles and the frequency.

Carbon-Consuming Batteries.—At a meeting of the Institution of Junior Engineers, held at the Westminster Palace Hotel, on the 3rd inst., a Paper on "Carbon-Consuming Batteries, and their Possibilities," was read by Mr. W. R. Cooper. The saving which might be effected in the cost of production of electrical energy by the use of a carbon-consuming battery was first discussed. The absolute mean efficiency of a steam plant, generating electrical energy for general supply purposes, might be taken as low as 6 per cent., whereas the corresponding figure for a battery working under the same conditions was about 78 per cent. Assuming that a Board of Trade unit could be generated and distributed by the combustion of 10lb. of coal, and that the cost per unit was 3·3d., with coal at 20s. per ton, then the efficiency of a battery rendered it possible to effect a saving of 30 per cent. of the cost per unit, provided that coke could be voltaically oxidised to CO_2, and that the electrolyte and the plate opposed to the carbon did not introduce additional expense. The cost of renewing the electrolyte and negative plates, however, might counteract the gain due to efficiency. It was also necessary to remember that the cost per unit depended upon maintenance, and that the price at which electrical energy could be supplied, depended upon capital expenditure. For the consumer to derive much benefit from a carbon-consuming battery a reduction in the capital expenditure, as well as in the coal bill, must be effected. The author next considered the various difficulties in attempting to solve the problem of the direct production of electricity from carbon; they were due to (1) the insoluble nature of carbon, (2) the scarcity of electrolytes among carbon compounds, (3) the inability of carbon to act as an ion in such organic compounds as are electrolytes, (4) the electro-negative character of carbon. In the place of the oxidation of carbon, that of CO might be attempted; but the possible E.M.F. from such a reaction was lower than that theoretically obtainable from the oxidation of carbon. There was also a difficulty in finding electrolytes in which CO acted as an ion. Suggestions for various forms of carbon-consuming cells were then reviewed. Grove's ordinary gas cell, in which the hydrogen may be replaced by CO was of no commercial value, because the current obtainable appears to depend upon the rate of occlusion of the gases by the platinum. The cell brought out by Borchers, with a view to the utilisation of CO, had not proved successful; the E.M.F. was, in fact, not due to the oxidation of CO, but to the solution of the copper which is used as one of the plates. The problem had been attacked by Reed in a manner which was suggestive, but without much practical result; this investigator arrived at a cell having indestructible electrodes and an electrolyte, by means of which the carbon was oxidised, but which was regenerated by the action of the cell itself. The indirect production of electrical energy from carbon by the use of H_2S and SO_2 was ingenious, but no practical outcome could be obtained by the inter-action of two liquids, because true voltaic action does not take place in that way. The utilisation of free carbon, combined with electrolytic solutions, had been attempted by Case and by Coehn. The Jacques cell was an example of one in which a fused electrolyte was employed. Owing to the many defects which are inherent in this form of cell, its efficiency was low; it also appeared extremely doubtful whether the electrical energy obtained was due to the voltaic consumption of carbon at all. Another cell of the same class was Blumenberg's, in which the same objectionable features were to be found as in the case of the Jacques cell.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, March 10th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Agenda: (1) "A Study of an Apparatus for the Determination of the Rate of Diffusion of Solids Dissolved in Liquids," by Albert Griffiths; (2) "Note on the Source of Energy in Diffusive Convection," by Albert Griffiths; (3) "An Exhibition of Dr. A. Wehnelt's Electrolytic Current Interrupter for Ruhmkorff Coils," by A. A. Campbell Swinton.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Measuring Extreme Temperatures," by Prof. H. L. Callendar, F.R.S.

SATURDAY, March 11th.

INSTITUTION OF ELECTRICAL ENGINEERS.

11 a.m. Students' Visit to the Davy-Faraday Research Laboratories of the Royal Institution.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture V.—"The Mechanical Properties of Bodies," by the Right Hon. Lord Rayleigh, F.R.S.

INSTITUTION OF JUNIOR ENGINEERS.

7 p.m. Conversazione at the Westminster Palace Hotel. Reception by the President (Sir W. H. White) and Lady White.

WEDNESDAY, March 15th.

INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read: "The Application of Electric Motors to Printing Presses," by E. V. Young.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "Liquid Fuel," by Sir Marcus Samuel.

THURSDAY, March 16th.

INSTITUTION OF CIVIL ENGINEERS.

2:30 p.m. Students' Visit to the Generating Station of the South London Electric Supply Corporation, in course of construction.

FRIDAY, March 17th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "The Electric Fish of the Nile," by Prof. Francis Gotch, F.R.S.

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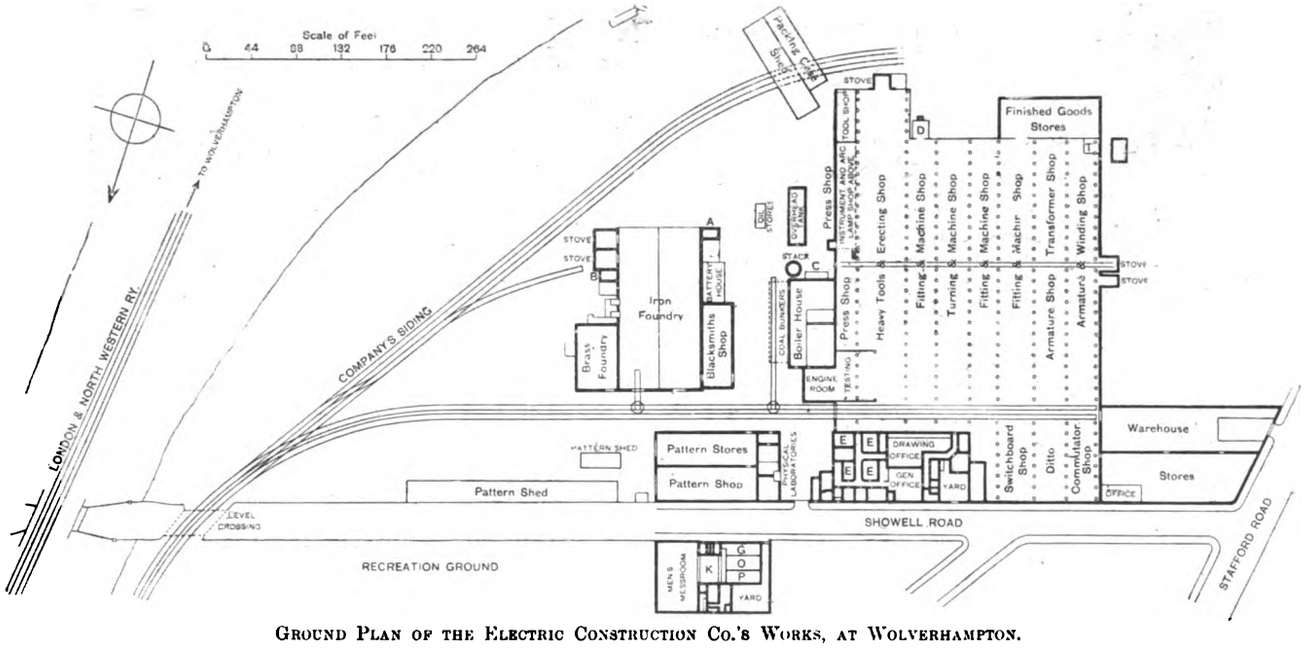
THE ELECTRIC CONSTRUCTION COMPANY'S WORKS AT WOLVERHAMPTON.

Although the engineering works of the Electric Construction Co. (Limited), at Wolverhampton, have been many years in existence, the fact that they have recently been considerably extended, as well as that there is now being carried on in them construction work for several electrical engineering contracts of special importance and interest, will render particularly appropriate some account of these works at the present time. Through the courtesy of Mr. A. B. Blackburn we recently had an opportunity of going round the works, and we propose to combine with a general description of the works, some particulars of the special work we saw in hand on that occasion.

We will commence with a short history of the development of this important engineering undertaking. The Electric Construction Co. (Limited) was registered on July 20, 1898, with a subscribed capital of nearly a quarter of a million in shares, and some £170,000 in debentures. It was formed to take over the original Electric Construction Corporation, which had been formed in May, 1889, with a capital of £500,000, in £10 shares, the immediate predecessor of this corporation having been the firm of Messrs. Elwell, Parker (Limited). The Directorial Board of the present concern is an influential one, the Chairman, Sir Daniel Cooper, Bart., G.C.M.G., being associated with Sir James Pender, Bart., K.G., Sir Henry Mance, and Messrs. J. W. Barclay, J. Irvine Courtenay and P. E. Beechcroft. The manager is Mr. A. B. Blackburn, and the secretarial work is in charge of Mr. James Gray at the London office.

At the time of their erection in 1892 the Bushbury Engineering works—which is the name of the E.C.C. works at Wolverhampton—were the only ones in the country for which it could be claimed that they had been designed and built throughout for the purposes of electrical engineering constructive work, and they still are, we believe, the largest of such works for purely electrical manufactures in this country. The area of the site on which they stand extends to about 28 acres, upwards of 5 acres being covered by buildings in three detached main blocks. The general arrangement of the workshops, offices, &c., is clearly indicated in the accompanying ground-plan of the works. Within the smallest of the blocks is a well-appointed physical laboratory, together with the pattern shop, this being on the left of the main entrance. The second block contains brass and iron foundries, and the smithy is separated from the first by an open roadway with a double line of railway tracks which pass the foundry end, and enter the third and principal block wherein are all the machine and other workshops. Practically the whole of the works are on the ground-floor, the exceptions being the meter and arc lamp shops and two staff officers' rooms. By this arrangement the convenience of access and supervision is considerable. Our first visit was to the physical laboratory department, which is well removed from all sources of vibration and disturbance, and although situated at some distance from the shops where the machinery under test would be, the laboratory is connected with these various departments by numerous cables and signal lines, thus enabling the necessary measurements to be made as accurately and quickly as if the laboratory were adjacent to the test beds. The equipment of the laboratory includes Kelvin balances of various sizes for current and pressure measurement, transformers for obtaining various test pressures, electrostatic voltmeters, and a general equipment of electrical testing instruments, including a very expeditiously arranged Ewing hysteresis meter, which is driven by a small electric motor.



GROUND PLAN OF THE ELECTRIC CONSTRUCTION CO.'S WORKS, AT WOLVERHAMPTON.

A, Chemical Laboratory. B, Blower. C, Economiser. D, Enamel Shop. E, Engineers' Offices. T, Testing Room. G, Girls' Mess. K, Kitchen. O, Office Mess. P, Pupils' Mess.

Beyond the laboratory and under another roof, is the pattern shop and pattern store room, the former containing the usual wood-working tools, lathes, boring machines, &c. There is a peculiar interest associated with this department, in that the machine tools are all driven by a single small 4 H.P. motor of the old-fashioned Elwell-Parker wall box type, this being the first machine built by the predecessors of the present company. The motor has been running in its present position almost continuously for 15 years, and has involved practically no expense for repairs with the exception that the commutator has been renewed once.

Crossing the railway siding we enter the brass foundry, a well-lighted and lofty shop. We may here state that we were particularly struck with the excellent arrangements for lighting and ventilating the whole of the works. All the shops are lofty and well provided with daylight. The lighting at night is carried out mostly by arc lamps, both inverted and direct; the latter being most generally used. In the brass foundry most of the work is cast from plate moulded patterns. The iron foundry adjoining, but under a separate and still more lofty roof, consists of two main bays, the one adjoining the cupolas being spanned by two powerful electric cranes, while the other is devoted to lighter work and is provided only with a hand traveller.

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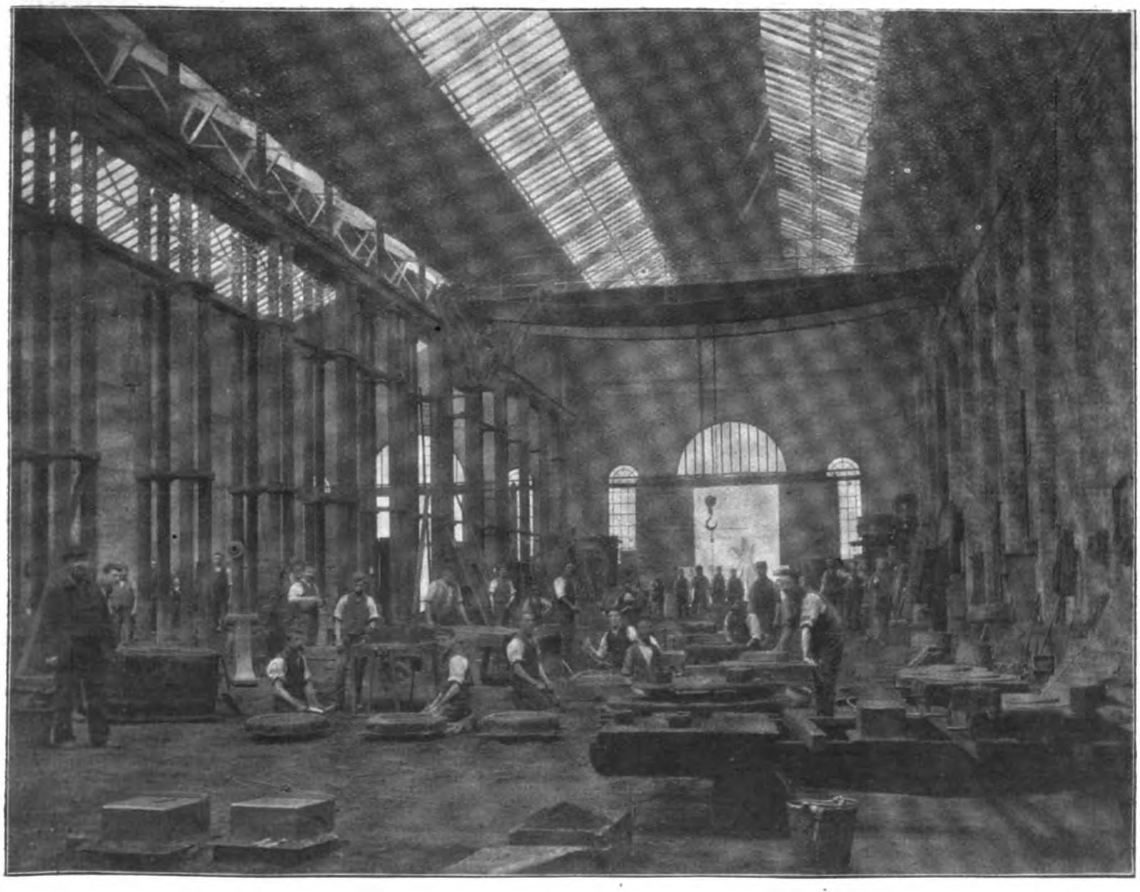
PATTERN SHOP.



IRON FOUNDRY.

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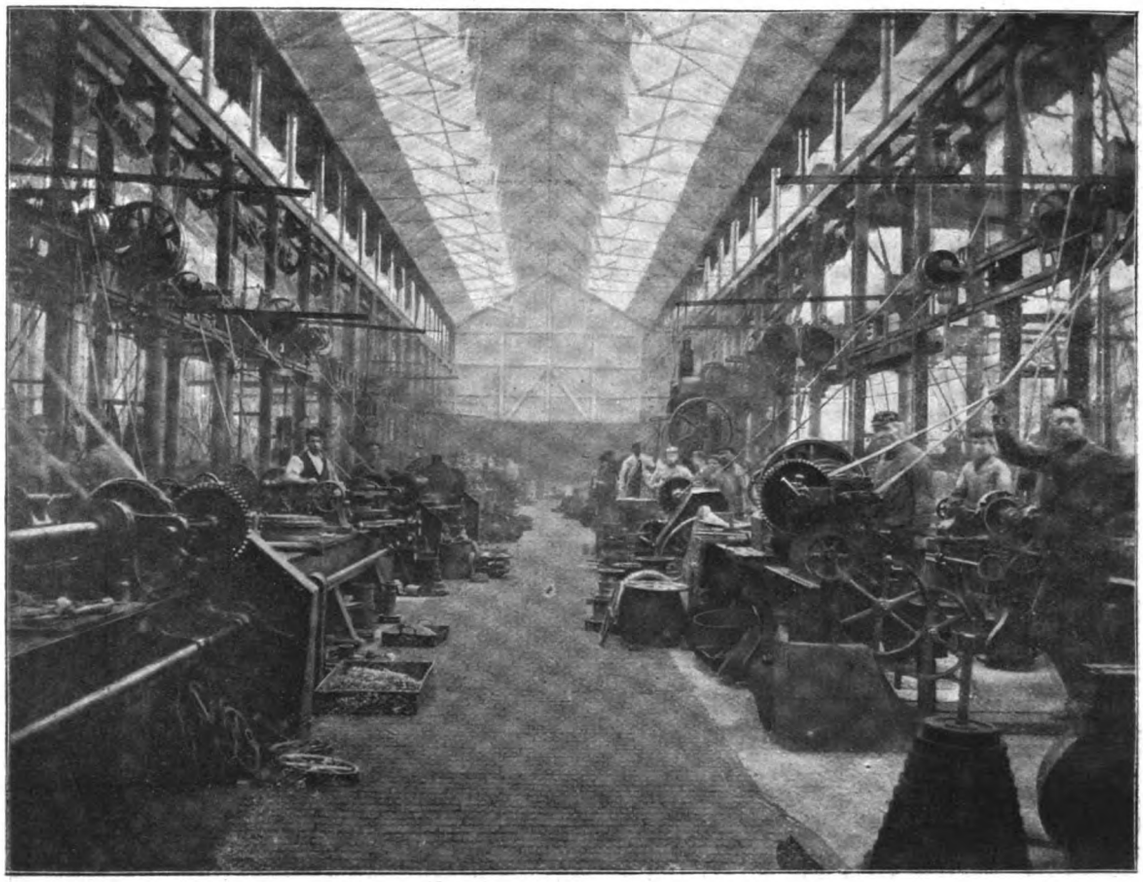

THE LATHE BAY.

ERECTING SHOP BAY.

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We may say that the cupolas, together with the furnaces in the brass shop and the smiths' fires, are all run by a Root's blower driven by an electric motor. Castings up to ten tons in weight have been run on several occasions in this foundry, and at the time of our visit the heavy castings for the new generators in the central power station about to be built by the City and South London Railway Co., were being cast. These generators will be of the 14-pole continuous-current type, direct-coupled to their steam engines, and will each be of 800 kilowatts capacity. Two others of half the capacity are shortly to be put in hand. The smithy on the other side of the iron foundry has seven or eight fires and a small steam hammer. In line with these, and on the same side of the foundry, are sundry stores, a battery room, paint shop and a chemical laboratory, in which latter analyses of armature and transformer iron, copper, &c., are regularly made.

Electrical power is used exclusively throughout the works for driving the tools, &c. Entering the electric power house, one sees a fine example of the compound horizontal slow-speed engine, with automatic cut-off gear, built by Messrs. Robey and Co., of Lincoln. This engine drives by belt a short shaft, to which a second vertical engine can be direct-connected by a claw-clutch. A third engine, of the Fowler type, can also be connected to the shaft, while a fourth engine, built by Messrs. Marshall, Son and Co., is available for auxiliary testing purposes. The whole of the power for the works and lighting, exclusive of testing, is supplied by a dynamo belted to the shaft and normally driven from the Robey engine, together with a direct-connected Willans set of some 60 kilowatt capacity. Thus the whole of these extensive works is run from a 125 H.P. engine, supplemented by a small Willans engine on occasion. The boiler house adjoining the engine range is on a somewhat lower level, and is equipped with four Babcock-Wilcox boilers working at 150lb. pressure, together with a Galloway boiler of double the capacity of each of the Babcock-Wilcox boilers. There is also an economiser, with motor-driven scrapers. From the engine house we pass to the testing bed, where every machine made in the works is subjected to electrical and mechanical tests, and to a thorough trial under working conditions, before being sent out of the works. This department is situated at the head of the main erecting and heavy tool bay.

The most noteworthy machines in this bay are a Whitworth planer, 10ft. wide between uprights with a 20ft. table, together with a Muir face plate lathe, taking work up to 18ft. in diameter. Each of these enormous tools is driven by its own independent motor. The remaining tools are belted in groups to motor driven shafting. Contrasting with these heavy tools, there are in this bay several E.C.C. enclosed motors each mounted on a small portable frame coupled with gearing to a flexible shaft and drill stock for working in difficult positions where otherwise a ratchet brace and manual labour would be necessary. The press shop, on the left of this bed, deals with all armature and transformer cores, and is equipped with a number of cutting and notching presses, circular shears, &c.; these machines having been developed to a pitch of perfection not generally met with, through the ingenuity of the foreman in charge of this particular department. The large experience with punches, dies and dividing plates acquired in this department, naturally tends to make it a suitable one for dealing with the lathe and other tools, cutters, &c., which are, therefore, placed in charge of this department. Over this bay, in a gallery, are situated the meter and arc lamp shops. Here, in addition to voltmeters and ammeters for direct and alternating current, large numbers of arc lamps are being turned out, among some of the recent contracts being the whole of the street lamps for Bath, Morley and Newport. Speaking of arc lighting, we may say that the Electric Construction Co. make a speciality of coast defence search light plant, over 200 complete sets having been manufactured and supplied to the War Office. These sets consist, in addition to the search lights themselves, of continuous current generators belted to oil engines.

ARMATURE CORE SHOP.

On the right of the main erecting shop are four machine shops equipped in the usual manner, but, of course, electrically driven. Some of the more noteworthy tools are a gear

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cutter, working entirely automatically, for cutting electric tramcar spur wheels and pinions; there are also several cold saws for magnet bars, vertical boring and turning mills for commutators, profiling machines, horizontal milling machines and plate and turret lathes, most of these tools being of American manufacture. The last two of the machine bays are also used for fitting and erecting small standard pattern E.C.C. machines and tramcar enclosed motors.

Two large bays of the same size as the last two named bays, but on the extreme right, are devoted exclusively to insulating and winding operations. In the first of these we noticed a rare display of machine-wound armature coils being wound on the Eickemeyer system. This, we should say, is the largest armature-winding shop in the United Kingdom. Frequently there may be seen here as many as 120 armatures, all, of course, of the drum type (for no ring-wound machines have been built here since 1893). Further down this same bay may be seen the building up of resistance frames, the armature shaft. The adjacent bay is occupied by brass finishing tools of various kinds, including screw cutting and turret lathes, plain and universal milling machines, shaping, screwing and drilling machines, &c. Two lines of shafting in this bay are each driven by an independent motor. One of these shafts, some 70ft. long and 2½in. in diameter, running in eight hangers and driving 21 brass-finishing tools, absorbed 4·68 kilowatts as the maximum ordinary load, rising to 5·70 kilowatts as an extreme momentary load. To run this shaft light, with its shafting only, took 3·01 kilowatts or 64·5 per cent. of the ordinary maximum load. This test serves to show how large an amount of power may be lost in shafting and belts in workshops.

The next two bays form the switch shop where a large variety of standard patterns of high and low pressure switches, both open and in cast iron cases, are constantly being turned out. Here, also, motor starting and controlling switches, fuses, &c., are put together. The work produced in this shop

ARMATURE WINDING SHOP.

winding of alternator armatures and magnets, direct-current field-magnets and transformer coils. In the next and principal bay of the armature shop may be seen at the bottom end transformer cores and windings assembled, mica insulation being put together and the armature and transformer iron sheets being insulated. Midway along this bay are large stoves for drying out and baking armatures, and further along the larger armatures for multipolar generators direct-current railway motors and rotatory transformers are handled.

Beyond the armature shop, and separated from it by a double line of railway track, which runs right into the works, is the brass shop, which consists of four bays. In the first, on the left hand, commutators are built up. Here copper bars are cut into lengths slotted for and soldered to the fork and assembled with the mica insulating strips already referred to. At this stage the now solid cylinder of copper and mica is subjected to great compression, together with a long baking, to expel all traces of moisture. It is then turned up at the ends and the mica rings applied, after which it is mounted on a cast iron bush ready for connecting on the has won for itself an unusually high reputation for accuracy and finish.

We may appropriately embody in this article some account of the leading manufactures of the Electric Construction Co. (Limited). In all classes of electric motor work this firm has long been to the fore. It will be remembered that the E.C.C. supplied the motors for the South Staffordshire tramways, the pioneer line on the overhead trolley system, connecting the towns of Walsall, Wednesbury and Darlaston. A still more important piece of work was the equipment of the Liverpool Overhead Railway in 1893. The Hartlepool tramway and the Halifax Corporation tramways in this country, besides various lines abroad, have also been equipped with E.C.C. plant. In the Isle of Man, the new high-speed railway running between Laxey and Ramsey is being equipped with E.C.C. generating and motor plant throughout. We may say that the company holds the exclusive rights of the "Sprague" patent method of motor suspension for traction work. This suspension consists in centering the motor on the wheel axle at one point, and supporting it flexibly or

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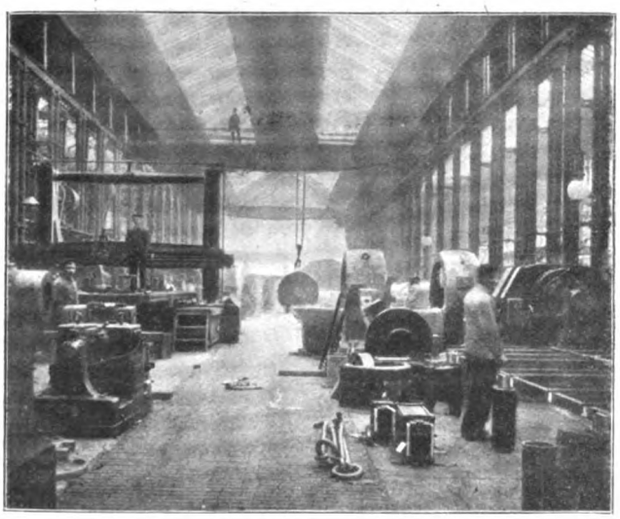
otherwise at another point, so that the motor swings on the axis of the driving wheel as a centre, and the depth of meshing of the gears is thus maintained constant under all conditions of the car. This suspension has been extensively used and is found to be highly satisfactory. We have already referred to the multipolar generators being built by this firm for the new central power station of the City and South London Railway. Multipolar generators have already been built for Woolwich Arsenal, Brighton Corporation, Chelsea Electric Light Co. and the Manchester Corporation. The machine supplied to the last-named corporation is the largest

THE SMITHY.

yet built by the Company. It has an armature, 13ft. in diameter, mounted directly on the crank shaft of the engine, and carrying a flywheel weighing 40 tons. The capacity of this generating plant is 2,500 H.P. Among the other larger manufactures are direct-current transformers and rotatory converters for use on the "Oxford" system of continuous-current distribution, with which the Company is so closely associated. This system has been widely adopted, and is now in use among other places at Oxford, Wolverhampton,



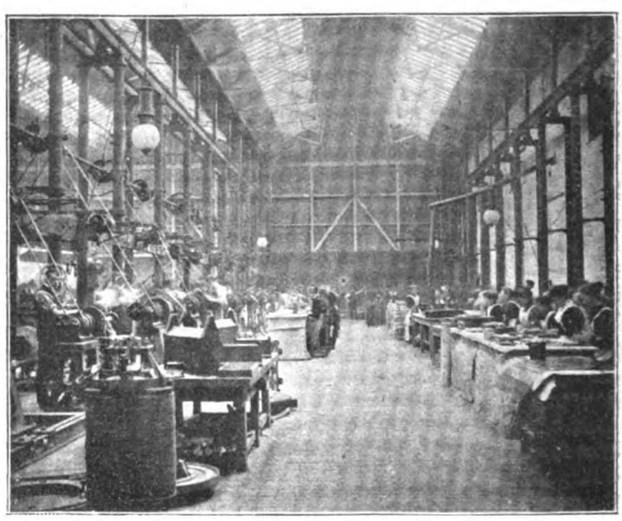
MAIN ERECTING SHOP.

Manchester, Shoreditch, Walsall, Hull, Barrow-in-Furness, Birmingham, Charing Cross and Strand Company, Chelsea Company and the Crystal Palace and District Company. It has also been quite recently adopted by the City and South London Railway Co. for their extensions to Islington and Clapham Common.

This last installation will include the improvements of recent years, by which the system has been perfected and adapted to three-wire distribution. Current will be supplied to sub-stations at a pressure of 2,000 volts, and at these sub-stations reducing transformers will lower the pressure to 500 volts above the middle pressure for the up line, and 500 volts below the middle pressure for the down line, the tracks being thus practically on the three wire system, with the rails as the neutral or middle wire. The transformation will be of the variable ratio type, compounded to compensate for feeder drop, and being connected to *reduce* instead of to *transform*, their efficiency of conversion will be over 96 per cent., instead of being rather less than 93 per cent., as hitherto. While their working efficiency is thus raised, the capacity for any given size of machine is just double that of similar transformers

ARC LAMP AND METER SHOP.

as hitherto used. The same machines will also act as balancers to compensate for inequality of load on the up and down lines. An incidental—but, nevertheless, important—advantage of this system is the absence of any considerable current flowing in the track rails, so that the Board of Trade regulations are more easily complied with even over long tracks. Among alternating plant the E.C.C. standard types of alternators and transformers take a very high place. Machines have been built in considerable numbers for direct connection to engines,



INSULATION AND LIGHT WINDING SHOP.

as well as for belt driving. The E.C.C. transformer is of the shell type, with only a single joint in the magnetic circuit.

Our thanks are due to Mr. A. B. Blackburn and Mr. James Gray for permission to prepare this illustrated description of the works, and for the photographs with which the article is illustrated. We also desire to express our thanks to Mr. Wilfred L. Spence, of the engineering staff, for the courteous manner in which he supplied us with information while conducting us round the works.

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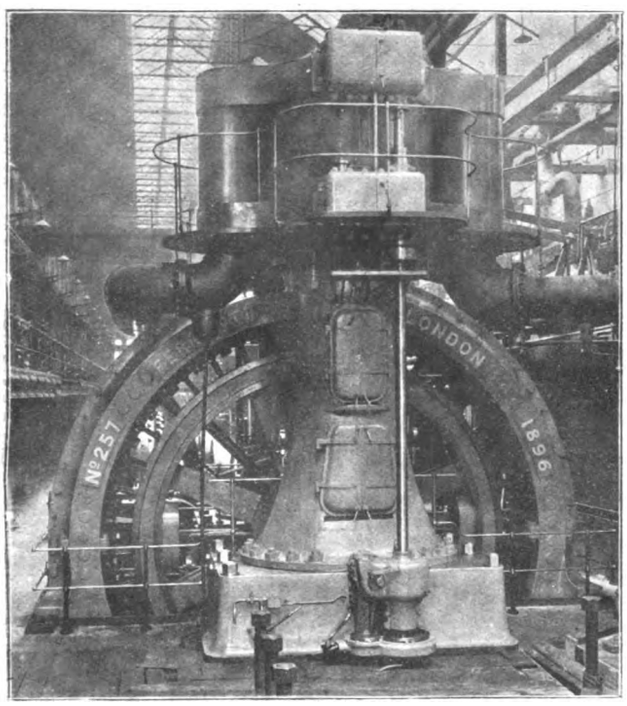
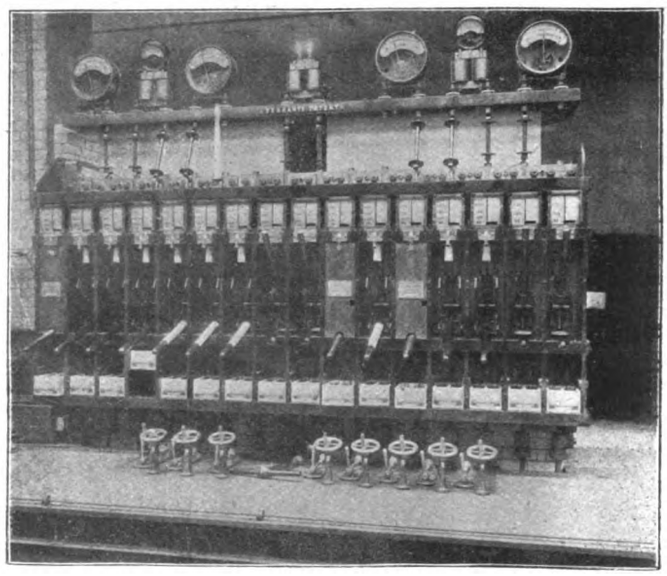
CLOUD AND FOG LOAD AT BANKSIDE STATION.

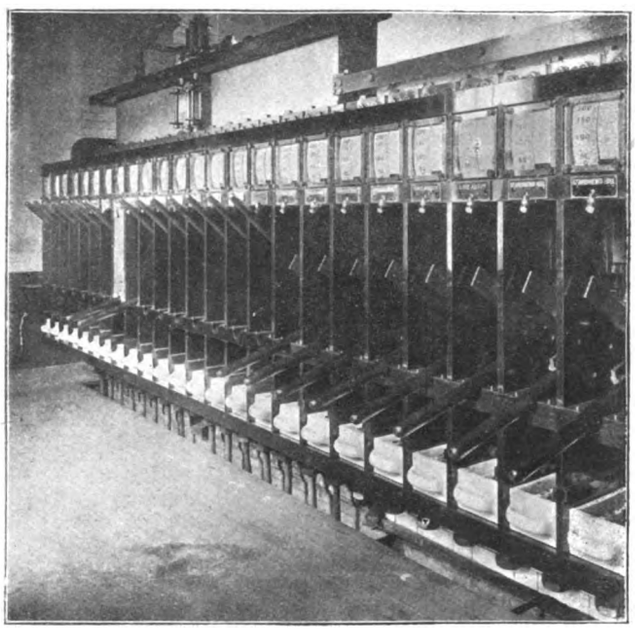
The electric supply works of the City of London Electric Lighting Co. are, in many respects, unique. The power station, at Bankside, is unique in the magnificence of its main machinery hall, and in the curious heterogeneity of its equipment; while, as to the daily load on the system, we doubt if there is another place on the whole globe which exhibits such vagaries and so many characterics trying alike to the plant and to the engineering staff, and exasperating to the shareholders. The extraordinary character of the load which is sometimes thrown on the Bankside station is well brought out in the set of curves which accompany this article. The city of London is more susceptible to sudden and excessive fogs than any other city in the world; other cities there doubtless are where fogs and clouds are more frequent, as, for instance, Manchester, but in these places darkness is not precipitated with such unexpected suddenness as so commonly occurs in the heart of London. The effect of fog and cloud load in London upon the working of the generating station is to necessitate a large reserve of steam plant always being kept in readiness for quickly turning out many times the normal amount of current; and, it is said, when a highly localised fog suddenly crosses the City its course is well defined on the switchboard by its effect on the ammeters and voltmeters of the feeders. To deal with such a condition of affairs is not a simple problem, especially in a station which has been developed rather by a process of accretion than of rational systematic evolution, as is the case at Bankside. A glance at the accompanying plan of the Bankside station is sufficient to indicate what we mean. Within its four, or, perhaps, we ought to say *forty*, walls (for it is a rambling collection of buildings rather than a compact single building), within these walls are to be found almost every variety of electric generating plant: continuous current, alternate current, high speed, low speed, direct coupled, belted, antiquated and modern. In the long main machinery hall, for example, are to be found eight Thomson-Houston generators, direct coupled to Willans engines; an equal number of open-type Brush engines direct coupled to Brush alternators, some with the original Mordey coils in them, others with coils of the Ferranti type; while ranged alongside these are a number of direct-coupled exciter sets and steam-driven pump sets. In an adjoining machinery room are to be found a number of Thomson-Houston and Brush arc lighters, belt driven by steam engines; and, in a smaller machinery room adjoining this, two small continuous-current plants, which have been recently been put into operation. In still another machinery room at the further end of the rambling pile of buildings, there will shortly be erected three large continuous-current direct coupled plants for dealing with the motor load which is gradually growing up in the City. Sufficient has been said, we think, to show that, however well the extensive boiler ranges may preserve a head of steam, it is very difficult with such a heterogeneous plant, split up into a large number of comparatively small units, to deal with the requirements produced by a sudden fog precipitated on the City.



One of Two 2 500-h p. Ferranti Flywheel Alternators at Bankside.



Front View of Ferranti Switchboard at Bankside.



Back View of Ferranti Switchboard at Bankside.

It was with a view to dealing more effectively and promptly than hitherto with this condition of affairs, that two immense direct coupled Ferranti generators have recently been erected

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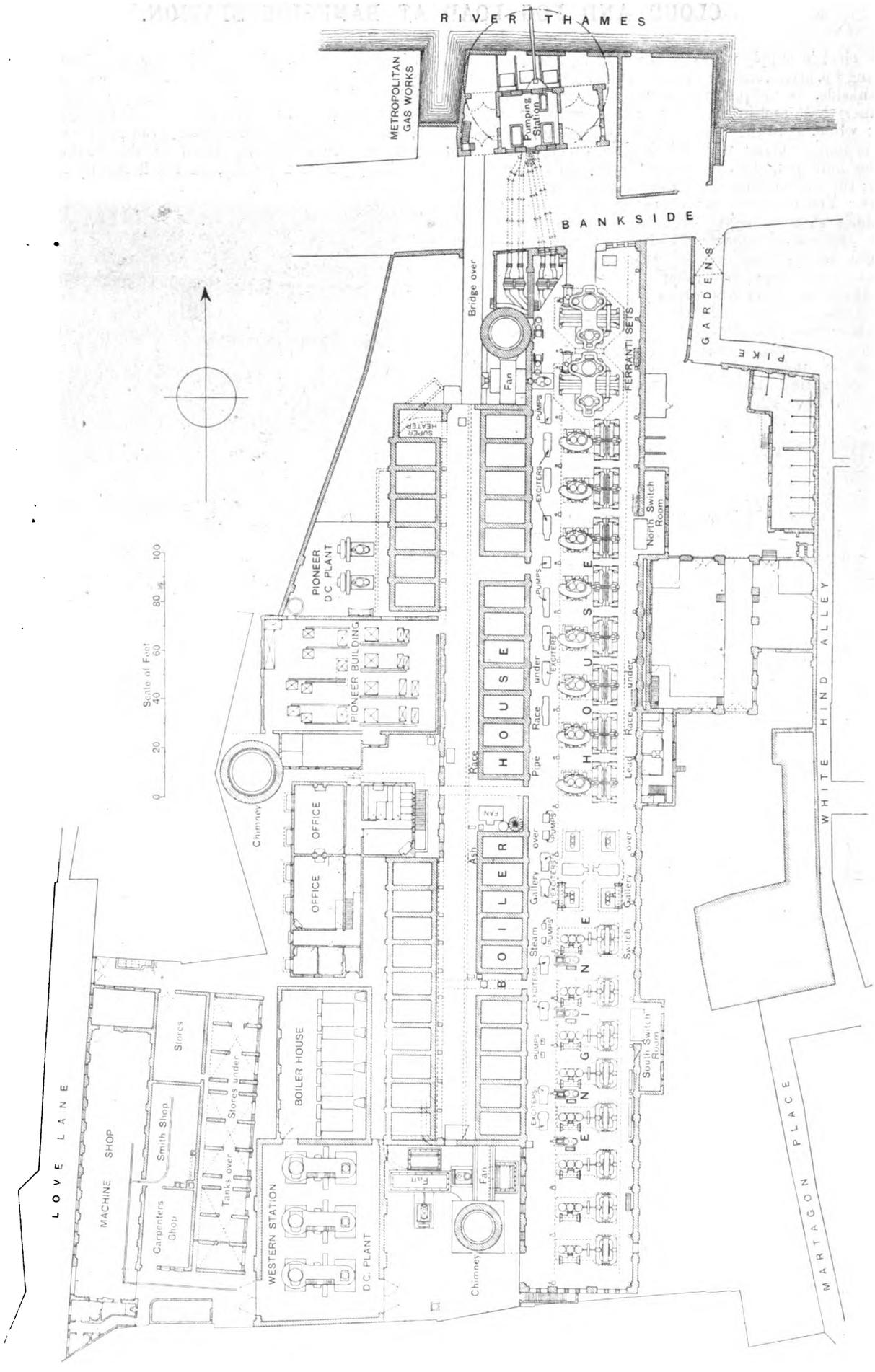
PLAN OF THE CITY OF LONDON ELECTRIC LIGHTING COMPANY'S GENERATING STATION, BANKSIDE, S.E.



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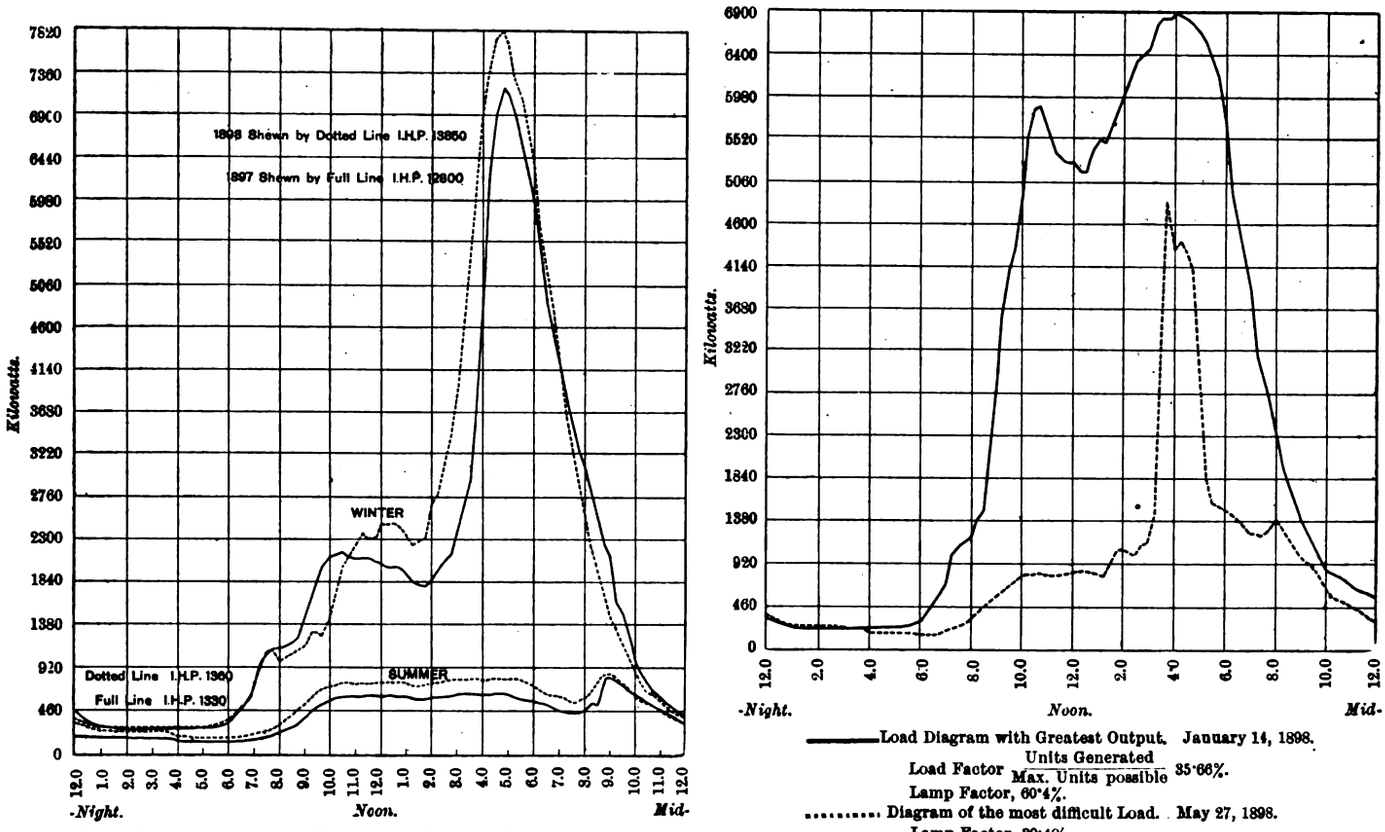
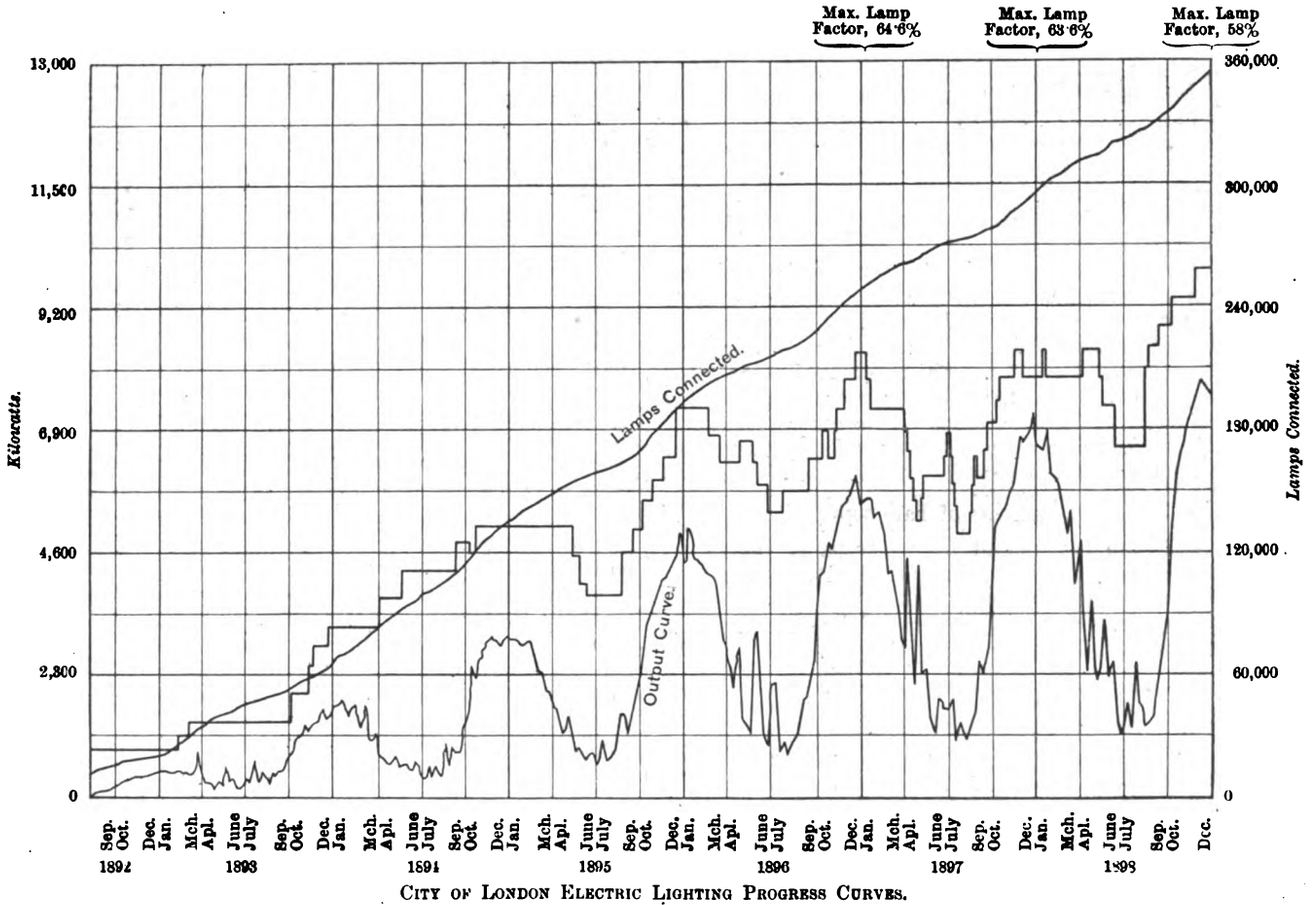
at one end of the main machinery hall, as indicated on the plan. One of our illustrations shows a photographic view of one of these generators. Having in view that the main purpose of these two generators is to take the burden of a sudden cloud or fog load in the City, it will be of some interest to consider their construction in greater detail. Each set consists of a 2,500 H.P. Ferranti steam engine direct coupled to a 1,500 kilowatt Ferranti alternator, the entire set having been invented and manufactured by Messrs. S. Z. de Ferranti (Limited).



LOAD DIAGRAMS SHOWING WINTER AND SUMMER REQUIREMENTS.



CITY OF LONDON ELECTRIC LIGHTING PROGRESS CURVES.

First, as to the steam engine, which is of the compound vertical type with high and low pressure cylinders, on opposite sides of the fly-wheel aternator. The diameters of the cylin-

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ders are 38in. and 68in. respectively, each with a 30in. stroke, and the normal speed is 150 revolutions per minute. The cranks, it will be observed, are overhung, there being no outside bearings. Thus the shaft of each set runs in two main spherical bearings, white metalled: one carried on the high pressure and the other on the low pressure bedplates. The weight of the wheel complete with shafts, discs, bobbins and bolts, &c., is 60 tons, and is taken on two roller bearings hung on springs resting on brackets on bedplates. The overall periphery of the armature is 20ft. The wheel is cast in two halves with eight cast arms. The halves are held together by steel links shrunk on to bosses cast on to the inside of the rim. The whole wheel is connected to its shaft by two steel rings shrunk on to turned registers of the cast boss of the wheel. Throughout, forced lubrication is distributed from pressure tank to the various bearings, at a pressure of 50lb. The oil leaking out falls into the centre of the bed-plate, where it is strained before passing into oil tanks under the bed-plates. The valve gear is driven from a vertical shaft by a second motion shaft driven from the crank pin (which also drives valveless oscillating oil pumps) through gearing, which reduces the speed of the vertical shaft to half that of the engine. There are two steam and two exhaust grid valves to each cylinder. The high-pressure steam valves are driven by the Ferranti trip gear, consisting of eccentrics on vertical shafts working a rocker arm which moves a gun-metal cross-head carrying engaging teeth, which strike into catch blocks on the valve spindle. When the rocker is in its two extreme positions, and moves the valve from its central position, it admits steam until disengaged by tripping piece working over a graduated wedge. The position of this wedge is controlled by a dead weight governor driven through gearing from the second motion shaft. The valve, when moved from central position, compresses two springs on the further end of the cylinder which, when the releasing takes place, returns the valve to a central position, the blow being fended by a piston on the valve spindle working in an oil dashpot. The low-pressure steam valves, and both high-pressure and low-pressure exhaust valves, are actuated by cams on a vertical shaft, which also produce a similar motion. The lubrication to the valve gear is by drip feed boxes, filled from the main oil supply, the valve gear boxes draining into the engine column. The clearance spaces for steam are reduced to a minimum, being limited to the actual piston clearance, the valves admitting and exhausting direct on to the top or bottom of the piston. The pipes connecting the high-pressure and low-pressure cylinders form a low-pressure receiver.

The direct-coupled alternator is of the usual Ferranti non-inductive armature type. The armature consists of 80 Ferranti coils, made up in pairs and carried on ebonited bolts sulphured into pockets cast in the rim of the wheel, giving a very high insulation resistance. The two halves of the armature are in parallel. From the collector gear two concentric cables lead away to the switchboards, the outer of the concentric main again being connected to the low-pressure bedplate, and thus a complete earthing of all parts of the plant is insured. The field coils are of bare copper wound on edge, and the pole-pieces are capped with micanite caps moulded on. The coils are magnetised from a separate exciter of 30 kilowatts, driven off a rope pulley mounted on the boss of the wheel from the high-pressure side.

The switch-gear, which has been erected by the same firm, is of the 500 ampere Ferranti single-pole type.

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"Annual Report of the Board of Regents of the Smithsonian Institution," until July, 1896. (Washington: Government Printing Office.)

"Professional Papers of the Corps of Royal Engineers." Edited by Capt. R. F. Edwards, R.E. Vol. XXIV., 1898. (Chatham: The Royal Engineers Institute.) Price 10s. 6d. net.

"Théorie du Potentiel Newtonien." By H. Poincaré. (Paris: G. Carré and C. Maud.) Price 14f.

"Science Abstracts," No. 14, February, 1899. Edited by W. R. Cooper. (London: E. and F. N. Spon.) Price 3s. net.

ELECTRICITY WORKS ACCOUNTS.

Cambridge Electric Supply Company (Limited).

The accounts of the Cambridge undertaking for 1898—the sixth completed year of working—show that the concern is making sure progress, not only in the accession of business, but also in economy of working.

The capital received has been raised during the year by £4,518, to £48,729, while an additional sum of £2,953 has been expended, bringing the total capital expenditure up to £46,875, or at the rate of £89·3 per kilowatt of plant capacity.

An equivalent of 3,885 8 c.p. lamps were added to the circuit, representing an increase of 18·3 per cent., the total equivalent number connected being 25,080 at December 31st last, the consumers numbering 365. The output shows an increase of 17·5 per cent. over 1897, the total number of units sold being 260,307 for which an average total revenue per unit of 6·81d. was received. Although the 1897 total costs were an improvement over those of 1896, the 1898 figure, at 3·29d. per unit, shows a more substantial reduction, thanks chiefly to the items of fuel and repairs and maintenance at the station.

Notwithstanding the reduction in the revenue, the economies in the working have had the effect of reducing the ratio of the costs to the revenue from 52·3 per cent. to 48·3 per cent., and of producing a working profit of £3,818. After writing off £300 to the depreciation fund, £200 towards reduction of preliminary expenses, £84 from the suspense account, and £71 as interest, a dividend of 7 per cent. has been paid. Previous dividends were:—1894, 2½ per cent.; 1895, 3½ per cent.; 1896, 5 per cent.; 1897, 6 per cent.; while the equivalent 8 c.p. lamp connection at the end of the respective years were: 1894, 11,644; 1895, 14,660; 1896, 18,633; and 1897, 21,195.

Hove Electric Lighting Company (Limited).

The accounts which form the basis of our table are those of the sixth completed year of working, and they bear evidence of a very flourishing state of affairs.

During the year the total authorised capital has been increased from £65,000 to £100,000, while the paid up share capital has increased by £4,360, and the loan capital by £1,700. The total loan capital stands at £26,000, of which £7,300 has been borrowed at 4½ per cent., and £18,700 at 4 per cent. interest.

The total expenditure has increased by £10,555, and stands now at £77,451, or at the rate of £116 per kilowatt capacity of plant installed in the station (this capacity is now 669 kilowatts).

The number of consumers added was 116, while the equivalent of 9,168 8 c.p. lamps were connected, raising the total to 36,967—an increase of about 33 per cent. A corresponding improvement in the output was made; that for 1898 being 30·6 per cent. higher than the 1897 figure.

We are glad to notice the improvement, slight as it is, in the costs, in spite of the rise in the fuel and oil, waste and water items. Unfortunately, the wages and maintenance charges at the station and on account of distribution are, in the accounts supplied us, not separately rendered. Management and property charges have quite appreciably sunk, while, on the other hand, works costs, in aggregate, have risen.

The revenue has remained practically steady at 6½d. per unit, and at about 5s. 2d. per 8 c.p. lamp connected.

Out of the working profit of £5,281 shown, £191, being the unexpended balance of £600 required to be set aside under the contract with the Hove Commissioners for repairs and maintenance, has been carried to the depreciation fund, £1,000 has been placed to reserve, £1,005 paid as interest on loans, and £248 written off preliminary expenses. The balance has furnished a dividend on the Ordinary shares of 6½ per cent., leaving £400 to carry forward.

During the year two new steam dynamos, of 350 H.P. and 40 H.P. respectively, and a Babcock and Wilcox boiler have been added to the plant. To meet the cost of further extensions of plant and mains it is proposed to issue the remaining 1,000 £5 shares at £7. 10s. per share, thus bringing the total subscribed capital up to £50,000.

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	CAMBRIDGE.		HOVE.	
Undertaking Worked by	Cambridge Electric Supply Co.		The Hove Electric Lighting Co. (Ltd.)	
Date of Commencement of Supply	November, 1892.		November, 1892.	
System of Supply	Alternate-current transformer sub-stationsand		Three-wire, continuous-current, with batteries.	
Chief Engineer	John H. Barker.	[house transformers.	C. B. Smith.	
YEAR ENDED	DEC. 31, **1897.**	DEC. 31, **1898.**	DEC. 31, **1897.**	DEC. 31, **1898.**
QUANTITIES—				
Units generated	—	435,383	311,129	415,332
,, **SOLD (TOTAL)**	**221,507**	**260,307**	**268,243**	**350,354**
,, sold to consumers	219,871	24,669	260,103	341,462
,, sold for public lighting, &c.	1,636	1,638	8,140	8,892
,, used on works	6,583	6,494	10,501	9,040
UNITS SOLD PER 8 C.P. LAMP CAPACITY	**13·5**	**15·9**	**20·6**	**16·75**
Maximum supply demanded	234 kilowatts	751 kilowatts	310 kilowatts	3,120 amperes
Number of public lamps	1	1	4 arc, 4 glow	2 arc, 9 glow
Number of consumers	329	365	397	513
Connections to mains in 8-c.p. lamps	21,195	25,080	27,799	36,967
CAPACITY OF PLANT IN 8-C.P. LAMPS	**16,400**	**16,400**	**13,000**	**20,900**
CAPACITY OF PLANT IN KILOWATTS	**525**	**525**	**440**	**669**
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	**£100,000 / £190**	**£100,000 / £190**	**£65,000 / £148**	**£100,000 / £149·5**
Share	100,000 / 190	100,000 / 190	40,000 / 90·9	50,000 / 74·8
Loan (including Debenture charges)	— / —	— / —	25,000 / 56·8	50,000 / 74·8
RECEIVED (TOTAL)	**44,211 / 84·3**	**48,729 / 92·8**	**63,850 / 145**	**69,910 / 104·5**
Share	44,203 / 84·2	48,666 / 92·6	39,550 / 89·9	43,910 / 65·7
Loan (including Debenture charges)	— / —	— / —	24,300 / 55·2	26,000 / 38·9
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	— / —	**51,334 / 97·7**	**1,150 / 2·61**	**30,090 / 45·0**
Share (unissued)	5,870 / 11·2	5,770 / —	nil / —	5,000 / 7·48
Share (uncalled)	49,927 / 95·1	45,564 / 86·7	450 / 1·02	1,090 / 1·63
Loan (including Debentures)	— / —	— / —	700 / 1·59	24,000 / 35·9
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	— / —	— / —	**2,260 / 5·14**	**5,288 / 7·91**
DEPRECIATION FUND	**700 / 1·33**	**1,000 / 1·90**	**915 / 2·08**	**1,106 / 1·65**
EXPENDED (TOTAL)	**43,922 / 83·6**	**46,875 / 89·3**	**66,896 / 152**	**77,451 / 116**
Lands and buildings	10,164 / 19·3	10,305 / 19·6	6,379 / 14·5	6,594 / 9·86
Plant	19,024 / 36·2	19,480 / 37·1	25,508 / 58·0	31,384 / 46·9
Mains	13,316 / 25·4	15,205 / 29·0	33,408 / 76·0	37,955 / 56·8
Miscellaneous	1,419 / 2·70	1,885 / 3·59	1,602 / 3·64	1,517 / 2·27
BALANCE OF CAPITAL ACCOUNT	**289 / 0·550**	**1,854 / 3·53**	**−3,046[i] / −6·92**	**−7,541[i] / −11·3**
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	**£6,623 / 7·180d.**	**£7,382 / 6·807d.**	**£7,270 / 6·510d.**	**£9,481 / 6·498d.**
Revenue from supply	5,834 / 6·320d.	6,769 / 6·242d.	6,650 / 5·950d.	8,770 / 6·012d.
,, meters, &c.	293 / 0·317d.	318 / 0·293d.	426 / 0·381d.	530 / 0·363d.
,, public lighting	23 / 0·025d.	23 / 0·021d.	189 / 0·169d.	178 / 0·122d.
,, sale of lamps, &c.	— / —	— / —	— / —	— / —
,, miscellaneous sources	473 / 0·512d.	272 / 0·251d.	5 / 0·004d.	3 / 0·002d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	**£3,460 / 3·750d.**	**£3,564 / 3·287d.**	**£3,276 / 2·930d.**	**£4,200 / 2·877d.**
WORKS COSTS	**2,453 / 2·660d.**	**2,592 / 2·390d.**	**1,920[a] / 1·720d.**	**2,704 / 1·853d.**
Generation of electricity	*2,420 / 2·620d.*	*2,537 / 2·340d.*	— / —	— / —
Fuel (including cartage, &c.)	1,099 / 1·190d.	1,189 / 1·097d.	805 / 0·720d.	1,289 / 0·883d.
Oil, waste, water, stores	134 / 0·145d.	173 / 0·160d.	119 / 0·107d.	179 / 0·123d.
Wages at station	770 / 0·834d.	858 / 0·792d.	787 / 0·704d.	827[f] / 0·567d.
Repairs and maintenance at station	417 / 0·452d.	317 / 0·292d.	—[a] / —	409[f] / 0·280d.
Distribution of electricity	*33 / 0·036d.*	*55 / 0·051d.*	—[a] / —	—[f] / —
Wages, &c.	33 / 0·036d.	55 / 0·051d.	— / —	—[f] / —
Repairs, renewals of mains, &c.	— / —	— / —	— / —	—[f] / —
Public lighting	— / —	— / —	—[a] / —	— / —
Attendance	— / —	— / —	— / —	— / —
Renewals	— / —	— / —	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	**1,008 / 1·090d.**	**972 / 0·896d.**	**1,356 / 1·210d.**	**1,496 / 1·025d.**
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*339 / 0·367d.*	*408 / 0·376d.*	*184 / 0·165d.*	*231 / 0·158d.*
Management	*669 / 0·725d.*	*564 / 0·520d.*	*1,172 / 1·050d.*	*1,265 / 0·867d.*
Salaries	390 / 0·422d.	404 / 0·373d.	851 / 0·762d.	872 / 0·598d.
Stationery, &c. / Establishment charges	150 / 0·163d.	101 / 0·093d.	44 / 0·039d.	53 / 0·036d.
Law charges, &c.	129[a] / 0·140d.	59[c] / 0·054d.	135 / 0·121d.	180 / 0·123d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	**£3,162 / 7·72%**	**£3,818 / 8·41%**	**£3,994 / 6·20%**	**£5,281 / 7·32%**
Sum carried to Depreciation Fund	300 / 0·732%	300 / 0·660%	391[c] / 0·607%	191[c] / 0·365%
Sum carried to Reserve or Sinking Fund	— / —	— / —	600 / 0·931%	1,000 / 1·395%
Net interest on loans (incl. Debenture charges)	48 / 0·117%	71 / 0·156%	915 / 1·42%	1,005 / 1·392%
BALANCE FROM LAST ACCOUNT	**279 / 0·681%**	**146[e] / 0·322%**	**183 / 0·284%**	**215 / 0·298%**
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	**2,692 / 6·57%**	**3,259[d] / 7·180%**	**2,121[d] / 3·29%**	**3,052[h] / 4·23%**
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	6% / —	7% / —	5% / —	6½% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	52·3%	48·3%	45·1%	44·3%
Expenditure per kilowatt capacity	£6. 11s. 10d.	£6. 15s. 10d.	£7. 9s. 0d.	£6. 5s. 7d.
REVENUE PER KILOWATT CAPACITY	**£12. 12s. 0d.**	**£14. 1s. 2d.**	**£16. 10s. 0d.**	**£14. 3s. 5d.**
Expenditure per 8-c. lamp capacity	4s. 2½d.	4s. 4d.	5s. 0½d.	4s. 0¼d.
REVENUE PER 8-C.P. LAMP CAPACITY	**8s. 1d.**	**9s. 0d.**	**11s. 2d.**	**9s. 0½d.**
REVENUE PER 8-C.P. LAMP CONNECTED	**6s. 3d.**	**5s. 10¾d.**	**5s. 2¾d.**	**5s. 1½d.**
Price charged for lighting, per unit	7d. to 5¼d.[b]	7d. to 5¼d.[b]	8d. to 4d.[e]	8d. to 4d.[e]
Price charged for power, per unit				4d.
Price charged for public lighting	£22. 18s. 6d. per arc.	£22. 18s. 6d. per arc.	—	6d.

CAMBRIDGE.—REMARKS—*a* Includes £25 to auditing, £68 to cost of issue of capital and £22 to insurance. *b* By discounts. *c* Includes £26 to auditing and £23 to insurance. *d* After deducting £250 towards reduction of preliminary expenses and £84 written off suspense account. *e* After deducting £147 Directors' remuneration for 1897, in arrear.

HOVE.—*a* Items of expenditure on distribution and public lighting not separately given. *b* Includes £92 to insurance and £11 to auditing. *c* Set aside under contract with the Hove Commissioners. *d* £150 having been written off preliminary expenses. *e* By the Wright system (first hour scale). *f* Distribution wages and repairs and maintenance are included in the corresponding generating items. *g* Includes £11 to auditing and £149 to insurance. *h* After deducting £248 written off preliminary expenses. *i* Over-expended.

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THE TELEPHONE QUESTION.

By Mr. Hanbury's speech in the House of Commons on Monday last, the intentions of the Government with respect to the telephone question have at last been definitely disclosed. Two experiments are to be tried concurrently; the Post Office is, contrary to the advice of its permanent officials, about to establish a telephone service in London in competition with that of the National Telephone Co.; and at the same time local authorities are to be encouraged to compete with the Company in the provinces. For this experiment the Government is about to devote an initial sum of £2,000,000—more may be needed, but this will carry them on for some considerable time, to quote Mr. Hanbury's words. Two millions is, by the way, a sum which Mr. Hanbury calculates would replace the whole telephone system of the National Telephone Co. It is also the sum spent by that Company on extensions during the last five years. The Company's service, Mr. Hanbury finds, is at present not efficient, not sufficient and too costly. The inefficiency, he owns, is due to the difficulty of obtaining wayleaves, a difficulty which it is within the power of the Government to remove. The insufficiency is largely due to the fact—a fact with which Mr. Hanbury tactlessly taunted Sir James Fergusson—that the Company's licence does not allow it to deliver written messages. This limitation could also be removed. As regards cost, Mr. Hanbury forgets that one-tenth of the rental paid by every subscriber is pocketed directly by the Post Office. The refusal of these facilities to the Company, and the obstacles placed in its way, were not, it must be remembered, with a view to safeguarding the interests of the public. The public interests could have been safeguarded by imposing a compulsory service within certain areas, as in the case of the gas, water and electric light companies, and by fixing a maximum tariff. No, the restrictions were imposed not to safeguard the public, but to safeguard the telegraph revenue, and in this way they have probably done what is required of them, for the £104,000 received as royalty from the National Telephone Co. last year will, no doubt, go far towards removing the so-called telegraph deficit.

We are not in favour of further concessions being granted to the Company, however; we are, and always have been, of the opinion that the way to obtain an adequate and efficient telephone service, is to place it entirely in the hands of a Government department, so that it can be developed on the lines tending to make it of maximum utility to the public. It was a Government servant who brought the first pair of practically working telephones into this country, and we may presume that he reported favourably on the properties and potentialities of the instrument, but yet the Government left it to a joint-stock company to introduce the telephone to the public and to perform all the valuable and hazardous pioneer work. In this the

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Company has from the outset been impeded rather than assisted by the Government; and now that its business has become a profitable one, instead of buying it at its market value, and carrying out the improvements and extensions that are needed to enable the use of the telephone to be extended as it should be, the Government thinks it is performing a public service by introducing competitive telephony. It hopes to save, say, a couple of millions, by risking a like sum in experiment.

We hold no brief for the National Telephone Co., but we cannot avoid commenting on the biassed manner in which Mr. HANBURY stated his case before the House of Commons. Not only did he virtually place the Company in the dock, and hold it responsible for all the mischief done by the short-sighted policy of successive Governments since the inception of telephony, but throughout his special pleading his statements were by no means as candid as might fairly be expected from a member of Her Majesty's Government. The one, and probably the only technical point in connection with the working of telephones, grasped by the lay mind, is that single circuits are bad, and metallic circuits good. Mr. HANBURY, aware that he might take so much knowledge in the general public for granted, took pains to create the impression that the National Company's system was substantially a single circuit one, whereas the fact is that 80 per cent. of the Company's exchange lines are on the metallic circuit system. Then, Mr. HANBURY says, that the Company expected the Government to refrain from establishing competition, although the Company itself had organised active competition with post office exchanges in several districts. Mr. HANBURY forgets, however, that ever since the principle of co-operation was laid down in the oft-mentioned Treasury Minute, no competitive exchange was opened by the Company. He could hardly expect it to retire from ground it had already conquered; moreover, this would have occasioned serious public inconvenience. When the trunk wires were handed over to the Post Office, we know that the Company's engineers co-operated loyally with those of the Post Office; Mr. Preece was one of the first to acknowledge this. How far, however, have the Post Office carried out their part of the compact? To what extent have the telephoning public been able to profit by the facilities that were to be given for telephoning telegrams, express letters and postal letters? How many, or how few, post offices have telephones on the Company's exchange system, and what proportion of the officials at these offices even know what these facilities are? There is no mention of them in the delphic "Post Office Guide."

Even Mr. HANBURY's arithmetic errs in favour of his argument. To justify his estimate of 2 or 2½ millions as the value of the National Telephone Co.'s undertaking, he takes the average capital cost of £30 per line, and multiplies this by 96,000. The product, we may inform Mr. HANBURY, does *not* fall short of two millions—it is considerably in excess of 2½ millions—moreover, the number of exchange lines is now over 100,000, the number of exchange and private lines together amounting to 120,000. The hint that the Company unreasonably refuses to connect subscribers was met by Sir JAMES FERGUSSON's reply that exchanges were opened whenever about a dozen subscribers could be obtained. Sir JAMES turned the tables on Mr. HANBURY when he reminded him that the Post Office had refused to put up trunk wires in some localities (Weybridge, we believe, among others) which have local exchanges, but no trunk connection, unless the Company would guarantee an interest on the expenditure. Lastly, the endeavour to make capital out of patriotic feeling, by the statement that all the principal telephonic appliances are purchased abroad, does not do Mr. HANBURY credit. The National Company buys its telephone material in exactly the same market as the Post Office does, and the major part of it —including all its overhead and underground line equipment— is manufactured in this country.

We come now to the new scheme which Mr. HANBURY proposes, although, until the Bill itself is brought in, we cannot review it in detail. The part of the scheme that refers to the provinces will not have come as a surprise to our readers, for a fortnight ago we referred to a statement of the POSTMASTER-GENERAL foreshadowing a Bill to grant powers for the acquisition of telephone licences by local authorities. It seems likely that the majority of municipalities who acquire licences, will merely use them as a weapon to force the National Telephone Co. to improve and extend its service and lower its tariffs. The pledge given by Mr. HANBURY, that the Government will buy all that is good and useful at the end of the term, amounts practically to nothing. As Sir JAMES FERGUSSON remarked, the Post Office would do that in any case. It happens very rarely in provincial towns that when one authority works the telephone, two large exchanges are needed, and it is by no means necessary that the equipment of the switchboards in the two exchanges are identical. Hence, only one of the two exchanges would probably be acquired by the Post Office, and Mr. HANBURY states that the preference would be given to the municipality, so that the Company would only thus sell its wires when underground, and its subscribers' instruments. Then the Company is to have the same wayleaves as the municipality, if it behaves itself, and allows subscribers to the municipal exchange to speak through to its own subscribers. No doubt the Company would do this, on receipt of a toll; it would be suicidal to allow it for nothing at the outset, when the number of subscribers to the municipal exchange is small. It will be interesting to see what provisions to guard against too intimate working relations between the Company and municipalities will be put in the Bill. The latter, of course, will not be allowed to sell to the former, but is the converse also to hold? Is there to be any provision to guard against the Company closing an exchange as soon as municipal competition is seriously threatened—say, in a town like Glasgow, where it is burdened with obsolete plant, and has to fight against a rooted prejudice towards municipalisation? Will an agreement as to the maximum rates to be paid to employés be allowed? For if there is competition there will certainly be a scarcity of skilled operators, and possible strikes of the latter must be guarded against. The Post Office already pays 4s. a week more than the National Telephone Co.

The competition that is to take place in London is certainly unexpected, especially in view of a written reply made by the POSTMASTER-GENERAL last November to a deputation of the Manchester Corporation, that "he has no immediate intention of establishing Post Office competition in a city like Manchester, where the Post Office has not hitherto established any local exchange." The only public exchanges that the Post Office has established, either in London or Manchester, are in connection with trunk lines. However, it appears that a post office exchange system is to be established in the metropolis, and that, with this experiment, another experiment is to be tried in the adoption of a new tariff. Those who have been inside an exchange and have examined its methods of working, can only appreciate the difficulties of introducing a tariff of this kind. It may work well in a country like Switzerland, where the telephone traffic is relatively small, but in London it will not only impede the speed of the service, but will also introduce friction and expense in the

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collection of the charges. We think that the majority of business men will resent a tariff of this sort. Perhaps, a future POSTMASTER-GENERAL may wish to extend it into something analagous to the "Wright" tariff system, and charge lower rates at luncheon time and a third rate between 6 p.m. and 10 a.m. The simple expedient of different charges for business and private houses answers the purpose best, and the Post Office will, we think, have to adopt that eventually, *i.e.*, if it is to have the power to charge two separate tariffs. If not, of course, the reason of the £8 rate with extras is evident. In Germany, as we noticed in our last issue, such a system is being introduced. While on the question of tariffs, we may add to a statement made by Mr. PROVAND. There may be some villages in America where a telephone service can be had for $15 per year, but, in the aggregate, the rates are, we believe, considerably higher than in this country. The average tariff in New York is far above that in London. That the new Post Office system in connection with express letters and telegrams will be acceptable in London there cannot be a doubt, but had the Post Office acted properly in the matter, the present subscribers to the National Telephone Company would already have these facilities. So far as efficiency of service and speed of making connections is concerned, the latter will be able to hold its own, for were it not for the difficulty in the maintenance of the overhead lines, the Company's metropolitan system now embodies practically all the most modern improvements. In fact, we believe that if the Company decides to reduce its tariffs to a more reasonable figure, there will be few subscribers who would desire to change over to a new exchange system, and the Post Office may find that its telephone service remains a subsidiary and unremunerative one in spite of their saving of 10 per cent. royalty and their underground facilities; and Mr. HANBURY may yet wish, as the permanent officials probably do already, that the two millions were spent on the National Telephone Company's "goodwill" instead of on a needless experiment. In conclusion, we would ask whether the Post Office has at its disposal the services of an engineer experienced in the erection of an exchange system for 10 or 20 thousand subscribers. On this occasion it will lack assistance which it had when establishing its trunk system.

THE "PREMIER" CARBIDE OF SILICON INCANDESCENT LAMP.

Many attempts have been made to increase the efficiency of an incandescent electric lamp, by employing for the filament materials capable of remaining solid and rigid at a higher temperature than is possible with carbon. In some instances carbon has been admixed with highly refractory bodies, in other attempts carbon has been entirely abandoned in favour of metallic oxides and similar solid substances. The most notable recent example of the second-named type of lamp is the Nernst lamp, which has attracted so much popular notice during the past few weeks. But of this lamp, it can scarcely be said that it is beyond the laboratory stage, for we are not aware that it has been publicly exhibited in this country except on a lecture table, or that any independent person has succeeded in obtaining a Nernst lamp either for experimental or commercial purposes. We have now to direct the attention of our readers to another invention for increasing the efficiency of electric glow lamps, by using materials capable of higher temperature than pure carbon. We refer to the lamp invented by Herr Langhans, and now being introduced by the Premier Electric Lamp Syndicate (Limited), of Liverpool. For some time past Herr Langhans and those associated with him have undertaken experiments* with a view to the production of a filament answering the above named requirements, with the result that a filament has been adopted consisting of the carbide of silicon, coated with silicon and carbon by means of a modification of the usual flashing process.

The first part of the process of manufacture consists in the treatment of cellulose in successive operations with sulphuric acid of varying concentration, or with both sulphuric and phosphoric acids, by which means a gelatinous semi-liquid substance is obtained with which silicon, in the form of a fine amorphous powder, is incorporated by mechanical mixture. This amorphous silicon is prepared by a special process invented by Herr Langhans, the ordinary silicon powder sold as amorphous not being suitable for the purpose. The semi-liquid mass of cellulose and silicon, after being freed from air bubbles by rapid rotation in a centrifugal machine, is pressed or squirted through a fine aperture, from which it issues in the form of a continuous thread, which, passing through alcohol into water, hardens in the way common to all cellulose processes. The thread so produced is washed and wound up on frames to dry, after which it is ready for the carbonising furnace. The process of carbonising does not differ from that usually employed, except that, in order to protect the silicon from any nitrogen which may be present, the forms on which the squirted thread is wound are surrounded by a mixture of carbon powder and titanic acid; and that the highest temperature attainable must be held for a sufficient time for the silicon and the carbon formed from the cellulose to combine.

After removal from the furnace the filaments are "flashed" in a vapour of silicon and carbon, by which the coating referred to above is given to them, and they are then ready to be made up into lamps.

Owing to the refractory nature of filaments produced by this process, lamps thus made will stand being run at a higher efficiency than is possible with any carbon filament. As is only too well known by users of the glow lamp, its two great faults, which become more marked with every increase in the efficiency when *new*, are falling off in the light and the blackening of the bulbs as time goes on. Both these faults, notwithstanding the high efficiency, are said to be practically absent from the carbide of silicon lamp. The claims of the inventor, which have been substantiated, both by the report of Prof. Ayrton on the performance of the lamp, and by later experience, gained while working out the practical details of factory production, are that this lamp, starting at an efficiency of 2·8 watts per amyl-acetate candle (*i.e.*, about 3·1 watts per English candle), will run for 600 to 800 hours without any material decrease in the light emitted, increase in the watts consumed per candle, or any blackening of the glass bulbs. So that, apart from the gain in appearance and comfort from the lamps remaining bright and clean, the user of this lamp should save, on this estimate, some 25 per cent. on his lighting bills, as compared with the expenses of the use of the ordinary carbon filament lamp. It remains, however, yet to be seen what the new lamp can do in actual commercial use; and while we welcome it, as we would welcome any attempt to increase the popularity and convenience of the electric light, we reserve until a later stage of its development any expression of opinion as to its prospects of success.

* For tests see *The Electrician*, Vol. XL., p. 713.

WIRELESS TELEGRAPHY.*

BY G. MARCONI.

"Wireless Telegraphy," or telegraphy through space without connecting wires, is a subject which has attracted considerable attention since the results of the first experiments I carried out in this country became known. It is not my intention this evening to give my views on or discuss the theory of the system, with which I have carried out so many experiments, and by means of which I have worked various installations, but I hope to put before you some exact information of what has been done by myself and my assistants during the last twelve months, and also some reliable data as to the means employed to obtain such results. Much has been published on the subject, I must say with varying accuracy, and there can hardly be any one here altogether ignorant of the

*Paper read before the Institution of Electrical Engineers.

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general characteristics of the system. Before I go into this subject further I wish to state that any success I have met with in the practical application of wireless telegraphy has been in a large measure due to the efficient co-operation which has been rendered by my assistants. I think it will not be out of place if I give a brief description of the apparatus.

Transmitter.—When long distances are to be bridged over and it is not necessary that the signals should be sent in one definite direction, I employ as transmitter an arrangement, as shown in Fig. 1, in which two small spheres connected to the terminals of the secondary winding of an induction coil *c* are connected, one to earth and the other to a vertical conductor *w*, which I will call the aërial conductor. Should it be necessary to direct a beam of rays in one given direction I prefer to use an arrangement similar to a Righi oscillator placed in the focal line of a suitable cylindrical parabolic reflector, *f*, Fig. 5. The transmitter works as follows:—When the key *b* is pressed, the current

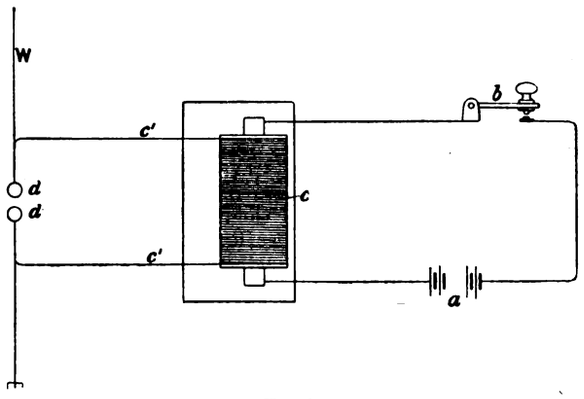

FIG. 1.

of the battery is allowed to actuate the spark coil *c* which charges the spheres of the Righi oscillator or the vertical wire *w* which discharges through the spark gap. This discharge is an oscillating one, and the system of spheres and insulated conductor becomes a radiator of electric waves. It is easy to understand how, by pressing the key for long or short intervals, it is possible to emit a long or short succession of waves, which, when they influence the receiver, reproduce on it a long or short effect, according to their duration, in this way reproducing the Morse or other signals transmitted from the sending station.

Receiver.—One of the principal parts in my receiver is the sensitive tube or coherer or radio-conductor, which was discovered, I think I am right in saying, by Prof. Calzecchi Onesti, of Fermo,* and was improved by Branly, and modified by Prof. Lodge and others. The only form of coherer I have found to be trustworthy and reliable for long distance work is one designed by myself as

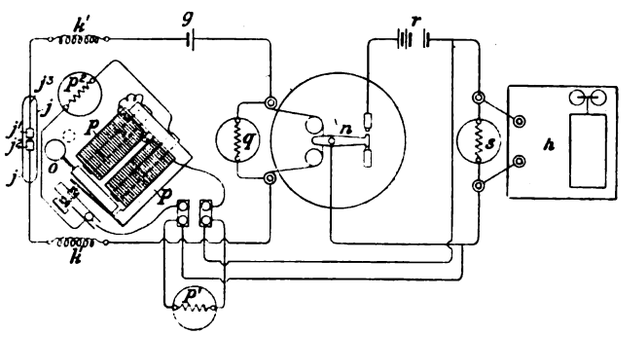

FIG. 2.

shown in Fig. 2. It consists of a small glass tube, four centimetres long, into which two metal pole pieces, j^1 j^2, are tightly fitted. They are separated from each other by a small gap, which is partly filled with a mixture of nickel and silver filings. This coherer forms part of a circuit containing the local cell and a sensitive telegraph relay actuating another circuit, which circuit works a trembler *p* or decoherer and a recording instrument *h*. In its normal condition the resistance of the filings in the tube *j* is infinite, or at least very great, but when the filings are influenced by electric waves or surgings, cohesion instantly takes place, and the tube becomes a comparatively good conductor, its resistance falling to between 100 and 500 ohms. This allows the current from the local cell *g* to actuate the relay *n*. One end of the tube is connected to earth and the other to a vertical conductor similar to that of the transmitter, Fig. 1, or if reflectors are used a short strip of copper is connected to each end, Fig. 4. The length of these strips of copper must be carefully determined, as good results cannot be obtained unless they happen to be of the proper length, which will cause them to be in tune or syntony with the transmitted oscillations. All the electromagnetic apparatus in the receiver is shunted by non-inductive resistances in such a manner that there may be no sparking at contacts and no sudden perturbations or jerks caused by the local battery current near the coherer. I find that the relay tapper and telegraphic instrument, if not properly shunted, produce disturbing effects, the result of which is to prevent the coherer from regaining its sensitive condition after the receipt of electrical oscillations. No such trouble is exprienced when suitable shunts are used, and I attribute to their action in very great measure the success which has been attained with this system. Small choking coils *k' k'* are intro-

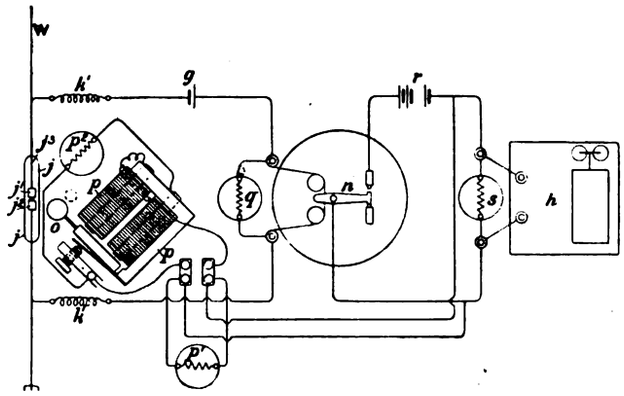

FIG. 3.

duced between the coherer and the relay. They compel the oscillating current due to the electric waves to traverse the coherer rather than waste its energy in the alternative path afforded by the relay. The oscillations induced on the strips *k k* or aërial conductor *w*, which acts as resonator, by the radiation from the oscillator affect the sensitive tube. This effect on the tube consists, as we have said, in a great increase of its conductivity, thus completing the circuit and allowing the current from the cell to actuate the relay. The relay in its turn causes a larger battery *r* to pass a current through the tapper or interrupter *p*, and also through the electro magnets of the recording instrument *h*.

The tapper or trembler is so adjusted as to tap the tube and shake the filings in it. If in the instant during which these various actions takes place, the electrical oscillations had died out in the

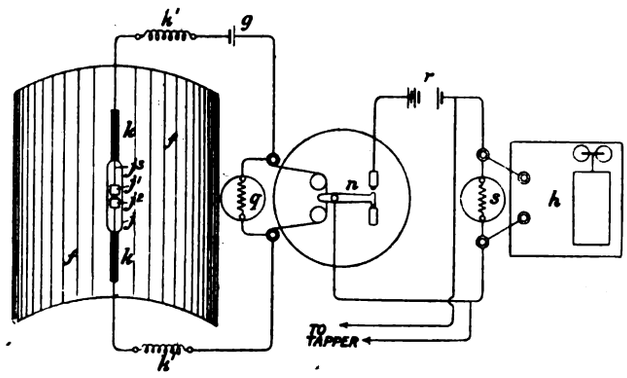

FIG. 4.

resonator, the shake or tap given to the tube by the hammer *o* would have restored it to its normal high-resistance condition, and the Morse instrument or recorder would have marked a dot on the tape; but if the oscillations continue at very brief intervals the acquired conductivity of the tube *j* is destroyed only for an instant by the tap of the trembler, and immediately re-established by the electrical surgings; and, therefore, the relay tapper and telegraph instrument are again actuated, and so on until the oscillations from the radiator have ceased. The practical result is that the receiver is actuated for a time equal to that during which the key is pressed at the transmitting station. For each signal, however short, the armatures of the relay and tapper perform some very rapid vibrations dependent on each other. For it is the action of the relay which starts the tapper, but the tapper by its action interrupts the relay. The armature of the Morse recording instrument being rather heavy, and possessing a comparatively large

* See *Nuovo Cimento*, Series 3, Vol. XVII., Jan.-Feb., 1885; and ditto, Jan.-Feb., 1896.

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inertia, cannot follow the very rapid vibrations of the tongue of the relay, but remains down all the time during which the rapidly-intermittent action of the receiver lasts. In this way the armature of the inker gives a practically exact reproduction of the movements of the key at the transmitting end, dashes coming out as dashes and dots as dots.

Much has been said and written about coherers being very unreliable and untrustworthy in their action, but I must confess that this has not been in any way my experience. Provided a coherer is properly constructed and used on a suitable receiver, it is just as certain in its action as any other electrical apparatus, such as an electromagnet or incandescent lamp. I have coherers which were made three years ago, that are now quite as good if not better than they were at that time, and we have had tubes working for months in most important installations without ever giving trouble. At the installation my company have erected at the South Foreland Lighthouse, which, as you probably know, is working to the East Goodwin Lightship, the coherer was mounted on the receiver when we first started in December of last year, and has done its work in a most satisfactory manner ever since. I must call your attention to the object and function of the vertical wire *w*. It has been by means of this addition to the apparatus, that we have been able to telegraph over distances which have been so far unattained, I think I am right in saying, by any other method of space telegraphy. The way I came to appreciate the great importance of the addition of the conductor *w* and earth connection E to the apparatus was as follows:—(I take this data from a copy of a letter I wrote to Mr. Preece in November, 1896.) When carrying out some experiments in Italy in 1895, I was using an oscillator having one pole earthed and the other connected to an insulated capacity, the receiver also earthed and connected to a similar capacity. The capacities were in this case cubes of tinned iron of 30cm. side, and I found that when these were placed on the top of a pole 2 metres high, signals could be obtained at

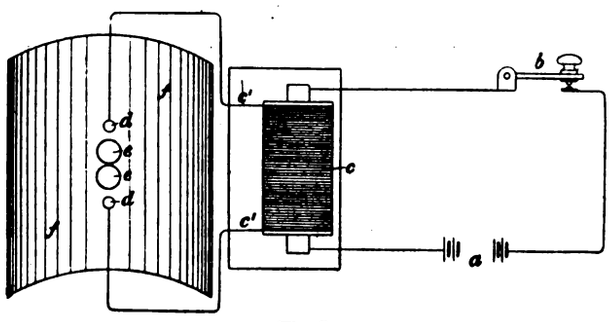

Fig. 5.

30 metres from the transmitter. With the same cubes on poles 4 metres high, signals were obtained at 100 metres, and with the same cubes at a height of 8 metres, other conditions being equal, Morse signals were easily obtained at 400 metres. With larger cubes of 100 centimetres side, fixed at a height of 8 metres, reliable signals could be obtained at 2,400 metres all round, equal to about one mile and a half. These results seemed to point out that a system of transmitter and receiver designed according to the lines on Fig. 1, *i.e.*, a radiator of the Hertzian type having one pole earthed and the other connected to a vertical, or almost vertical, conductor, or to a lofty capacity area, and a resonator consisting of a suitable receiver having similarly one terminal connected to earth and the other to an insulated vertical conductor, constitute a system of transmitter and receiver capable of giving effects at far greater distances than the ordinary systems of Hertzian radiators and resonators. The results I have referred to also show that the distance at which signals could be obtained varied approximately with the square of the distance of the capacities from earth, or perhaps with the square of the length of the vertical conductors. This law has since been verified by a careful series of experiments and found correct, and has furnished us with a sure and safe means of calculating what length the vertical wire should be in order to obtain results at a given distance. It is well to know that the said law has never failed to give the expected results across clear space in any installation or experiment I have carried out, although it usually seems that the distance obtained is slightly in excess of what one might expect. I find that with parity of other conditions a vertical wire 20ft. long at the transmitter and receiver is sufficient for communicating one mile, 40ft. at each end for four miles, and 80ft. for 16 miles and so on. An installation is now working over a distance of 18 miles with a vertical wire 80ft. high at each installation station.

Prof. Ascoli* has confirmed this, and demonstrated mathematically, using Neumann's formula, that the inductive action is proportional to the square of the length of one of the two conductors if the two are vertical and of equal length, and in simple inverse proportion of the distance between them. Therefore, the intensity of the induced oscillation does not diminish with the increase of distance if the length of the vertical conductors is increased in proportion with the square root of the distance—that is, if the height of the wire is double, the possible distance becomes quadrupled. Should it be necessary to rig up an installation at a distance of, say, 32 miles, such as is about the distance between Folkestone and Boulogne, it is easy to find that a vertical wire 114ft. long would be quite sufficient for that purpose.

Such laws are applicable only when apparatus properly constructed is employed. With apparatus in which some or several improved details are omitted, I find it quite impossible to obtain anything like the results above mentioned. If, say, the impedance coils *k'' k''* are omitted, the distance (other conditions being equal) is reduced to almost half its original value. I must also call your attention to such cases as when obstacles like hills or mountains, or large metallic objects, happen to intervene between the places between which it is desired to establish communication. With all other forms of Hertzian transmitters and receivers with which I have experimented I find it to be quite impossible to obtain any results if a hill, mountain, or large metallic object intervenes in any way between the two stations. I am not aware whether any satisfactory results have been obtained by others where such obstacles have intervened, but when the vertical wire system is employed it becomes easy to telegraph between positions screened from each other by hills or by the curvature of the earth. In such cases it seems to be a marked advantage if the aërial conductor is thick or if a capacity area is placed at the top of it. I am rather doubtful as to the correct explanation that can be given to this effect. I think there can be very little doubt as to the complete opacity, to electric waves, of a hill three miles thick, or of, say, several miles of sea water. A solution of this difficulty might be given by attributing the results to the effect of the diffraction of such long waves as those radiated by a conductor 100ft. long, but in that case it is difficult to explain why other forms of Hertzian transmitters and receivers, also giving long waves, do not act when such obstacles intervene. A way out

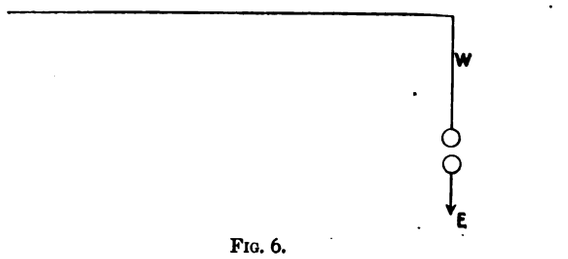

Fig. 6.

of the difficulty may be arrived at if we suppose that the electrical oscillations are transmitted to the earth by the earth wire E of the transmitter and travel in all directions along the surface of the earth till they reach the earth wire of the receiving instrument, and by travelling up the said wire to the coherer thus bring about its action. This was the first explanation I came to during my early experiments. I, however, do not wish to say that I hold entirely to this view at present, although I have not yet found any other perfectly satisfactory explanation of the phenomena. It is well, also, to note that a horizontal wire, even if supported at a considerable height from earth, seems to be of little or no practical utility in increasing the range of signals. If, say, a vertical wire 30ft. long is employed at both stations, and to the top of this is added a horizontal length of 300ft., as shown in Fig. 6, the distance obtained is greater with the vertical wire without the horizontal length than it would be if both were employed. These results show that with this system it is not sufficient to use a horizontal radiating or collecting wire, as such a wire would be of no utility for long-distance signalling.

I believe that the exceedingly marked advance made by the adoption of the vertical conductor is due to the fact that the plane of polarisation of the rays radiated is vertical, and that therefore they are not absorbed by the surface of the earth, which acts as a receiving conductor placed horizontally. As the maximum effect is obtainable when the conductors of the transmitter and receiver are parallel, this makes it necessary to have a vertical conductor connected to one pole of the coherer.

Before proceeding to describe the results obtained under various conditions by means of what we may call the vertical wire system, I think it desirable to bring before you some observations and results I have obtained with a system of Hertzian wave telegraphy, which was the first with which I worked, and in which parabolic reflectors are used to control the propagation and intensify the effects obtained when comparatively short electric waves are employed for signalling. As in ordinary

* See *Elettricista*, August number, 1897. (Rowe.)

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optics, so also in the optics of electromagnetic oscillations, it is possible, as has been shown by Hertz, to reflect the waves radiated from the oscillator in one definite direction only. This can be done, as you know, by using convenient reflectors, similar to those used for projectors, but preferably, for economical reasons, made of copper or zinc, instead of silver amalgam or silver. Except when very small radiators of the Righi or Lebedew type are employed, it is desirable to use cylindrical parabolic reflectors, and it is with reflectors such as I here exhibit that the trials to which I am alluding have been carried out. The advantages obtainable by their use are obvious.

In any other system intended for the transmission of telegraphic signals by means of electric waves through space, the waves have been allowed to radiate in all directions, and would affect all suitable receivers within a certain radius, which, of course, is dependent on the power of the radiator or transmitter and on the sensitiveness of the resonator or receiver. It is, however, possible, by means of syntonising arrangements, to prevent, to a certain extent, messages affecting instruments or receivers for which they are not intended, and therefore to select any receiver by altering the wave length of the transmitter. By means of reflectors it is possible to project the waves in one almost parallel beam which will not affect any receiver placed out of its line of propagation, whether the said receiver is or is not in tune or syntony with the oscillation transmitted. This would enable several forts, or hill-tops, or islands to communicate with each other without any fear of the enemy tapping or interfering with the signals, for if the forts are on small heights the beam of rays would pass above the positions which might be occupied by the enemy. An illustration of the possibility of directing these waves can be shown by the action of the receiver, which in this case rings a bell only when the radiator in the reflector is directed towards it. These results are much more marked in an open space than in a lecture theatre, as the walls, gilt hangings, &c., tend to reflect the rays in all directions and may alter the results.

In experiments carried out over a distance of 1¾ miles, I noticed that only a very small movement of the transmitting reflector was sufficient to stop the signals at the receiving end, which could be only obtained within a latitude of 50ft. to the right or left of what was believed to be the centre of the beam of reflected radiations. There exists a most important case to which the reflector system is applicable, namely, to enable ships to be warned by lighthouses, light-vessels, or other ships, not only of their proximity to danger, but also of the direction from which the warning comes. If we imagine that A is a lighthouse provided with a transmitter of electric waves, constantly giving a series of intermittent impulses or flashes, and B a ship provided with a receiving apparatus placed in the focal line of a reflector, it is plain that when the receiver is within range of the oscillator the bell will be rung only when the reflector is directed towards the transmitter, and will not ring when the reflector is not directed towards it. If the reflector is caused to revolve by clockwork or by hand, it will therefore give warning only when occupying a certain sector of the circle in which it revolves. It is therefore easy for a ship in a fog to make out the exact direction of point A, whereby, by the conventional number of taps or rings, she will be able to discern either a dangerous point to be avoided or the port or harbour for which she is endeavouring to steer. I have not up to the present attempted to signal any greater distance than about two miles with reflectors, but I am of opinion that across clear space it will be quite possible to obtain satisfactory results at far greater distances, especially if the reflectors are accurately made any larger than those I have used. By means of the same apparatus exhibited here I have succeeded in signalling over a distance of 2½ miles, without, of course, the use of any real "base" lines, which were supposed to be essential for any distance greater than a few feet. It was by means of reflectors I obtained the results over 1¾ miles mentioned by Mr. Preece at the British Association meeting of 1896. I have, however, dedicated more time to the other system, *i.e.*, the vertical wire system.

A station at Alum Bay, Isle of Wight, and another at Bournemouth, the distance between them being 14½ miles, were erected at the beginning of last year, in order to test the practicability of the system under all conditions of weather, and also to afford an opportunity of proving that "Wireless Telegraphy" was not a myth but a working reality. I believe some details of the special conditions of these stations would be of interest. The installation at Alum Bay is in the Needles Hotel, and the Bournemouth station (which has lately been transferred to the Haven Hotel, Poole, thereby increasing the distance to 18 miles), was at Madeira House, South Cliff. At each station a pole 120ft. high was used, which supported the aërial conductor, usually a stranded conductor of 7/20 copper wire insulated with rubber and tape. A 10in. induction coil is used at each station, worked by a battery of 100 Obach cells "M" size, the current taken by the coil being at 14 volts from 6 to 9 amperes. The spark discharge takes place between two small spheres about 1in. in diameter, this form of transmitter having been found more simple and more effective than the Righi oscillator I had previously used. The length of spark is adjusted to about 1 centimetre, this, being a much shorter spark than the coil can give, allows a good margin over for any irregularity that might be caused by the break. No care is ever taken to polish the spheres *d d* at the place where the spark occurs, as the results seem decidedly better with dull spheres than with polished ones. The first tests were made between the Isle of Wight and a steamer, the height of the mast on the boat being about 60*ft*. Readable signals were obtained up to a distance of 18 miles from Alum Bay. During the course of these experiments, I had the pleasure of the company and assistance of Capt. Kennedy, R.E., who was good enough to draw a map showing the course of the steamer. It has apparently been thought that weather or varying conditions of atmospheric electricity may interfere with or stop the signals transmitted by this system, but experience of over 14 months of continual everyday work has brought me to the conclusion that there is no kind of weather which can stop or seriously interfere with the working of such an installation. We have given demonstrations to several eminent scientists, who came down and wanted a show, often when we did not expect them, but on no occasion have they found any difficulty in the work of transmitting and receiving messages between the two stations.

In September of last year, in consequence of the expiration of our lease at Madeira House, Bournemouth, we transferred that station, as I have said, to the Haven Hotel, Poole, thereby increasing the distance to 18 miles. Experiments and tests are carried out daily between the two stations, the improvement in apparatus having allowed us to reduce the height to 80ft. at each end. An average of fully 1,000 words are daily transmitted through the ether each way. In the spring of last year Lord Kelvin inspected our station at Alum Bay, and he was kind enough to express himself as highly pleased with what he saw. He sent several telegrams to his friends, including Mr. Preece and Sir George Stokes, and insisted on paying 1s. royalty on each message, wishing in this way to show his appreciation of what was done, and to illustrate its fitness at that time for commercial use. We are now working at experiments directed towards still further reducing the height necessary for a given distance, and also a good deal on syntonic systems. In May of last year Lloyds desired to have an illustration of the possibility of signalling between Ballycastle and Rathlin Island, in the north of Ireland. My assistants, Mr. Kemp and the late Mr. Glanville, installed the instruments at Ballycastle and at Rathlin Island. The distance between the two positions is 7½ miles, of which about four are overland and the remainder across the sea, a high cliff also intervening between the two positions. At Ballycastle a pole 70ft. high was used to support the wire, and at Rathlin a vertical conductor was supported by the lighthouse 80ft. high. Signalling was found quite possible between the two points, but it was thought desirable to bring the height of the pole at Ballycastle to 100ft., as the proximity of the lighthouse to the wire at Rathlin seemed to diminish the effectiveness of that station. At Rathlin we found that the lighthouse-keepers were not long in learning how to work the instruments, and, after the sad accident which happened to poor Mr. Glanville, that installation was worked by them alone, there being no expert on the island at the time. Following this, in July we were requested by a Dublin paper, the *Daily Express*, to report from the high seas the results and incidents of the Kingstown Regatta. In order to do this we erected a land station, by the kind permission of the harbour-master at Kingstown, in his grounds, where a pole 110ft. high was placed. A steamer, the "Flying Huntress," was chartered to follow the racing yachts, the instruments being placed in the cabin. The height of the vertical wire attainable by the mast was 75ft. A telephone was fixed from our land station at Kingstown to the *Express* office in Dublin, and as the messages came from the ship they were telephoned to Dublin, and published in succeeding editions of the evening papers. The relative positions of the various yachts were thus wirelessly signalled while the races were in progress, sometimes over a distance of ten miles, and were published long before the yachts had returned to harbour. During the several days the system was in use between the tug and the land station, over 700 messages were sent and received, none requiring to be repeated. On trying longer distances it was found that with a height of 80ft. on the ship and the same height as already stated on land, it was possible to communicate up to a distance of 25 miles, and it is worthy of note in this case that the curvature of the earth intervened very considerably at such a distance between the two positions. On one occasion, on a regatta day, I had the pleasure of the company of Prof. G. F. Fitzgerald, of Trinity College, Dublin, on the ship, who, as would be expected, took a very great interest in the proceedings.

Immediately after finishing at Kingstown I had the honour of being asked to instal wireless telegraph communication between the Royal yacht "Osborne" and Osborne House, Isle of Wight, in order that her Majesty might communicate with H R H. the Prince

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of Wales, from Osborne House, to the Royal yacht in Cowes Bay, and during the trips His Royal Highness frequently took. The working of this installation was a very pleasant experience for me, and it afforded, also, an opportunity of more thoroughly studying the effect of intervening hills. In this installation induction coils capable of giving a 10in. spark were used at both stations. The height of the pole supporting the vertical conductor was 100ft. at Osborne House. On the Royal yacht "Osborne" the top of our conductor was suspended to the main mast at a height of 83ft. from the deck, the conductor being very near one of the funnels, and in the proximity of a great number of wire stays. The vertical conductor consisted of a 7/20 stranded wire at each station. The Royal yacht was moored in Cowes Bay at a distance of 1¾ miles from Osborne House, the two positions not being in sight of each other, the hills behind East Cowes intervening. This circumstance would have rendered direct signalling between the two positions impossible by means of any flag, semaphore, or heliograph system. Constant and uninterrupted communication was maintained between the Royal yacht and Osborn House during the 16 days the system was in use, no hitch whatever occurring. One hundred and fifty messages were sent, being chiefly private communications between the Queen and the Prince. Many of these messages contained over 150 words, and the average speed of transmission was about 15 words per minute. By kind permission of the Prince of Wales I will now read to you some of the telegrams which passed between the Royal yacht and Osborn House :—

August 4th.

From DR. FRIPP *to* SIR JAMES REID.

H.R.H. the Prince of Wales has passed another excellent night, and is in very good spirits and health. The knee is most satisfactory.

August 5th.

From DR. FRIPP *to* SIR JAMES REID.

H.R.H. the Prince of Wales has passed another excellent night, and the knee is in good condition.

The following telegram was sent during a cruise, and while the Royal yacht was under way, as you will see from the context :—

August 10th.

From H.R.H. THE PRINCE OF WALES *to* DUKE OF CONNAUGHT.

Will be very pleased to see you on board any time this afternoon when the "Osborne" returns.

This telegram was sent when the yacht was off Bembridge, at a distance of about seven or eight miles from Osborne. On August 12th the "Osborne" steamed to the Needles, and communication was kept up with Osborne House until off Newton Bay, a distance of seven miles, the two positions being completely screened from each other (even to the tops of the masts) by the hills lying between. At the same position we found it quite possible to speak with our station at Alum Bay, although Headon Hill, Golden Hill, and over five miles of land lay directly between. The positions were eight and a half miles apart. Headon Hill was 45ft. higher than the top of our conductor at Alum Bay station, and 314ft. higher than the vertical wire on the "Osborne." The yacht on the same trip proceeded till about three miles past the Needles, communication having been maintained during the whole trip. Another day, when I did not happen to be on board, the yacht went on a cruise round Bembridge and Sandown, communication being maintained with Osborne House, although more than eight miles of land lay between the two positions. The Prince of Wales and other members of the Royal Family, especially the Duke of York, made much use of the system, and expressed themselves as highly satisfied with its practicability. I consider these results rather interesting, as doubts have been expressed by some as to whether it would be possible by this system to telegraph over long stretches of land. Results across hills were also obtained near Spezia by officers of the Italian Navy, using my system.

In December of last year my Company thought it desirable to demonstrate that the system was quite practical and available for enabling telegraphic communication to be established and maintained between lightships and the shore. This, as you are probably aware, is a matter of much importance, as all other systems tried so far have failed, and the cables, by which some three or four ships are sometimes connected, are exceedingly expensive, and require special moorings and fittings, which are troublesome to maintain and liable to break in storms.

The officials of Trinity House offered us the opportunity of demonstrating to them the utility of the system between the South Foreland Lighthouse, and one of the following light-vessels, viz., the "Gull," the "South Goodwin," and the "East Goodwin." We naturally chose the one furthest away—the "East Goodwin"—which is just 12 miles from the South Foreland Lighthouse. The apparatus was taken on board in an open boat, and rigged up in one afternoon. The installation started working from the very first without the slightest difficulty. The system has continued to work admirably through all the storms, which during this year have been remarkable for their continuance and severity. On one occasion, during a big gale in January, a very heavy sea struck the ship, carring part of her bulwarks away. The report of this mishap was promptly telegraphed to the Superintendent of Trinity House, with all details of the damage sustained. The height of the wire on board the ship is 80ft., the mast being for 60ft. of its length of iron, and the remainder of wood. The aërial wire is let down among a great number of metal stays and chains, which do not appear to have any detrimental effect on the strength of the signals. The instruments are placed in the aft-cabin, and the aërial wire comes through the framework of a skylight. from which it is insulated by means of a rubber pipe. As usual, a 10in. coil is used, worked by a battery of dry cells, the current taken being about 6 to 8 amperes at 14 volts. Various members of the crew learned in two days how to send and receive, and in fact how to run the station, and owing to the assistant on board not being as good a sailor as the instruments have proved to be, nearly all the messages during very bad weather are sent and received by these men, who, previous to our visit to the ship, had probably scarcely heard of wireless telegraphy, and were certainly unacquainted with even the rudiments of electricity. It is remarkable that wireless telegraphy, which had been considered by some as rather uncertain, or that might work one day and not the next, has proved in this case to be more reliable, even under such unfavourable conditions, than the ordinary land wires, very many of which were broken down in the storms of last month. The instruments at the South Foreland Lighthouse are similar to those used on the ship, but as we contemplate making some long distance tests from the South Foreland to the coast of France, the height of the pole is much greater than would be necessary for the lightship installation. We found that 80ft. of height is quite sufficient for speaking to the ship, but I am of opinion that the height available on the ship and on shore would be ample even if the distance to which messages had to be sent were more than double what it is at present. Service messages are constantly passing between the ship and the lighthouse, and the officials of Trinity House have been good enough to give expression of their entire satisfaction with the result of this installation. The men on board send numerous messages almost daily on their own private affairs; and this naturally tends to make their isolated life less irksome.

My Company has been anxious for some time to establish wireless communication between England and France across the Channel, in order that our French neighbours might also have an opportunity of testing for themselves the practicability of the system, but the promised official consent of the French Government has only been received this evening. Otherwise this communication would have been established long ago. The positions for the stations chosen were situated at Folkestone and Boulogne, the distance between them being 32 miles. I prefer these positions to Calais and Dover, as the latter are only separated by a distance of about 20 miles, which is only slightly more than we are doing every day at Poole and Alum Bay, and as we find that distance so easy, we would naturally prefer further tests to be made at much greater distances. We did ask for permission to erect a station at Cherbourg, the corresponding station to be at the Isle of Wight, but the French authorities stated that they would prefer us to have our station in that country in some other position on the north coast.

My system has been in use in the Italian Navy for more than a year, but I am not at liberty to give many details of what is done there. Various installations have been erected and are working along the coast, two of these being at Spezia. Distances of 19 miles have been bridged over in communicating with war vessels, although 10 miles have been found quite sufficient for the ordinary fleet requirements. Other installations are now contemplated in this country for commercial and military purposes, and I am confident that in a few months many more wireless telegraph stations will be established both here and abroad.

"Beacon" High-Resistance Wire.—A circular has been sent us by Messrs. W. N. Brunton and Son relating to a new material for resistance coils, which they are putting on the market. In it we are informed that tests made on it by the Electrical Standardising, Testing and Training Institution indicate a specific resistance of 85·13 (presumably microhms per cubic centimetre) at 20°C., a temperature coefficient of 0·0007, and a specific gravity of 8·1. The specific resistance is, it is seen, considerably higher than that of manganin, and about the same as that of Messrs. Krupp's high-resistance alloy. It can, the makers claim, be heated to 650°C. without fear of injury, and it would seem to have three most excellent negative qualities:—It does not lose its springiness when wound in a spiral, it does not become "cold brittle," and it does not deteriorate in open or damp situations.

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CORRESPONDENCE.

RAILWAY TELEPHONY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the paragraph, page 525, in your issue of the 10th inst., "Telephoning Over Railway Telegraph Wires," in America, our "cousins" are evidently a long way behind us in this. Some four or five years ago I tried some experiments in this direction, on the Phonopore principle, and, by the combined efforts of self and staff, we made an instrument, which has most successfully been working for the last three or four years on many lines of railways in this country and on the Continent. In Africa it was put on a circuit of 243 miles (No. 8 iron wire) and worked well. It is used on the City and South London Railway, where heavy currents surround the telegraph wires and succeeds well; whereas others that were tried were of no use. A small company was formed to work this, and is doing well, and on its own merits the system seems to be working its way and giving great satisfaction. It is economical, as it saves special wires for the telephone instruments, and the maintenance of the same.

—Yours, &c., C. E. SPAGNOLETTI.

Ealing, W., Feb. 27, 1899.

PARLIAMENTARY INTELLIGENCE.

GENERAL POWER DISTRIBUTING CO.'S (SUSPENDED) BILL.

In the House of Commons on Friday last the General Power Distributing Co. (Suspended) Bill came up for second reading, and

Mr. STUART WORTLEY moved its rejection. He said that the Bill would empower a company of private undertakers to establish at Worksop, Notts., an extensive generating station for electricity supply, but the company would be under no obligation to carry out the provisions of the Bill. They would be free to establish generating stations anywhere within an area of 26 miles, which would include places as distant and as important as Ilkeston, Mansfield, Retford, Chesterfield, Doncaster, Lincoln, Rotherham, Nottingham and Sheffield. The Bill was against all precedents governing matters of this kind, and was not necessary or in the interest of consumers. In no case had Parliament allowed private undertakings to compete with local authorities in the supply of electric current, although a public authority was allowed to purchase a private undertaking. In fact, special provision was made for its so purchasing. The fact that the House of Lords had passed the Bill only indicated that there had not been that jealous watchfulness for the integrity and independence of municipal privileges the House of Commons had always shown.

The motion for rejection was seconded by Mr. PICKERSGILL, who said that by sanctioning this Bill the House would prevent the initiation of new schemes by local authorities, and check the development of the schemes already existing.

Mr. DAVENPORT supported the second reading. With the fate of this Bill was unquestionably bound up the fate of a similar Bill affecting the interests of the constituency which he represented (the Macclesfield division of Cheshire). Mr. Wortley, in his opposition to the measure, had omitted to inform the House that the Chamber of Commerce of the city of Sheffield had petitioned Parliament in favour of this Bill. Chambers of commerce were composed of practical business men who were not concerned with the market value of existing electric or gas monopolies, but were eager to provide for the future development of the industries of this country. Were such bodies of practical men to be disregarded by the opponents of this Bill, who considered only the interests of a small, but powerful, clique. He had himself been confronted with the difficulty of resisting the wishes of a municipality upon a matter so nearly affecting municipal interests. But he had declined to oppose the Bill, which he thought was an excellent one, and one which would be of great value to his constitutents. If the Bill proposed to confer a monopoly, he would have opposed it. This Bill had practically received the sanction of two Parliamentary committees, and now came before that House for second reading, having been suspended from last session, and they were now asked to ignore the work of those two committees, and to reject their carefully considered recommendations. They were to do this at the instigation of an association of municipal corporations scattered all over the country, some of whom were interested in gas undertakings, and were therefore jealous of electricity supply; some of whom had electric supplies of their own at a cost to the consumers in every case higher than the maximum which was permitted under this Bill, and others of whom neither had nor proposed to have any electric supply, but who combined with the other corporations when the sacred rights of municipal monopoly were threatened with the possibility of competition by private enterprise. This Bill proposed to give power to supply electric current in an area of 2,100 square miles, in 66 only of which did such powers exist at all, and in only 4½ square miles was there actually a supply of electric current at the present time. Although the population in the whole of this area was about a million, there were only 1,546 consumers of current. In Nottingham and Sheffield the price of electricity had recently dropped very considerably, and he suggested that the price was reduced in consequence of the competition threatened by this Bill. But last year the price of electricity in those towns was 5¾d. per unit, while the maximum amount which would be permitted under this Bill would be 4d. for the first 200 hours in each quarter, and after that the maximum would be 2d. Undue influence had been brought to bear on members of that House to vote against this Bill, and he regretted and resented that influence. He desired to obtain the second reading of this Bill, and he understood that he could make sure of the second reading by conceding the only demand which the corporations made—namely, the inclusion of their boroughs within the area of supply. If the opponents of the Bill would allow the second reading, he would undertake that whatever was necessary would be done to prohibit under the Bill any power to supply any municipal borough within the area of the Bill except by assent of the corporation.

Mr. STUART WORTLEY said that on that understanding he did not think the representatives of the municipal corporations would be justified in continuing their opposition to the Bill.

Mr. C. T. RITCHIE said he considered the Bill a direct attack upon the rights, privileges and duties of municipal corporations. But he thought Mr. Davenport, on behalf of the promoters of the Bill, had practically removed all the objections to the second reading.

Mr. G. WHITELEY asked Mr. Davenport if local authorities as well as municipal corporations were included in his undertaking.

Mr. DAVENPORT: No.

Sir J. WOODHOUSE, speaking for the Association of Municipal Corporations, said the association had taken up the matter, not in reference to a particular area, but in reference to the great principle which underlay the Bill.

On a motion for adjournment the voting was:—For adjournment, 149; against, 150.

The House then divided on the motion for the second reading with the following result:—For the second reading, 132; against, 164.

TELEPHONIC COMMUNICATION.

On Monday, in the House of Commons,

Mr. HANBURY (Secretary to the Treasury) moved a resolution, which he explained was in two parts, to adapt it to the two clauses of a short Bill to be subsequently introduced. The first portion of the resolution was to enable the Post Office to extend its means of telephonic communication by the extension of exchanges. In presenting his resolution, Mr. Hanbury said that we were in Great Britain behindhand in the general use of the telephone by all classes. In Norway and Sweden there is one telephone line for every 145 of the population; in Switzerland one for 170; in Denmark one for 210; in Germany one for 450; and in the United Kingdom one for 636. The committee which sat last year was unanimous against the claim put forward by the National Telephone Co. to go everywhere in the United Kingdom, and also against the right claimed by the Company to refuse to go anywhere—to have, in fact, rights without any corresponding duties. The Government was most anxious to be perfectly fair to the National Telephone Co. It would be most unjust not to recognise fully the work that the Company had done to develop telephonic communication in this country. He believed the Company had been its own worst enemy. It was working under the old licence of 1884, granted in the very height of public competition, and directly after Mr. Fawcett changed the Government policy and decided that he would grant licences everywhere and to everybody that applied. The Company held the only existing licence at the present moment, which was not a purely local one, and this enabled them to set up areas practically everywhere. The Company had all the privileges denied even to the smallest local monopoly of gas and water. It had a right to refuse services, there was no limit upon its maximum, and it was entitled to give preferences, and what was more it used that power. It was clearly stated in the licence of 1884 that nothing should prejudice or affect the right of the Postmaster-General to establish, maintain, and work any system or systems of communication or his right to make agreements or grant licences. A new agreement was signed in 1896 retaining this clause of the 1884 licence. That clause was alluded to in the Treasury Minute of 1892, in the Fergusson draft of 1892, in the Morley draft of 1894, and in the Norfolk agreement of 1896. The Treasury Minute reserved the right of competition, and left no ground to the Company to complain of any breach of contract or want of good faith on the part of the Postmaster-General. The committee which sat last year were told that there was some understanding and some undertaking at the back of this public agreement. All he (Mr. Hanbury) could say was that, when the agreement of 1896 was signed, neither the present Postmaster-General nor any one at the Treasury knew of any such understanding or undertaking. Two ex-Chancellors of the Exchequer and two ex-Postmasters-General denied that they had given any such assurance or entered into any such understanding. In fact, confidential letters were produced on the last day of the sittings, showing that private negotiations had been going on, and that the National Company had tried to get this understanding, but the Post Office had declined to agree to any such undertaking. In his evidence before the Committee, Mr. Forbes stated that the Post Office were absolutely free in all the negotiations, and that there never was the slightest suggestion directly or indirectly of any such cession on the part of the Post Office. It was only fair to say, with regard to Mr. Forbes, that his voice was always the voice of a very simple person indeed; but the hands were the hands of a very able chairman of a public company. He said, with some fairness, "I am not bound by a mere written agreement such as bind ordinary men of business; the moral law alone is the thing for me." Co-operation was undoubtedly mentioned in the Treasury Minute—that is to say, the Post Office were to put the National Company in connection, as a rule, on our trunk lines, and no doubt there was a great similarity of interests between the two bodies. But it never went to the extent of indicating that the Post Office were never in any circumstance to compete with the Company. Mr. Forbes's interpretation of co-operation, however,

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was that there was to be no competition against the Company by the Post Office; but when the Post Office has an exchange of its own the National Company was to compete with it tooth and nail, and was to refuse to put itself in connection with its partner, with whom elsewhere it was anxious to be on such friendly terms. As to the trunk lines, what were the facts of the case? At the present moment the trunk system and the messages sent along it represented only 3 per cent. of the whole. The Post Office bought and paid for the trunk wires, and gave an ample price for them—the original cost price, plus 10 per cent., which represented a very adequate recompense to the Company. With regard to the lines taken over, they were, after all, much the least important of the existing trunk lines, because they were mainly the shorter trunk lines, where competition was possible, and less expensive to lay, and the Government might have licensed another company to start trunk lines against them. Ever since the trunk lines had been taken over by the State the use of these lines had practically been monopolised by the subscribers of the National Company. The trunk system had been largely extended, and a submarine telephone cable had been established between this country and Ireland, which threw the whole of Ireland open and gave the company very important way-leaves under the agreement of 1896. These were very tangible advantages. He hoped he had shown to the satisfaction of the committee that the Post Office was free, both legally and morally, to compete with the company. But were the Post Office free to refuse to compete? Of that he was not so sure. There were two questions that had to be answered: Was the service efficient? and was the service sufficient? To both of these questions the telephone committee unanimously gave a negative reply. The efficiency of a service like this mainly depended on way-leaves, and way-leaves undoubtedly this company had not got, and would not be able to get in future to the extent it might wish. Why? It had applied to Parliament time after time, but Parliament was not going to override the local authorities, to impose everywhere and in every locality in the country a company on these local authorities without their permission. So backed up by Parliament, the municipalities were refusing to grant these way-leaves, and if they were not granted an efficient service was impossible. What was the position of the Company with regard to the existing wires? It had got 143,000 miles of wire. Out of this number, no fewer than 120,000 miles were on sufferance and terminable at very short notice—at the utmost in twelve months. Was it tolerable that this great telephone system, so important to the trade of the country, should exist any longer on sufferance? There are other difficulties. What was called the single-wire system prevailed in places like Glasgow, and was largely used over the rest of the United Kingdom; but it was impossible that the single-wire system could be an effective or efficient system. The Treasury Minute prescribed that no company hereafter licensed should have anything but the double-wire or the metallic circuit system. It was absolutely essential, in order to lay the double circuit, to take up the streets again, and the municipalities refused to grant such permission. The result was, that in places like Glasgow, where the single-wire system was in use, the service was an inefficient one. Further, the Post Office was under no obligation whatever to put the Company into communication even with its trunk wires. As between post offices and exchanges the agreement of 1896 distinctly stated that the Post Office was under no obligation whatever to do anything of the kind, that the Company must provide its own way-leaves between post offices and exchanges; and those way-leaves were being refused by the municipalities. He was bound to say it was reasonable in a case of that kind that the Post Office, although under no obligation, should meet the wishes of the Company, and it was, as a matter of fact, using its powers to connect the Company's exchanges its own trunk wires. Under the licence it holds the Company has got most unusual powers. It can pick and choose the localities it will serve. Naturally it chooses the more profitable areas and leaves the least profitable areas for the Government to undertake. But more serious he thought, than this choice of localities was the fact that, even in the same locality, it had the right, while it gave telephonic communication to one man to refuse it to his neighbour. Between two tradesmen engaged in the same trade, and in keen competition, this was a power which ought not to be in the hands of any private company. Similarly the Company had the right to levy different rates from different localities and even from different persons within the same locality. Finally they had the fact that the Company had no intention whatever of extending their system after 1904. If that was to be the case, and the licence expired in 1911, it was absolutely necessary that some other competitors should come into the field to supply the void between 1904 and 1911. By the subscription system adopted the Company's service was limited to a small class of rich subscribers, and it was not right that a service of communication of this kind, so essential to the trade of the country, should be so limited. They had, therefore, to introduce competitors who would, in the first place, be assured of their way-leaves, and, in the second place, would be perfectly free to introduce a system which would popularise telephonic communication. It was for this reason that he was bringing in this Bill. His resolution proposed to ask for two millions of money to develop telephonic communication on the part of the Post Office. The first place to which their operations will extend would be London itself. He did not say that was the final sum they would spend, but it would carry them on for a considerable time. He might be asked why London had been picked out. The area of the London exchange was something enormous—634 square miles—with a population of 6,000,000, and its public wires number 19,000, representing more than one-fifth of the whole of the wires of the country. In that large area the Post Office was determined to compete at once. The main reason why in London the Post Office would work the telephone itself was the question of way-leaves. The Post Office had the trunk wires, and the trunk-wire system in London was, perhaps, the best in Europe. The Post Office do not propose to work on the system of subscriptions only. They would adopt the system prevalent in Switzerland, by which subscribers paid a very small subscription—for London about £3 a year—and afterwards a small fee for every message sent. He did not believe there would be any unfair competition with the National Company. There was work for both the Post Office and the company in London, and, indeed, in all exchange areas. The Post Office would also establish a system by which the express letter service would work more harmoniously with the telephonic system than hitherto. The result of enabling a telephonic message to be delivered by express messenger and the toll system they were about to inaugurate would be that anybody, whether a subscriber or not, would be able to use the telephone system. As to municipalities, and the establishment of telephonic competition, they had fixed the limit at about 50,000 population, which corresponded roughly with the county boroughs, and such local authorities could start a municipal telephonic system of their own. All that would be necessary would be the insertion of a clause in the Bill to enable them, if they received a licence from the Postmaster-General, to work a telephonic system themselves at the cost of the borough rates without the expense of a provisional order. Municipalities could also go outside their own jurisdiction if they could make private arrangements for way-leaves with the local authorities outside. He recognised the fact that the competition of the municipality might prove very serious to the National Company. There was the case of way-leaves. It was perfectly true that a municipality would be able to grant itself wayleaves and to refuse them to the Company. Of course, it would be equally able to grant wayleaves to a rival company, and still refuse them to the National Company. They proposed if the National Company were reasonable, and if in the interests of the public service it would connect itself with the system of the municipality, that it should have exactly the same wayleaves as the municipality. With regard to the purchase of the plant in 1911, they could get no municipality to undertake this work unless it had some promise that under certain conditions its plant would be purchased, and it would be unfair to give that concession to the municipality and refuse it to the Company, even though the Post Office were under no obligation to buy a single pennyworth of the plant of the National Company in 1911. The Post Office is willing, where the two systems are in competition, to give a pledge to purchase the good and useful property of both—giving, of course, the preference to the municipality, because it will be the last in the field. The Post Office would reserve the right to purchase at the then value of the plant, and would insist that there should be the most absolute right of free inter-communication between all the rival systems throughout the country. The National Telephone Co. would, he thought, recognise that they had done their best, if competition must come, to ease it off, and establish the fairest possible practical terms, as far as that company was concerned. They hoped that one result would follow from the system they proposed to establish. Hitherto what he believed might be a great trade had gone abroad. All the principal appliances of telephony had to be purchased in Sweden, in Norway and in Holland. He hoped that if they had competitors in the field, if they had a large extension of telephonic communications, if they had these three services working side by side, they would get such competition that a trade for making telephonic instruments, wires, and the rest of it, would be established in this country. He then moved:—"That it is expedient to authorise the issue out of the Consolidated Fund of a sum not exceeding two millions for making further provision for the improvement of telephonic communication and to enable local authorities to raise or apply money for telephonic purposes."

Sir J. FERGUSSON said he was Postmaster-General when the agreement to which the right hon. gentleman had referred was come to, in 1891—an agreement which certainly did not err in strictness. He entirely agreed as to the absolute discretion which was reserved to the Post Office, and which the Government of the day was most careful to maintain. As a director of the National Company he never should have thought of questioning for a moment the right of the Post Office to compete with the Company in any part of the country, or to licence any other company, or to licence a municipality. With regard to the telephone service, it should be remembered that at this moment there were only 75,000,000 telegraphic messages sent in the year, while there were 450,000,000 telephonic communications. Again, for every 12 words sent by telegram the sender has to pay 6d., whereas in telephonic communication two persons could carry on a conversation averaging 100 words at a cost of about ½d. The right hon. gentleman had treated the National Company as criminal to some extent, as an enemy of the public, and especially of the Post Office. Since 1892, and especially since 1896, when the agreement was completed, the Post Office and the Company had been in the most complete harmony. The scientific advisers of the Postmaster-General told the Committee of 1895 that the Company was doing its work extremely well, that the system was the best that could be introduced, and that the Company was pushing its business as hard as it could. The right hon. gentleman said that the Company held a monopoly, that it was not like gas and other companies, with restrictions placed upon it, that it had unlimited powers to charge what it liked. He could not understand how the right hon. gentleman could make such a statement as that. What was the reason why the Company was not restricted in its charges? It was that it had no rights, no powers. Gas and water companies had compulsory powers; they could place their undertakings where they liked, and where there were such powers there were corresponnding restrictions. The telephone company had no right to put a wire across a public road or a house unless it had the sanction of the local authority or of the individual, as the case might be. It had been stated that the Company had fought the Post Office tooth and nail. If that meant that the Company tried to get subscribers from the Post Office exchanges by undercutting Post Office rates, it was—well, not the fact. The Post Office, for the most part, withdrew their competition, and the company did nothing more than push their business in the areas respecting which they were licensed.

Mr. HANBURY said that at Cardiff and other places where the Post Office were working the company came in and fought tooth and nail the very body that had granted them licences.

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Sir J. FERGUSSON said Cardiff was one of the areas sanctioned. Why did the Government sanction that area if the Company were not to go there and try and supply every house in the town it could? How could the Post Office complain of the Company operating effectively in an area which they had expressly licensed? The right hon. gentleman had asked if it was tolerable that the present system should exist on sufferance. The question was unfair in view of the terms on which the company was allowed to work. As to the talk about watering the Company's stock; there was no idea of purchasing any company at a fancy price; all the company did was to purchase other undertakings at their market price. In the ordinary course of things mistakes were made at the start, and no doubt the capital expenditure was much greater than would be that of another Company starting now with the knowledge possessed by the present company. Out of £6,242,000 invested in the Company, over £5,000,000 had been actually expended in the work of construction: and such a company should not be told that it had watered its stock, especially as the gross revenue for one year was very nearly equal to the whole amount of what the right hon. gentleman called its "watered stock." It was not the case that the Company alone had been slow, while the Post Office had done everything, to build the trunk wires. So far from that being the case, there were places to which the Post Office refused to extend the trunk wires, except under a guarantee of interest from the Company. Wherever a dozen or so subscribers could be obtained, the Company had been ready to open an exchange. The right hon. gentleman said the Company had the right to levy different rates on different subscribers. The only difference in rates was caused by the difference in working cost. The Company had been considering the propriety of altering the present system so as to provide for a low subscription and a charge according to the number of messages sent. They had not adopted that plan simply from fear of provoking violent displeasure in commercial communities, which were very jealous of any change. The general public had just as much access to the telephones as they had to the telegraphs. He was glad to hear that something was to be done to give the Company way-leaves. It would be an injustice, so gross, that no Government would perpetuate it, to give licences to the municipalities with the power to take up the streets, and deny that power to the Company.

Mr. HANBURY: We only give these way-leaves to the Company where they consider the public interest and work hand in hand with the municipal system.

Sir J. FERGUSSON asked whether that meant that municipal subscribers were to be placed in communication with the Company's subscribers, not only in their own area, but all over the kingdom.

Mr. HANBURY said that co-operation between the municipal and Company's systems would not deprive the former's subscribers of the right to use the trunk wires.

Sir J. FERGUSSON said that he understood so much; but what he wanted to know was whether co-operation meant that the municipal subscriber was to have the right to communicate with every subscriber of the Company in any part of the kingdom.

Mr. HANBURY said that the Company would undoubtedly be able to charge terminals. The muicipalities would not be allowed to charge terminals, but undoubtedly that right could not be taken from the Company.

Sir J. FERGUSSON said he doubted the perfect fairness of the proposal. The Post Office would in 1911 purchase such of the properties of the National Company as were useful to the Post Office. He had never imagined the Post Office would do anything else. The National Telephone Co. had done nothing to justify its being treated as a criminal. The Company was now actually told that the Postmaster-General would not bring the Company's subscribers into the Post Office in any area in which the Post Office competed. Moreover, although it was stated in the House at the time by the then Chancellor of the Exchequer that the grant of way-leaves for a nominal rent was part of the agreement of 1892, they were now told that the Postmaster-General would not grant way-leaves to the company in any area where he was competing. One of the main conditions made in return for the surrender of the trunk wires was that way-leaves should be freely granted at a nominal rent, and the Chancellor of the Exchequer at the time actually made an apology for charging anything at all. The competition proposed was a grossly unfair competition. He was quite sure that in 1892 the trunk wires would never have been surrendered if it had been thought that such an interpretation would have been put on the agreement. He was sorry that a Minister should treat the Company to which he belonged with the hostility which the right hon. gentleman had shown.

Mr. G. BOSCAWEN denied that the Committee which sat last year had dealt unfairly with the National Company or that there was any sort of moral undertaking that the Post Office should not compete with the Company. The only point upon which he thought the scheme of the Government was open to adverse criticism was the proposal to limit the granting of licences to towns of 50,000 inhabitants. He could see no reason why every local authority willing and able to provide a telephone service should not be allowed to do so. The fact that 97 per cent. of the messages sent by telephone were local—that was, that they ended in the same area in which they originated—was a strong reason for granting a licence to every local authority which applied.

Mr. PROVAND congratulated the Government upon the Bill. Cheap and effective telephone service was as necessary to the commercial community as railway and steamboat service. He hoped the restriction of licenses to towns of 50,000 inhabitants would be withdrawn.

Sir JOHN LUBBOCK said he was one of those who at once appreciated the great importance of the telephone, and took a part in introducing it into this country. It was true that the telephone had not made such progress as in some foreign countries. But this was mainly due to the heavy payments claimed by the Post Office. These payments made the service more expensive than it would otherwise have been. Much had been said about watered stock. He understood that the original subscribers were receiving 7 per cent., and anyone who had had experience of patents, and knew how many proved absolutely unremunerative, would consider that in an invention which had proved so great a success that was not an excessive profit. He doubted whether under the Post Office the service would be more efficient. Already messages sent over the wires of the Company were far more numerous than telegrams sent over the wires of the Post Office. One speaker anticipated the Post Office would make a large profit. He hoped it might be so. The same was said when the Post Office took over the telegraphs, but the result had been a loss of £6,000,000, which was still increasing. He regretted the Government were encouraging municipalities to enter into another business, just when the whole subject was about to be inquired into. Unless each municipality had a highly trained staff, their system would be a failure, and if they had, it would be very expensive. He feared that the result in the long run would be to check telephone development and add still further to local indebtedness and the ever-increasing burden of our rates.

Mr. BARTLEY was satisfied the Post Office was really going to make a proper and energetic step towards the provision of a system of telephonic communication which would meet the requirements of the people. While he agreed with Sir J. Lubbock that it was undesirable to extend trading by municipalities, yet, seeing that the work must be done by underground wires, and that the opening of roads should not be under the control of a private company, he heartily agreed with the recommendation of the committee. He would be sorry to see unfair hardship inflicted on the Company, for he recognised how much the Company, under their energetic manager, had done for telephonic communication.

Mr. HEDDERWICK asked what would be the position of municipalities with populations less than 50,000. Would they be swept into the Bill, and would the Post Office have power to open streets without consent of the local authorities?

Mr. HANBURY said the Post Office everywhere in towns had the right to take up the streets for Post Office purposes, subject to the veto of the local authority, which veto was subject again to an appeal to a county court or other judge, and this power would continue under the Bill.

Mr. FAITHFUL BEGG held strongly that the new departure was a mistake. It was bold, but likely to end in disastrous failure. He had always held that the only cure for the troubles that had grown up around this question was the immediate purchase by the Government of the telephone company's undertaking and the carrying on of one system by the Post Office. The agitation which led up to the appointment of the committee was not so much in favour of municipalities being permitted to participate in the business as against Government neglect in the past and the incapacity manifested throughout the Government efforts to take part in the business. He wished to know why the Committee had gone out of its way to report on a branch of the subject not included in the reference and had not touched upon an exceedingly important aspect of the question dealt with in expert evidence given by Mr. Lamb and Mr. Preece. Mr. Lamb, in his evidence, expressed the opinion that the telephone service was Post Office business, and that it was against public interest that there should be a competitive system of telephone exchanges, that the policy of the Department had been to take over the whole system, but that the Government had overruled the Department. All expert evidence proved that competition by different systems ended in confusion, and not in economy. Subscribers were obliged to subscribe to two systems or more instead of one efficient system, so that confusion and waste inevitably followed.

Mr. C. McARTHUR said it was generally agreed that the Post Office was the proper Department to deal with the telephones. He was sorry to learn that municipalities would have telephones of their own.

Mr. WEIR said the National Telephone Co. had been giving hon. members of the House telephonic communication for £2 per month. When he himself asked for it he was informed that a contract must now be entered into for five years at £10 or £12 per year.

Mr. CAWLEY said the co-operation of the Post Office with the National Company had not been of the slightest service. The Post Office had merely helped the Company to maintain a monopoly which had been against the interest of the public.

The resolution was agreed to.

TELEGRAPH (CHANNEL ISLANDS) BILL.

This Bill, which provides for the laying of a telegraph cable between the mainland and the Channel, was read a second time in the House of Lords last week.

MUNICIPAL TRADING.

In the House of Lords on Friday last the Earl of Weymss presented 142 petitions against clauses in various private Bills respecting municipal trading. In commending these petitions to the consideration of the House, Lord Wemyss took as an illustration the purchase by a municipality of a patent relating to electrical apparatus upon which a large amount of public money might be spent in bringing the patent into use for the benefit of ratepayers. Shortly afterwards, however (continued his lordship), it might be found that another invention was better and of more public utility, and the result would be that the money expended by the municipality on the prior invention would be rendered worthless. Thus the great evil of municipal and State trading would be the checking of private enterprise and the progress of invention, being at the same time a hindrance to national progress. The petitioners proposed that all Bills containing a manufacturing and selling clause should have their powers suspended until there had been a full inquiry into the whole question of municipal trading. Owing to the action of the Chairman of committees in both Houses in striking out these clauses, there was no danger from these Bills this year, but the principle remained, and he asked that there should be a full inquiry on the subject either by Royal Commission or by a joint committee of both Houses of Parliament.

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LEGAL INTELLIGENCE.

Castner-Kellner Alkali Co. (Limited) v. Commercial Development Corporation (Limited).

The hearing of this case was resumed on Saturday.

Mr. ASTBURY, continuing his argument on behalf of the appellants, said the point Mr. Justice Bigham held against them was that the mercury was stationary in relation to the cell which held it. He (counsel) did not care what rate it went at if it went at all. Lord Justice Williams had asked what would happen if the ribs were taken away. It was quite obvious there would be more flow in the mercury because the ribs, if they had any action, it was clearly in one way—an action which retarded the circulation of the mercury. The difficulty that had to be overcome was very clearly explained in Atkins and Applegarth. What he said was this: "Where you have got your salt solution over your mercury, you get your deposit on the mercury; but before you can get that deposit of sodium out of your salt solution, the oxygen in the salt solution will pick it up again, and you will get a mixture of caustic and water, as well as of salt and water, and then the two electromotive forces will be counter to each other, and one will block and stop the other." Castner overcame this difficulty, and there was no problem before Kellner. Kellner's was simply a detail of apparatus. Castner discovered—and he was the first to discover it—that, in order to get over this difficulty of the counter electromotive force, they must completely stir up the whole thing,

The MASTER OF THE ROLLS: Now, Mr. Moulton, do you mind taking the question of infringement first, because, if we are against you on that, it is no use going into subject-matter and disconformity; but, if we are with you on that, we can take the other afterwards?

Mr. MOULTON: I cannot accede at once, because I cannot help thinking that the argument before your lordships has confused the three points of subject-matter, disconformity and infringement. This was a very peculiar action in one respect. It practically was an action which right through depended on documents. Of course, one was accustomed sometimes to prior user; but there was no prior user alleged, so that the anticipations were documents. Disconformity depended on two documents; but, curiously enough, here the infringement depended on documents, too, and he thought his learned friends had a little forgotten the way in which this action came up. There was a proposal to sell for a large sum this patent to the public. The plaintiffs warned them that this patent was, in their opinion, for an apparatus which was an infringement of the plaintiffs' patent. They brought an action to stop the plaintiffs giving such intimations unless they brought an action. Plaintiffs pointed out that they could not bring an action, because on their own statement they never used the machine. Defendants then said they would give an admission that they had used that which was found in Rhodin's specification, and that was the admission on which the action was brought. His learned friends had made a very ingenious argument on questions of particular rates, results of turning round at a foot a second, and everything of that kind; but the issue here was whether the apparatus was an infringement of the plaintiffs' patent. He was going to admit that if there was no distinction between a rotary movement and the to-and-fro movement, then that there was no practical distinction between the plaintiffs' apparatus and the defendants. Now, whether there was a difference between rotary and to-and-fro related to disconformity, but did not relate to infringement, because in the claims of the complete specification plaintiffs clearly claimed rotary motion.

Lord Justice RIGBY: We have the models, which we have seen with our eyes. In yours there is a circular or cylindrical space divided by a partition into two cells. They are equal, you know, and in one of these cells the salt solution is operated and in the other is not.

Mr. MOULTON: Your lordship is confusing our invention and our drawings. The difference is enormous. You put one drawing as an illustration.

Lord Justice RIGBY: Very well. Suppose that that which is an illustration is wrong? Your patent is bad, is it not?

Mr. MOULTON: No, not at all.

The MASTER OF THE ROLLS: Do you say the annulus is no essential part of the defendants' case?

Mr. MOULTON: Certainly not. It is not even mentioned in their specification. It is only shown in the drawings.

Mr. TERRELL: It is point blank claimed.

Mr. MOULTON: No. What had been done before. People had got the idea of electrolysis into what I may call an absorbing cathode, a cathode which, instead of leaving the deposited metal on it, as in silver plate, sucked it in mercury. When they have once got it into that state, if they had paused there and stopped the current, this is a very unstable absorption in the presence of the liquids out of which it was driven, and it would have undone the work. More than that, if you go on loading you are changing your cathode from a thing that is pure mercury with an avidity for the metal into what I might call gorged or loaded mercury, which has a less appetite. Consequently, in the same way as we find in everything, a partially satisfied man has not the appetite that he had when he began to eat.

Lord Justice RIGBY: Is not that gorged mercury more useful for this process than a moderately charged mercury?

Mr. MOULTON: It is more useful in this way, that gorged mercury yields up its charge, when you have taken it away to a place where you want it to yield up its charge much more easily. In the loading cell you get on best when you have got hungry, unloaded mercury. As you pile it up it gets less avidity for the metal, and that you feel by finding you have to use more electrical force to drive it in. On the other hand, if you take the first moment when it takes so eagerly, and draw the mercury off, that which it took eagerly it yields up reluctantly.

Lord Justice WILLIAMS: Is it quite true to say the more electrical force to drive it in. The electrical force decomposes the salt and water, so that you get the sodium in a separate form so that the mercury can absorb it.

Mr. MOULTON: Yes.

Lord Justice WILLIAMS: Then if that is so it is not true to say that the electrical current quickens the absorption. What the electrical current does is to increase the amount of material which can be absorbed.

Mr. MOULTON: When an electric current passes through it decomposes exactly in proportion to its size. Therefore, it is right to say that if the electric current is the same the amount of sodium presented for this chemical absorption is the same, but the electrical force required to drive that current gets bigger and bigger as the amalgam gets loaded, and that is what is meant in the passages which talk about getting up a counter electromotive force, because mercury which is loaded would, if it was left without a current of electricity, start one backwards, so that it is ready to rush forward, and when you are passing your electrical current through you have got to keep this back before you can get any current through. You are, as it were, pushing up hill. Therefore, the amount of electrical force required to drive the same current gets bigger and bigger as the loading gets greater, because you have got this back spring, which you have to neutralise before you can get any of your current through. Castner, no doubt, marked an important era. Before Castner what they had done was: they had charged their mercury, they had run it off into a separate vessel entirely, and they had treated it there so as to disgorge it, and then they had put it back again. Castner certainly made a very considerable advance in that. Castner took a cell, and he divided it in two by a partition that did not go quite to the bottom.

Lord Justice RIGBY: But still into the mercury.

Mr. MOULTON: Physically he cut it in two by a layer of mercury, chemically he did not cut it in two, but the slowness of action would be too great, and either rocked the thing or put in a paddle which stirred the thing round in order to drive loaded mercury into the other cell; he generally did that by means of a pump. Now, Kellner did something which, so far as the evidence went, was absolutely novel; he cut his cell in two, and he got his results by moving one part of the cell relative to the other.

Lord Justice WILLIAMS: It seems to me that there is one point that you and Mr. Terrell are absolutely agreed on that, if one wishes to find out what was the novelty in either one of these patents, one must not look at anything said in the letters patent about it. You say the great thing, if you look at the Kellner patent, is something which is not mentioned from beginning to end of it. Then I hear Mr. Terrell say the great point about the Rhodin patent is so-and-so. I look at the Rhodin patent and find nothing about it.

Mr. MOULTON: You have heard the Kellner patent only when treated with unloving hands. Let me say what I say he did. He was the first person to take an electrolytic cell. Of course, an electrolytic cell is a thing which contains necessarily a fluid, necessarily an anode, and necessarily a cathode; he took an electrolytic cell containing its fluid and moved it about in a bath of other fluid, carrying its own fluid still, thus cutting in two an electrolytic cell and moving the sides and the contents by themselves for the purpose of getting electrolytic decomposition of these salts.

The MASTER OF THE ROLLS: He slid the cells over the mercury, instead of sliding the mercury under the cells.

Mr. MOULTON: Yes, but whoever slid a cell before containing a fluid in the middle of a bath of another fluid, keeping the two fluids absolutely from mixing, because that is the one thing that is essential. He kept his electrolytic cell perpetually changing its walls in the sense of perpetually moving it, and changing the bottom on which it rested; he moved that about among the other fluid in which he intended ultimately to deposit its contents, and yet he did it without any confusion, without any mixture of the two fluids and without any destruction of the separate and independent action of an electrolytic cell. Now with regard to subject matter about which there has been a long argument. Kellner's invention was a thing which unquestionably possessed subject matter; it was a way of doing something which was by no means obvious, and which gave to the public the choice of setting this alteration by which I may call mechanical movement of rigid structures instead of fluid movement; that is, by operating on the fluid. They cannot effectually dispute utility for this reason. I am not talking about Kellner's way of applying it, but if I am right in saying that Kellner was the first to do that at all, then that idea, that proposal, and that invention is clearly one which you cannot say is not good subject matter on the ground of utility, because we have an instance of it in this to which the defendants attach so great value.

Lord Justice RIGBY: You may be perfectly right in all that you say so far, but if you choose to put into a patent something entirely different you may invalidate the patent.

Lord Justice WILLIAMS: The difficulty that your argument seems to overlook is this. Your patent has never been commercially tried.

Mr. MOULTON: No.

Lord Justice WILLIAMS: I am not sure; I do not know whether it would be a success if it were tried, or whether it would not, but you have already told us that it is very much a question of degrees and proportions, and one thing and another. They say, rightly or wrongly, that their Rhodin process includes a variety of functions which are not included in your patent in any way, and no reference made to them. They say, for instance, there is much greater exposure of the loaded mercury to the action of water, and they say also that the lips of their cells stir up the mercury and prevent the occurring of that irregular richness of the mercury which practically would prevent their machine working. Let us assume for a moment there is no proof that your machine would work commercially, and supposing we are satisfied upon the evidence that their machine, plus their differences, will work efficiently commercially, would you be entitled to judgment under these circumstances?

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Mr. MOULTON: Competitive utility is not the test of utility. We gave by our invention a useful choice to the world, by which they could attain this alternation of circumstances by new mechanism, which, under some circumstances, would be valuable, and perhaps, under others, would not. Now if we have done that, and their patent—which I do not admit—shows how great an advantage can be taken of that, then there is a tributary patent; they are using our invention, although they have added to it. They have ploughed with our heifer. I do not mean to say the skill of the ploughman is nothing, but still, whose heifer was it? The bell-shaped, salt-charged cells passing over the mercury and penetrating into it caused the mercury to become charged with the sodium, and the water in the spaces between the bells made the mercury discharge it, and that being the principle of Kellner's invention, he was perfectly within his right in utilising the nine months allowed between the provisional and complete specifications to perfect his invention. It was obvious that it was a fair development of the principle to say, in his complete specification, that it was easier mechanically to make the mercury go round and round instead of to and fro, and he also showed that two of the machines might be moved round one axis. The inventor realised that the same thing might be done by causing the electrolytic cells of the upper vessel to rotate over the mercury, as by turning backwards the vessel containing the mercury, and he submitted that there was no more difference between the defendants' apparatus than there would be in two mechanical organs, in one of which a perforated music sheet moved round over the tops of the pipes, while in the other the pipes were turned round under a fixed sheet of music. Castner had got a single rigid structure, and they had to see what Kellner did. Kellner taught the world a way of doing something which no one had thought of before. As to the issue of disconformity, that which was described in Kellner's complete specification was, so far as the electrolytic action was concerned, nothing more than the working out of the original idea described in his provisional specification—that was to say, taking his electrolytic cell and moving it about or keeping the cell still and moving about the vessel containing the mercury. That was not a departure in any way from the original idea, but merely a development which the inventor was entitled to make. The true invention disclosed in the provisional specification was a cell in two parts and a bottom movable with regard to the top, so as to bring the mercury alternately under the action of the salt and water and of the water. As to the point of novelty, taking the extremest form of Kellner's apparatus, the form nearest to Castner, viz., that inside the compartments were still and the vessel containing them rotating, it would be seen that Castner got a rigid cell and no bells in the containing vessel, and the only thing he did was to move the mercury round on the stationary bottom. If the bottom was cut off, and put into a larger vessel, and the inner vessel had divided compartments, the bottom being movable with regard to the top, that would make Castner's apparatus like Kellner's. He submitted that Kellner had not claimed anything that was not new, but if he had overlapped anything that had gone before he must submit to a limitation of his claim in that respect. Kellner's apparatus would do its work if the mercury was frozen, and he did not think he need trouble himself about anything that moved the fluid mercury relatively to its containing vessel in the only way that a fluid could work. Whatever amount of rotary flow there might be in Kellner or Rhodin, both considered that rotary flow not only was not essential but not advantageous, and both of them tried to check it as much as they could. The question of something quite different from rotary action, such as agitation, and the inward and outward current raised other issues.

Lord Justice RIGBY: That is for the purpose of churning it.

The MASTER OF THE ROLLS said he understood it was agreed that the defendants' apparatus, which had not yet been at work, was to be constructed according to their specification. The language of the specification might be open to criticism, which might turn out to have no application to the actual working.

Mr. MOULTON said that on the question of infringement, what was intended by Rhodin, and how was it intended to work?

Lord Justice RIGBY did not think that mattered much.

Mr. MOULTON said in Rhodin's there was a vessel gliding over mercury, which both Rhodin and Kellner took pains to keep still. It was, in fact, Kellner, and he might have sold Rhodin for Kellner. All the forms of action in Rhodin were essential to Kellner. If, in the course of four years, Rhodin had learnt that he ought to move more quickly, surely that did not affect the fact that he was taking the plaintiffs' mechanism, and obtaining the same results that the plaintiffs must get; and the learned judge in the Court below came to the conclusion that Rhodin was but a description of what Kellner was. If the plaintiffs had got a valid patent, it appeared to him there could be no doubt but that Rhodin had used their invention and their apparatus—for it was a claim for apparatus—and was proposing to utilise it in the same way. That the defendants had used a larger containing vessel, and thus got a larger water space was immaterial, the amount of decomposition being proportionate—not to the water space, but to the electric current, and if there was vertical churning that would take place whatever the size of the vessel.

Mr. BOUSFIELD, Q.C., followed on the same side.

Owing to indisposition the Master of the Rolls did not attend the Court on Wednesday, and it was agreed that Mr. Terrell should make his reply upon the whole case.

Mr. TERRELL contended that though there might be some difference between Kellner's patent and the alleged anticipations of Kellner there was no evidence, and no suggestion even, that there was utility in such difference. Kellner's specification did not describe a stationary mercury cathode, as he spoke of rotating the vessel containing the mercury. What he described was a flowing mercury cathode as distinguished from a mercury cathode, stirred or agitated. With regard to Kellner, one could not help thinking that between the date of his provisional and the date of his complete specification, some direct knowledge of Castner came to him, for the reason that Kellner took the two things which Castner had from the first time introduced. He took a differentiated current by that which was well known to all electricians as an equivalent metal. The learned counsel said that what the defendants complained of was that, when a man like Kellner chose to take out a patent of an invention, being exactly the opposite to what Castner proclaimed he wanted to do, they, who were doing the same thing as Castner, should be accused of doing the same thing as Kellner.

At the conclusion of the arguments their Lordships reserved judgment.

Cooper v. The Electrical Installation Co. (Limited).

On Friday, in the High Court, Mr. Justice Kennedy and a jury heard this action. The case has already been fully reported in *The Electrician*. At an early stage of the present proceedings, Mr. Justice Kennedy suggested it would be best to refer the case, and later the officer of the Court pointed out that the agreement put in was not the original, but a counterpart. The document lacked authority as it had not the proper stamp. The hearing was, therefore, adjourned for the rectification of the document.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free; abroad 11s.

"The Students' Guide to Submarine Cable Testing."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition now ready.*

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinsor, M.I.E.E., &c., fully illustrated; price 12s. 6d.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves."—By Dr. O. J. Lodge, with many original illustrations. *Enlarged Edition*, 2s. 6d. net, 2s. 9d. post free.

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The "Big Blue Book" for 1899 is Now Ready. The Directory Division has been corrected up to Feb. 8, 1899, and all the latest new names, changes of address, &c., will be found included. The Handbook Division has been much extended, many valuable tables having been added. The volume contains, also, the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways, finally corrected to Feb. 9, 1899. The price of the Directory and Handbook remains the same—10s., post free 10s. 9d.; abroad, post free, 12s. (United States 13s. 6d.)

TENDERS INVITED.

The *Paddington* (London) Guardians invite tenders for the wiring of the workhouse in Harrow-road. Specifications, &c., may be obtained of Mr. A. W. Sclater, 182, Oxford-street, London, W., and tenders must be delivered at the offices of the Guardians before 5 p.m. of 28th inst. An advertisement contains further particulars.

As announced in an advertisement, the *Barking* District Council invite tenders for the supply and erection of one 80-kilowatt steam dynamo, with necessary pipe-work and accessories. Plans, &c., may be obtained from the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C., after 11th inst., and tenders, addressed to the chairman of the Council, must be lodged at the Council Offices before noon of the 27th inst.

The *Sunderland* Corporation invite tenders for (*a*) india-rubber covered cables, (*b*) cast and wrought iron pipes and street service boxes, (*c*) stoneware casings and bearers, and (*d*) house fuse boxes. An advertisement contains further particulars, and specifications, &c., can be obtained on application to the borough electrical engineer (Mr. J. F. C. Snell), Dunning-street. Tenders addressed to the Chairman of the Lighting committee must be delivered at the

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office of the town clerk (Mr. Fras. M. Bowey), Town Hall, Sunderland, by noon of Thursday, 30th inst.

The *Plymouth* Corporation invite tenders for twelve months' supply, from April 1 next, of transformers and arc lamp carbons. Specifications may be obtained from the borough electrical engineer (Mr. John H. Rider), to whom tenders must be sent by 23rd inst. Further particulars are given in an advertisement.

As announced in an advertisement the Electric Lighting committee of the *Rothesay* Town Council invite tenders for the supply and erection of two 20 H P. coupled engines and dynamos, switchboard, cables, arc lamps and posts, feed pump, steam and exhaust pipes, &c. Specifications, &c., may be obtained from the consulting engineer (Mr. T. Crichton Fulton), 44, West George-street, Glasgow, and tenders must be lodged with the town clerk (Mr. John T. Wilson) before noon of Monday, 27th inst.

The *Doncaster* Corporation invite tenders for the supply and erection of (*b*) three mild steel Lancashire double-flued boilers; (*c*) three sets of steam dynamos, two sets of larger steam dynamos, condensing plant, &c., and a 6-ton overhead traveller; (*d*) storage battery of 136 cells, having a capacity of 750 ampere-hours; (*e*) electrical instruments and other apparatus; (*f*) underground armoured cables, street boxes, &c. Further particulars are given in an advertisement, and specifications can be obtained from the consulting engineer (Mr. James N. Shoolbred), 47, Victoria-street, London, S.W., or at the office of the Borough Surveyor, Doncaster, after 14th inst. Tenders must be sent to the town clerk (Mr. Thos. B. Sugden) by noon of 28th inst.

The *Aberdeen* Corporation invite tenders for the supply and erection of the following materials for the equipment of their George-street and Woodside tramway route:—(*a*) permanent way and roadwork, (*b*) overhead line construction, (*c*) feeder and test cables, (*d*) tramway cars and all accessories, and (*e*) switchboard, instruments, &c. Copies of specifications, &c., may be obtained from the city electrical engineer (Mr. J. Alex. Bell) after 15th inst., and tenders must be sent to the town clerk (Mr. W. Gordon) by 10 a.m. of 29th inst. Further particulars are given in an advertisement.

As announced in an advertisement, the *Dundee* Gas Commissioners invite tenders for the supply and erection of four Lancashire boilers, two 450 H.P. steam engines and dynamos and one 700 H.P. steam engine and dynamo. Specifications, &c., can be obtained from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope Crescent-road, Dundee, and tenders must be sent to the town clerk (Sir Thos. Thornton), City Chambers, Dundee, not later than March 15.

The *Great Central Railway Co.* invite tenders for stores and materials during the twelve months ending April 30, 1900, including electric light and telegraph materials, asbestos packing, crucibles, india-rubber, screws, signal materials, tools, wire, &c. Specifications, &c., may be obtained from the secretary (Mr. Oliver S. Holt), with whom tenders must be lodged by 14th inst.

The Guardians of the *Poplar* (London) Union invite tenders for the supply and erection of (*a*) steam turbines and dynamos (direct coupled), (*b*) electric motors, (*c*) accumulators, (*d*) electric cables, wiring, and fittings, and (*e*) main switchboard and distribution boards. Tenders to Mr. G. H. Lough, before 6 p.m. of 22nd inst.

The Vestry of *Hammersmith* (London) invite tenders for the supply and erection of three water-tube boilers, two 1,000 H.P. slow-speed engines, coupled direct to two 600 kilowatt alternators, underground feeders and cast-iron pipes. Tenders before 5 p.m. March 15.

The committee of the *Stockport* Sunday School require tenders for the electric lighting of their premises. Applications for permission to view premises to secretary by March 24.

The *Greenock* Board of Police invite tenders for the supply of low-tension mains, including the erection of arc lamp poles, &c. Tenders to Mr. G. MacCulloch, by March 16.

The *Glasgow* Corporation invite tenders for the reconstruction of tramways. Tenders to Sir J. D. Marwick, City Chambers, Glasgow, by March 15.

The Electric committee of the County Borough of *Belfast* invite tenders for the supply and erection of switchboard extension. Tenders to Sir Samuel Black by noon of March 16.

The *Ambleside* Council invite tenders for the supply of gas engines, generators, boosters, switchboard and battery, and mains. Particulars from Messrs. Hopkinsons and Talbot, 29, Princess-street, Manchester, or 26, Victoria-street, London, S.W.

The Lighting committee of the *Canterbury* Corporation require tenders for the supply and erection of:—(*a*) Boiler-house plant, (*b*) engine-house plant, (*c*) extension of switchboard, (*d*) extensions to mains. Tenders by March 14.

The *Harwich* Corporation invite offers for the transfer of their provisional order. Tenders by May 17.

The *Southend* Corporation invite tenders for the temporary transfer of their provisional order. Tenders to town clerk by April 6.

The *Lewes* Corporation invite offers for the erection of electricity supply works. Tenders by March 24.

The *Southampton* Corporation require rails and fish plates for the reconstruction of the tramways. Tenders by 21st inst.

The *Great Northern Railway Co.* (of Ireland) invite tenders for the construction of about 2¾ miles of tramway between Bailey Post Office, Sutton, to Howth Station. Tenders to secretary, Amiens-street Terminus, Dublin, by 27th inst.

The *Dewsbury* Corporation invite tenders for the extension of the electricity station building. Tenders to Town Clerk by 25th inst.

The *Plymouth* Corporation invite tenders for wiring the Council Chamber. Tenders to borough electrical engineer (Mr. J. H. Rider) by 22nd inst.

The *Bury* (Lancs.) Electric Lighting committee invite tenders for a Lancashire boiler with steam and other pipes. Tenders to Town Clerk by 20th inst.

The *Edinburgh* Corporation invite tenders for the construction of about 1,080 yards of electric main subway in Macdonald-road and Leith-walk. Tenders to the Town Clerk by 17th inst.

The *Perth* (Western Australia) City Council invite tenders for a concession for the erection of electricity supply works. Tenders to Town Clerk by May 2.

The *French* Post and Telegraph Authorities invite tenders for the supply of 825 tons of bronze or copper wire. Tenders to le Sous-Secretariat d'Etat des Postes et des Télégraphes, 103, Rue de Grenelle, Paris, by 16th inst.

The *Santiago* (Spain) Municipal Authorities invite tenders for the erection of electricity works, with a view to utilising the water power of the River Tambre. Tenders to el Presidente del Consejo de Administracion by April 20.

The *Norwegian* State Telegraph Administration invite tenders for (1) galvanised iron top plates, (2) galvanised soft Swedish Siemens-Martens steel telephone angles, and (3) brackets, with accompanying collars and nuts, of two different descriptions. Tenders to the Telegrafintendantes Kontor, Christiania, by March 11.

TENDERS RECEIVED AND ACCEPTED.

Messrs. Robinson, Sadler and Co. have obtained the contract for wiring the Free Public Library, Plymouth.

The Watford Town Council have accepted the tender of Messrs. W. T. Allen and Co. for the supply of 120 incandescent lamp columns at £1. 19s. each.

At the meeting of the Accrington Town Council on Monday the following tenders were accepted for the supply of electric lighting plant:—

Johnson and Phillips (three engines and dynamos)	£2,804 10
W. T. Glover and Co. (mains and cables)	4,550 0
Chloride Electrical Storage Syndicate (storage battery)	910 0
Crompton and Co. (switchboard)	641 0

The Shoreditch (London) Guardians have received the following tenders for wiring and fitting-up the workhouse, infirmary, casual wards, dispensary, nurses' homes, porter's lodge, &c.:—

Peacock and Co. (*accepted*)	£1,330	Elec. & Gen. Engineering Co.	£1,779
John Bolding and Son	2,039	Nat. Elec. Free Wiring Co.	1,500
Handford and Driscoll	1,998	Electrical Erection Co.	1,355

The Whitechapel District Board of Works have accepted, upon the recommendation of the Electrical committee, the tender of Messrs. Manlove, Alliott and Co. for the erection of a refuse destructor, at £17,740. 16s.

The contract for ventilating work, including an installation of electric fans, at Bridgewater House, St. James's Park, has been let to the Grahtryx Ventilating and Engineering Co., at £1,250.

The Doncaster Guardians have accepted the tender of Mr. T. Scott Anderson for the electric lighting of the workhouse, at £2,730. There were 32 tenders, ranging from £2,500 to £6,260.

The Lincoln Town Council have accepted the tender of Messrs. Ruston, Proctor and Co. for the supply and erection of two dry back marine boilers for their electricity works, at £1,145.

The Tunbridge Wells Council have accepted the tender of Messrs. Seale and Austen for the supply of 50 incandescent lamp columns, at 24s. each.

The Exeter Town Council have accepted the tender of Messrs. Babcock and Wilcox for the supply of a 500 H.P. boiler for £1,120, and of Messrs. S. Z. de Ferranti (Limited) for a 250 kw. alternator for £3,460.

APPOINTMENTS VACANT AND FILLED.

A thoroughly competent manager is required for large india rubber works to be established on the continent. Some further particulars are given in an advertisement.

The Barnsley Corporation require a clerk of works for their electricity undertaking. Salary £150, rising to £200 per annum on

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the commencement of supply. Applications to the consulting engineer, Mr. Thomas L. Miller, 7, Tower-buildings, N., Water-street, Liverpool, by 17th inst. Further particulars are given in an advertisement.

There is a vacancy for an improver at the Bury electricity supply works. Applications to borough electrical engineer (Mr. S. J. Watson). See advertisement.

The Brighton Town Council have appointed Mr. C. C. Fowler assistant manager of the Corporation electricity works on the terms set out in our last issue.

Mr. P. W. Robson, of South Shields, has been appointed superintendent engineer for the equipment of the mechanical appliances in the new Municipal Technical School, Manchester.

Mr. John Pilling, assistant engineer at Bolton, has been appointed resident electrical engineer to the King's Lynn Town Council.

Mr. W. Wyld, assistant engineer at the Salford electricity works, has been appointed electrical engineer to the Patent Shaft and Axletree Co., who propose to put down a large polyphase power plant.

BUSINESS NOTICES.

W. T. Henley's Telegraph Works Co. (Limited), have opened a branch office and warehouse at 30, Mosley-street, Newcastle-on-Tyne, where a large stock of wires and cables is kept. The branch is under the management of Mr. W. Odgers, who has been in the company's service for many years.

Mr. Heinrich A. Brandt has opened offices and factory at 33, Minories, London, E.C., where stocks of mica and micanite will be held.

Messrs. F. F. Bennett and W. H. Walley, electrical engineers, 13, Victoria-buildings, Deansgate, Manchester, have dissolved partnership. Debts by Mr. Bennett.

Messrs. A. Costar and C. Martin, electrical engineers, 37, Broadway, Deptford, and 10, Church-street, Croydon, have dissolved partnership. Debts by Mr. C. Martin, who continues at Deptford. Mr. A. Costar will carry on business at Croydon.

Messrs. E. J. Crosier and W. J. Stephens (trading as Crosier, Stephens and Co.), 2, Collingwood-street, Newcastle-on-Tyne, have dissolved partnership. Debts by Mr. E. J. Crosier, who continues.

Messrs. W. R. Snetzler and A. Pearse (trading as Snetzler and Co.), electrical engineers, &c., Little James-street, London, W.C., have dissolved partnership.

BANKRUPTCIES, LIQUIDATIONS, &c.

The following are some of the creditors in connection with the execution of a deed of assignment by John A. Edmondson, electrical engineer, Globe electrical works, Kirkstall-road, Leeds :—

W. T. Glover and Co.	£553	William Patterson	£27
Johnstone, Benjamin and Co.	211	Doulton and Co.	27
Globe Engineering Co.	209	Simplex Steel Conduit Co.	27
Edgar Allen and Co.	177	W. N. Brunton and Son	26
F. H. Royce and Co.	167	Nalder Bros. and Thompson	24
General Electric Co.	90	English Electric Carbon Co.	23
Wm. McGeoch and Co.	83	Thomas Danks and Co.	20
A. Dougill and Co.	75	Beanland, Perkin and Co.	19
Cox-Walkers	73	Aluminium Supply Co.	18
Verity's (Limited)	61	H. M. Salmony and Co.	17
Alfred Hickman (Limited)	61	Beecroft and Wightman	15
Midland Electric Wire Co.	45	National Telephone Co.	16
Lee and Whitfield	44	C. Lindley and Co.	13
Edison and Swan Co.	43	Automatic Standard Screw Co.	13
Harrison and Singleton	41	L. Hervé	12
Hulbert Bros.	35	Mosses and Mitchell	12
Turner Bros.	33	Charles Joyner and Co.	12
Le Carbone	32	North British Wire Mfg. Co.	12
Joseph Sankey and Sons	32	Connolly Bros.	11
Meirowsky and Co.	31	T. Bolton and Sons	11
Greenwood and Batley	30	India Rubber Co.	10
David Moseley and Sons	29	Frederick Smith and Co.	10

The debts are returned at £7,135. 0s. 8d., assets at £7,947. 1s. Mr. Myles Lee, C.A., 17, East Parade, Leeds, is trustee.

Claims against the Northern Counties Electric and Motor Co. (Limited) are to be sent by April 14 to the liquidator (Mr. Jas. Robinson), the Nook, Lightcliffe, Yorks.

A first and final dividend of 8s. 1½d. in the £ is payable at Bankruptcy Buiidings, Carey-street, London, in the failure of J. Dewhurst, electrician, &c., 52, North End-road, West Kensington, London.

Creditors of Binko, Ridsdale and Co., Limited (in voluntary liquidation) must send particulars of their claims to the liquidator (Mr. W. B. Peat), 3, Lothbury, E.C., by April 14.

For Sale.—As announced in an advertisement Messrs. Fuller, Horsey, Sons and Cassell have been instructed by the receiver for the debenture holders (pursuant to order of Mr. Justice Wright) to sell by tender in one lot the valuable leasehold engineering works, lately occupied by the London Stamping Co. (Limited), and known as the Castle, Barnsbury-street, Islington, London, N. The plant and machinery are practically new, and the works may be viewed by order. Particulars, with forms of tender, may be had of the receiver (Mr. Robertson Lawson), 34, Old Broad-street, E.C., Messrs. Dale, Newman and Hood, solicitors, 75 and 76, Cornhill, E.C., and of the auctioneers, 11, Billiter-square, E.C. Tenders must be sent before noon of Thursday, March 23, to the registrar of companies (winding up), Bankruptcy-buildings, Carey-street, London, W.C.

Salvage Sale.—Messrs. Wheatley Kirk, Price and Goulty will, on Wednesday, March 22, sell by auction a quantity of slightly damaged electrical stock, upon the premises of the General Electric Co., 203, Upper Thames-street, London, E.C., consisting chiefly of an extensive collection of electrical fittings and appliances damaged at the recent fire. Some particulars will be found in an advertisement on another page.

Fire.—We are informed that the fire which has been reported in the daily papers as having occurred at Messrs. W. T. Henley's Telegraph Works, North Woolwich, on Tuesday, was of a very trivial nature, was extinguished before the arrival of the fire engines, and will cause no delay in the company's business. The man who was injured is progressing favourably.

British Insulated Wire Co.'s Staff Dinner.—On Friday evening last, the annual staff dinner of the British Insulated Wire Co. was celebrated in sumptuous style at the Adelphi Hotel, Liverpool. About 100 guests and members of the staff met together in the spacious reception room, which presented the cheery appearance of a sort of "gathering of the clans." Many had come from remote parts of the British islands, and the faces of numerous supply station engineers were to be noticed among the crowd. Dinner was served in the adjoining banqueting room, where five tastefully arranged tables had been set. The chairman of the company (Mr. W. M. Brigg) presided, and by his genial countenance and cheery speeches made everyone feel thoroughly at home. During dinner instrumental music, under the direction of Mr. G. Barton, was provided, and the after-dinner speeches were interspersed with song. The toast list gave occasion for some excellent speeches. Mr. Brigg proposed the toast of "The Queen," after which Mr. Muspratt proposed "The Electrical Industry," and in his remarks directed attention to the flourishing condition of the industry at the present time, and commented on the conditions which seemed unduly to favour foreign competition. Mr. Ferranti, in responding, said that standardisation and uniformity of manufacture were much needed to cheapen and promote electrical industry. After several other toasts, the proceedings terminated at a late hour. On the following day a party of the guests paid a brief visit to the British Insulated Wire Co.'s works at Prescot, which recently have been very much extended to meet the requirements of the enormous and still growing cable business of the company.

Automatic Telephone Exchanges.—The Telephone Construction Co. (Limited), whose automatic exchanges have been fully described in our columns, have now issued a pamphlet setting forth the merits of the automatic system, and explaining the action of the apparatus with the help of copious diagrams.——Mr. A. R. Bennet has inspected eight automatic telephone exchanges in the United States, the largest one being in Augusta (Georgia), and having 530 subscribers, and a copy of his report has also reached us. He is satisfied that a service for 10,000 lines could be conducted as satisfactorily by the automatic as by the manual system.

Phonophore Apparatus.—The new catalogue of telephonic apparatus on the phonophore system is issued by the New Phonophore Telephone Co. (Limited), fully illustrating and describing the company's system.

Steam Users' Specialities.—Messrs. Holden and Brooke (Limited), of West Gorton, Manchester, have just issued a handy catalogue containing particulars of a number of their manufactured articles for steam users. The list includes injectors, ejectors, pumps, driers, ante-primers, traps, &c. A number of illustrations and tables of sizes and prices are included in the list, which is a useful shape for easy reference.

Sunbeam Lamps.—The Sunbeam Lamp Co., of Gateshead-on-Tyne, have just published a new price list giving particulars of a large variety of Sunbeam lamps, lamp-holders and lighting accessories, which will be of service to the trade. The new list is well arranged and nicely printed.

Export Merchant Shippers.—A valuable annual publication for those seeking information regarding the leading firms of exporters and shippers is the "Export Merchant Shippers' Directory," published by Messrs. Dean and Son, of 162, Fleet-street, London. The 1899 (34th annual) edition is now ready, and shows an increased bulk over its predecessors. The increase includes the addition of a number of lists of exporters from districts in the United Kingdom not previously included, and the old lists have been considerably amplified. It is now claimed that they include every firm of

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importance in the export shipping line. The book has been entirely re-set in new type, and the arrangement of the contents has been rendered even more accessible than hitherto. Notwithstanding a large addition to the number of pages, the compression of the matter and the use of thinner paper leave this excellent annual as handy for handling and reference as previous editions. The general accuracy and get-up of the book are creditable to all concerned in its production.

Cassier's Magazine.—The March issue contains articles on "The Rome-Tivoli Electric Installation," by Alfred O. Dubsky; "The Problem of Battleship Design," "The Generation of Acetylene," "The United States Revenue Cutter Service," "Ancient Mining," "The Outlork in Marine Engineering," "The Venturi Water Meter," and "Points in Water and Engine Selection."

The "Engineering Magazine."—The contents of the March issue of this magazine include "Electricity at the Paris Exposition of 1900," by Georges Dary; "Readings from Experience in Naval Engineering," "America and Germany as Export Competitors and Customers," "Railway Location and Surveys in Rajputana, India," "Machine Shop Management in Europe and America," "The Development of Wood Working Machinery," "Standard Specifications for Steel," "Machine Tool Depreciation as an Element of Manufacturing Cost," "The Field for an Automatic Gas Meter," and "A Review of the Nicaragua Canal Scheme." The usual Review of the World's Engineering Press is also given. Copies of the magazine may be had at 1, 2 and 3, Salisbury-court, Fleet-street, London.

"Motor Car Journal."—This is the title of a new penny weekly published by Messrs. Cordingley and Co., Shoe-lane, London, E.C.

Willing's Press Guide, 1899.—We have to acknowledge the receipt of the 1899 issue of this extremely useful newspaper press guide, which is in its twenty-sixth annual issue. Copies can be obtained of Messrs. Willing, 125, Strand, London, W.C., price 1s. It will be found a serviceable office reference book.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from March 1 to March 7, with the ports of destination:—

Argentina—Buenos Ayres, £763. *Australasia*—Adelaide, £38; Christchurch, £13; Hobart, £137; Launceston, £98; Lyttelton, £25; Melbourne, £1,207 (including £946 telegraph material); Perth, £178; Port Chalmers, £31; Sydney, £286; Wellington, £446 (including £298 telegraph material). *Brazil*—Rio Janeiro, £331 (telegraph material). *Canada*—Montreal, £35. *Ceylon*—Colombo, £41. *China*—Shanghai, £469. *Columbia (Republic of)*—Santos, £113 (telegraph material). *Denmark*—Copenhagen, £168. *Egypt*—Alexandria, £18; Port Said, £137. *France*—Boulogne, £42. *Germany*—Bremen, £30 (telegraph material); Hamburg, £140. *Gibraltar*, £1,789 (including £1,530 telegraph instruments). *Holland*—Amsterdam, £142; Rotterdam, £36 (telegraph material). *India*—Calcutta, £201. *Japan*—Kobe, £2,342. *Norway*—Christiania, £25. *South Africa*—Delagoa Bay, £206; Durban, £387 (including £117 telegraph material); East London, £1,099 and 10 tons copper cable; Port Elizabeth, £2,290 (including £773 telegraph material). *Spain*—Cadiz, £10. *Straits Settlements*—Penang, £20; Singapore, £161 (telegraph material). *Sweden*—Gothenburg, £70; Stockholm, £123 (telegraph material). Total £13,647, against £24,543 in the corresponding week last year (March 2 to March 8).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Aberdeen—The report of the electric lighting department for the year 1898 has been issued by the city electrical engineer (Mr. J. A. Bell). During the period the equivalent of 11,400 8 c.p. lamps were connected to the mains, making the total at the end of December, 35,400. Applications for current from the west end of the city are steadily coming in. The work on the harbour mains was not finished in time to affect the winter's load. The department has, however, in addition to private consumers, an equivalent of 5,429 8 c.p. lamps guaranteed by the Harbour Commissioners, and the floating dock is also to be electrically controlled, demanding some 40 B.H.P. In estimating the consumers for 1899, Mr. Bell assumes that the department will connect up 25 per cent. more lamps than in the past year. As there are now nine miles of distributing cable laid, compared with only four miles last year, he considers this estimate on the safe side. The number of lamps connected for the last month are double those connected in January, 1897. To meet next winter's demand additional engine and boiler power will be required. This will also allow for supplying the necessary power for the trams. The estimated cost of the necessary extensions is put at £7,500. The committee are at the present moment inviting tenders for this additional plant.

Alleged Fraud.—Claude Vautin was again brought up at the Guildhall, London, on Monday charged with fraudulent bankruptcy. After a large amount of evidence had been taken the case was again adjourned, bail being refused.

Banquet to Prof. O. J. Lodge.—On Saturday evening last, at Liverpool, Prof. O. J. Lodge was entertained at dinner by the Lord Mayor of Liverpool, the company including Sir W. Crookes, Sir J. T. Brunner, M.P., Mr. A. F. Ward, M.P., Prof. Rücker, Prof. Myers, Prof. FitzGerald and many others. The Lord Mayor, in proposing Dr. Lodge's health, spoke in glowing terms of his devotion to science and his services to Liverpool, where, in 1891, he was appointed to a professorship in University College. The Lord Mayor intimated that he had received letters from Mr. A. J. Balfour, M.P., Lord Derby, Lord Kelvin, Lord Rayleigh, Lord Lister, Sir Henry Roscoe and others, expressing their great regret at compulsory absence, and all expressing high appreciation of Dr. Lodge's scientific attainments and devotion to scientific work. Responding to the toast of his health, Dr. Lodge referred to the endowment of a physical laboratory at Liverpool, and said that whoever endowed such a laboratory would be doing a tremendous piece of work for the advancement of science. The biennial award of the Rumford medal was an event of national, nay even sometimes of international importance, because it was often given to foreigners, and in this way promoted a friendly feeling among workers in science in different parts of the world. Principal Glazebrook responded to the toast of "Liverpool University College" and described its progress. He said that £13,000 had been received towards the medical school, and what was wanted next was a physical laboratory for Prof. Lodge, the cost of which was put at between £30,000 and £40,000. One generous donor, who at present wished to remain unknown, had promised £10,000, and that evening Sir J. T. Brunner had promised £5,000, and Mr. Alfred Booth had made a challenge offer of £2,500 if three others would give the same amount. Principal Glazebrook thought that before long they would have the necessary funds in hand for the completion of this great object. In replying to a subsequent toast, Sir Wm. Crookes referred to Prof. Lodge's work in connection with wireless telegraphy, and said he believed that by their guest's system of space telegraphy they would be able to telegraph from Liverpool to America, and that before many years Prof. Lodge will have succeeded in accomplishing this feat. The proceedings were enthusiastic throughout.

Bangor.—The opponents of electric lighting are leaving no stone unturned to delay, if not defeat, the Town Council's electric lighting scheme. It will be remembered that some two years ago, when the opposition was asserting that the introduction of the electric light would mean a great increase in the rates, some members of the Council, in order to allay any fears on this score, signed a bond guaranteeing the rates from loss to the extent of £650 per annum for five years, conditionally that when the electric lighting scheme became a financial success they should be refunded the amount of their guarantee called up with interest at the rate of 5 per cent. It was, however, asserted that every member of the Council who had signed this guarantee had thereby disqualified himself from sitting. The Council consulted Mr. Levett, of the Equity Bar, who declared that the bond was not a legal instrument, whilst Mr. McMorran held that those members who had signed the bond were disqualified from membership. The signatories of the document held a meeting on Tuesday to consider the situation, and decided to withdraw the bond. It is stated that the promoters of the scheme intend to promote a local company to supply the town with electricity.

Battersea (London).—The scheme prepared by Prof. Kennedy for the electric lighting of the parish was submitted to the Vestry on Wednesday. It provides for the erection of generating plant for the equivalent of 24,000 8 c.p. lamps and 240 arcs, with mains capable of an additional 20,000 lamps, to meet possible extensions. The first instalment of plant in the central station to be built in Lombard-road includes 500 H.P. for reserve. The system to be adopted is the 3-wire continuous current at 230 volts. The approximate estimate of cost is—for buildings £40,000, and for plant, mains and lamps £60,000. It is proposed to charge 5½d. per unit for current to private consumers, and £16 per lamp per annum for arcs. The total income, when 24,000 incandescents and 240 arcs are connected, is put at £14,040 per annum, the total annual up-keep expenses (including interest and repayment of loans), £12,110. The Lighting committee recommended the Vestry to approve it, and to authorise them to take steps to carry it into effect. The recommendation was adopted.

Bettws-y-Coed.—A committee was recently appointed to report upon the advisability of establishing electricity works. This report was presented at the last meeting of the Council, and recommended the utilisation of the water power available at the Swallow Falls. Owing to the desire to preserve the Falls, which are a great attraction in the district, the question has been deferred.

Birkdale.—The Council is dissatisfied with the quality of the gas supplied by the Southport Corporation, and the Lighting committee recommend that steps be taken to establish electricity works for public and private lighting. The Birkdale provisional order was obtained last year.

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Birmingham.—The City Council on Tuesday adopted the report of the General Purposes committee, recommending the purchase of the local tramways on the expiry of the existing leases in 1917.

Blackburn.—The Board of Trade inspection of the Preston New-road and Witton sections of the electric tramways took place on Tuesday. The former section will be opened for traffic at once.

Burton-on-Trent.—An inquiry was held here, on Monday, into the application of the Corporation to borrow, amongst other sums, £11,000 for electric light extension purposes. The town clerk (Mr. T. N. Whitehead) explained that the present works commenced supply on Feb. 26, 1894, and the present plant was in three sets, each set being designed to supply 66 kilowatts, or 1,000 16 c.p. lamps, the idea being to supply current for 2,000 16 c.p. lamps from two sets, leaving the third for reserve. In 1894 there was a loss of £315, in 1895 £292; in 1896 there was a profit of £289, in 1897 of £704, and in 1898 £906. They now proposed to extend their works, and put down a 250-kilowatt steam alternator, at a cost of £3,500, and three Lancashire boilers. By these additions they would more than double the capacity of the station. The balance of the loan would be required for new mains and meters. Applications for current in the district where the mains were laid were being continually received, and it was proposed to further develop the business by extensions in every portion of the borough. Mr. F. L. Ramsden, manager of the gas and electric lighting works, submitted technical details of the various extensions. They had found that the works were on too small a scale to make them pay, and they were consequently anxious to extend as occasion required. Mr. Wardle opposed the application as he considered the site of the station unsuitable as well as costly. Ald. Lowe said they had the authority of Mr. Frank Bailey, chief engineer of the City of London Electric Lighting Co., that they had chosen the very best possible place for the station. He had confidence that in time, when the electric lighting undertaking was fully developed, they would have a satisfactory return from the works. There was no further opposition.

Central London Railway.—It is anticipated that the Mansion House to Shepherd's Bush section of this railway will be opened for traffic on Nov. 1 next.

Cheaper Telegrams.—A statement is published that the Postmaster-General contemplates a reduction in inland telegram rates, by which the address on telegrams will be allowed free of charge.

Cheriton.—The Council are applying for leave to amend their provisional order by omitting certain streets.

City of London.—A Board of Trade inquiry will be held by Sir Courtenay Boyle, K.C.B., at the Guildhall, on 27th inst., into the applications of the Charing Cross and Strand Electricity Supply Corporation, the Metropolitan Electric Supply Co., and the Smithfield Markets Electric Supply Co. for provisional orders for the City of London.

Colchester.—The borough surveyor is preparing a detailed report and will submit estimates for providing additional plant at the electricity works for the winter of 1901, and for various extensions of the mains.

Constantinople.—The first electric lighting installation in this city was put into operation last week. According to the *Standard* correspondent the proprietor of a circus recently had the honour of giving a cinematograph exhibition at Yildiz, and the Sultan was so delighted that he granted permission for an installation at the circus, though such permission had hitherto been refused to all applicants. Now that the prejudices of the Sultan to the electric light have been, apparently, overcome, it is to be hoped that no further obstacles will be placed in the way of introducing electric lighting and tramways into Constantinople.

Darwen.—It is expected that the electricity works will be completed by June.

Eccles.—The borough electrical engineer (Mr. L. H. Combe) recently tendered his resignation owing to certain criticisms passed by some of the members of the Electric Lighting committee on the staff of the electricity department. The chairman (Ald. Kendall) has now been deputed to wait upon Mr. Combe and request him to withdraw his resignation. The committee state that as the works have not yet left the contractors' hands they cannot take the view that Mr. Combe can be held answerable for defects which have been found in the street lighting cables.

Edinburgh.—The Corporation have approved the recommendation of the Electric Lighting committee to provide additional boiler plant at Dewar-place station at an estimated cost of £4,000. At Tuesday's Council meeting, the committee renewed their former recommendation that the resident electrical engineer (Mr. F. A. Newington) be allowed, as at present, and so far as consistent with his regular duties, to perform work connected with the wiring of buildings for the Corporation and to charge the proper departments therefor. This course was sanctioned.

Electricity in Gold Mining.—The *Investors' Review* states that a small syndicate, with a capital of £10,000, is being formed to establish electricity supply at the Kalgurli Goldfield, Western Australia. Electricity is so largely employed at Johannesburg, and has proved so great an aid in the reduction of working expenses, that the operations of the syndicate will be watched with interest. At present only one company (Lake View Consols) has any electrical plant of importance in operation in this district.

Glasgow.—Mr. H. F. Parshall's report to the Tramways sub-committee, which was briefly referred to in our last number, has now been issued. Mr. Parshall commences by stating that he has studied the conditions under which the Glasgow Tramways have to be worked, and submits his suggestions as to the most efficient and economical method of generating and distributing electricity for the overhead trolley system. The report reviews the present tramway working arrangements in Glasgow and its suitability for dealing with the present traffic of the lines. With regard to the proposed extensions, Mr. Parshall is of opinion that 600 cars may be taken as a reasonable number to provide for in the generating and distributing arrangements. In fixing upon this number as a basis, he urges that such an increase over the present number of cars (407) is not excessive, and it may be safely predicted that the normal growth of tramway traffic will justify these figures. The consumption of power per car mile (Mr. Parshall continues) varies in different cities with the conditions as to permanent way, frequency of stoppages, gradients, &c., and in Glasgow, the track construction adopted is admirably suited for electric traction, the rails being of the best possible cross section, and of ample weight. Taking, therefore, this 600 car estimate, and allowing for an effective working supply of current and a safe margin for spare plant, an aggregate of 17,000 I.H.P. will be required in the generating station. Mr. Parshall recommends that several centres of distribution shall be established, as the distances to which electric energy has to be conveyed are so great and varied as to preclude an economical supply at 500 volts. Further, the maintenance of the Corporation's property, such as gas and water mains, and the observance of the conditions laid down by the Board of Trade, would entail in the case of a single centre of distribution an elaborate and complicated return system, involving great outlay in cables and machinery. Mr. Parshall advises that a three-phase high-tension generating station should be established, with sub-stations, which, he urges, would involve less capital expenditure, and possess other advantages, including (1) lower working cost and repairs; (2) greater flexibility, especially in regard to future extensions; (3) a generating station of this character could be installed, and put in working order quickly. Mr. Parshall further urges that in installing a multiphase station the very latest and most approved practice would be adopted, and there would be little likelihood of such a type of plant being early superseded. Mr. Parshall estimates that for traction purposes in Glasgow there would be consumed, approximately, 26,000,000 units of current per annum, or four times as much as is generated by the largest lighting station in London. The cars will be working 16 hours per day at full service, and four to five hours per day additional at one-third service. This distribution of load over so many hours per day would be very satisfactory, as the generating station could be so designed as to work at the highest economy during all hours. Mr. Parshall estimates that four generating sets would give the best results, three of these to be worked during the normal conditions of load, and the fourth to provide for abnormal conditions and emergencies. He recommends the three-crank tandem compound type of engine provided with massive flywheels to give the uniform turning moment, and to provide the maximum effort for fluctuations of load. These engines should work at no more than 75 revolutions per minute and be direct connected to triphase generators of the flywheel type with rotating magnets and stationary armatures. Such machines have, he continues, been constructed to work satisfactorily at a pressure as high as 13,000 volts, but having regard to the comparatively short distance of transmission in the case of Glasgow, 6,500 volts would be a satisfactory working pressure, and the calculations of cost are based upon this voltage. The generating stations should be designed with electrically driven auxiliaries throughout. In connection with the distributing arrangements the method already adopted in Glasgow of drawing cables into ducts and manholes represents the best practice in electric traction and can be readily adapted to the requirements of these extensions. Mr. Parshall then makes a comparison of lighting and tramway plants, and points out that on a large scale the two systems are best kept separate owing to the difference in the lighting plant and that used for the supply of power. He proceeds to detail the points which militate against a supply of current for lighting and traction from lighting stations, and gives some

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particulars of stations established at Bristol, Sheffield, Toledo (U.S.A.), and Hamburg, and finally decides against joint supply for Glasgow. Mr. Parshall concludes an interesting and elaborate report by summarising the advantages of the recommendations above set out.

The Tramways sub-committee having discussed this report have issued a statement, which has been adopted by the full Tramways committee, advising the Corporation to adopt Mr. Parshall's recommendations that the generation and supply of current for the tramways should be separate from that of the lighting supply. The Tramways committee cordially support the view that stations for lighting and traction combined would be of no benefit to either the Electricity committee or the Tramways committee, but that such an arrangement would be a great disadvantage to the Tramways department. The Corporation will be invited at an early meeting to adopt the recommendations of the Tramways committee arising out of Mr. Parshall's report.

Glasgow Exhibition, 1901.—The prospectus of the Glasgow International Exhibition, to be held in Kelvin-grove Park in 1901, is now published, and forms interesting reading. It gives evidence of the intention of the promoters of the exhibition to make it, bar accidents, a great success. The exhibition will be under the patronage of Her Majesty, and the Prince of Wales is vice-president. Lord Blythwood is president, and there is a very lengthy list of honorary vice-presidents, honorary members, &c., and a strong executive council. Copies of the prospectus can be obtained from the secretary and general manager (Mr. H. A. Hedley), 36, St. Vincent-place, Glasgow.

Great Central Railway.—Mr. C. T. Ritchie, President of the Board of Trade, performed the opening ceremony yesterday of the new extension line to London of the Great Central Railway. The chief London station of the railway is established in the Marylebone-road, W., and here a representative gathering of Members of Parliament and railway magnates were present at the opening ceremony. The company included Sir Edward W. Watkin, who thus lives to see the completion of his work in connection with these extensions. Huge sums of money have been spent upon new rolling stock and the provision of machinery and apparatus for insuring the comfort of the travelling public. Electric communication between passengers and attendants has been introduced on all trains, the dining cars will be mainly lighted electrically, and the great station itself has been equipped with a very complete electric lighting installation. The service throughout has, in fact, the benefit of all the latest advances in electrical apparatus for railway working. The establishment of this additional means of communication between London and the provinces marks a prominent forward step in railway extension.

Hammersmith (London).—At present there are 110 customers of the electricity department, representing a total of 21,570 8 c.p. lamps, and of these 254, representing 17,768 lamps, are connected.

Harrogate.—Thirty additional arcs are being erected in the principal streets of the town.

Hawick (N.B.).—The Town Council intimate that they are willing to consider the application of a company, which has applied for sanction to apply for a provisional order for the district.

Hornsey (Middlesex).—Electric lighting matters make very little progress in this district. A report presented by the Lighting committee at the last meeting of the Council stated that the Westminster Electric Supply Corporation had made a proposal for the transfer of the provisional order. Pending experiments with incandescent gas lighting, the committee had not taken any steps towards putting their order into force, but the matter was being considered. An animated discussion took place on the report and a motion by Mr. Fox to refer the question of putting the order into force was declared informal. Mr. Burt said the electric lighting question was being shelved. The chairman of the Lighting committee (Mr. Sloper) explained that the matter was not fully reported upon as they were waiting for other offers.

Karachi (India).—Messrs. Macdonald and Company, agents for an English electrical engineering firm, have approached the municipality with a view to obtaining a concession for the erection of electricity works.

Kingston-on-Thames.—The Town Council have decided to construct electric tramways in the district, and application is to be made for a provisional order.

Kingswood.—Messrs. Alexander, Daniel and Co. sold the local electric lighting plant to Mr. J. Pugsley, Cheese-lane, Bristol, for £475, and also the 99 years' lease of the station, which is for £25 a year. Meanwhile the District Council are preparing to adopt gas lighting.

Light Railways.—The Board of Trade have confirmed the order for the construction of a light (electric) railway between Grimsby and Saltfleetby, with a branch to Cleesthorpes.

The Light Railway Commissioners have sanctioned the application of the British Electric Traction Co. for the construction of light (electric) railways in the Dudley and Stourbridge district. At Stourbridge the Company propose to make a branch to Lye, and another to join the authorised Kinver line, which is about to be commenced. At Dudley a branch is proposed to connect the Stourbridge line with the Wolverhampton tramways.

The Cheltenham Town Council have approved the draft order for the construction of the proposed Cheltenham-Cleeve light (electric) railway. The council will support Mr. T. Nevins' application at the forthcoming inquiry by the Light Railway Commissioners.

A light railway inquiry was held at Bilston last week into the application of the British Electric Traction Co. to construct light (electric) railways in South Staffordshire, including the districts of Bilston, Willenhall and Darlaston. Mr. Sydney Morse explained that the British Electric Traction Co. had made an agreement as to the portions outside Wolverhampton, which, if carried out, would result in the line to Moxley on one side, and to Willenhall on the north, becoming the property of the company. All the local authorities were in favour of the scheme. The Wolverhampton Corporation were promoting a bill for powers to get local lines, and powers for working them, notwithstanding that their capital would be raised on the rates of the town. Mr. S. Sellon, the company's engineer, submitted plans of the various lines, the estimate for the construction of which was put at £28,767. The town clerk of Wolverhampton objected to the application, as (he said) the proposed lines were tramways, and not light railways, and consequently the procedure should have been under the Tramways Act. Decision deferred.

The Light Railway Commissioners held an inquiry at Rhyl on Wednesday into the application of the Rhyl and Prestatyn Light Railway Co. to construct a light (electric) railway between Rhyl and Prestatyn. The overhead trolley system would be used, and the gauge of the system would be 3ft. 3in. The estimated cost was £26,000. The Commissioners notified they would recommend the granting of the application.

A light railway inquiry was held at Manchester on Tuesday into the application of the British Electric Traction Company for an order to authorise the construction of a light electric railway between Cheetham Hill and Rhodes, near Middleton. Mr. Sydney Morse having explained the nature of the Company's application, Mr. Balfour Browne, who opposed, stated that all the local authorities affected by the application were opposed to the scheme. The commissioners consequently decided that it was useless to proceed with the inquiry.

Liverpool-Manchester Electric Railway.—It is announced that a joint committee of representative citizens of Liverpool and Manchester has been formed to investigate the commercial and engineering possibilities of an electric railway between Liverpool and Manchester. The project is receiving considerable support in both cities.

Llanrwst.—It is anticipated that current will be switched on by Lord Carrington on 30th inst.

London County Council.—On Tuesday the Council granted a loan of £38,750 to the Islington Vestry, for electric lighting purposes.

The works department of the Council were authorised to prepare the foundations for the engines and dynamos required in connection with the electric light installation at the Crossness Outfall, at a cost of £150.

The Highways committee submitted a report asking the endorsement by the Council of the resolutions passed at the recent conference of London local authorities on the telephone service. It was moved that the matter be referred back, on the ground that Mr. Hanbury's resolutions in Parliament had rendered such endorsement unnecessary. Mr. Benn thought the resolutions would strengthen the hand of the Postmaster-General in dealing with the London telephone service. They did not know what would be the position of London under the new arrangement which Mr. Hanbury had formulated; it might possibly be that the result would make matters worse for London than the present arrangement. Ultimately the report was referred back.

Newcastle on-Tyne.—A special meeting of the Council, on Wednesday, resolved to retain the working of the new tramway in their own hands.

New Swindon.—The Council have decided to engage an electrical expert to prepare a report on the lighting of New and Old Swindon electrically. In the meantime the Old Swindon Council are recommended "not to facilitate any separate arrangement for providing electric energy in their district."

Oswestry.—The Oswestry Electrical Light and Power Co. have intimated willingness to sell their undertaking to the Town Council, and the latter are taking steps to obtain an independent valuation of the plant and mains.

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Partick.—A Board of Trade inquiry will be held on the 16th inst. into the application of the Kelvinside Electricity Co. for a provisional order for the burgh of Partick.

Post Office Telephone Competition.—A start has been made by the Post Office, in its competition with the National Telephone Co., at Hampstead, where the Board of Guardians desired telephonic communication to be established between the workhouse and the medical officer's residence. According to a report, negotiations with the National Company fell through, owing to certain conditions as to the use of the workhouse buildings as a basis for other subscribers' wires. The Post Office was then approached, and has agreed to provide communication without any conditions. The case seems to explain in a nutshell the different conditions in the facilities owned by the two telephone bodies.

Presentation.—On Sunday last Mr. H. Collings Bishop was presented with a handsome chiming clock on his leaving Leyton to undertake the duties of borough electrical engineer at Wigan. The chairman of the Electric Lighting committee (Mr. Musgrave), on behalf of the engineers and staff, made the presentation from the station switchboard.

Private Bill Legislation.—Under Clause 30 of the Central Electric Supply Co.'s Bill power is sought to supply various companies and authorities, including the Hampstead Vestry, with electricity in bulk. The Vestry have unsuccessfully attempted to induce the company to insert a clause providing that current should be supplied only to the companies named, and consequently the Bill is to be opposed by the Vestry. The St. James's (Westminster) Vestry have already petitioned against the Bill on the ground that it would prejudice their right of purchasing the undertaking of the St. James' and Pall Mall Electric Light Co., one of the companies proposed to be supplied with current in bulk.

Provisional Order Transfer.—The Margate Corporation notify that they have transferred their provisional order to the Isle of Thanet Light Railways (Electric) Co. (Limited). The charge for current for private lighting must not exceed 6d. per unit, and for public lighting 2½d. The Company are to lay mains in the whole of the streets specified in the order within two years, and also agree to pay the cost of obtaining the order, and undertake not to do any street work during the months of June, July, August and September, except in cases of urgency.

Reading.—The Corporation are to take over the management of the tramways next year, when the overhead trolley system of traction will be introduced.

Royal Alfred Aged Seamens' Institution.—This old sailors' charity is making a special effort to secure increased support, and asks for funds from all who have at heart the making provision for assisting the seaman in his old age. We heartily commend the appeal to our readers.

Salford.—The Town Council have approved the recommendation of their Electric Lighting committee to appoint Messrs. Lacey, Clirehugh and Sillar, consulting engineers for three years, with a remuneration of 2½ per cent. on all capital expenditure incurred in connection with the proposed generating stations and the electrical equipment of the tramways.

Secret Commissions.—A report is issued of the proceedings taken by the Special Committee of the London Chamber of Commerce appointed some time back to inquire into the question of secret commissions in various trades and the extent to which the payment of these commissions prevails. The report refers to the difficulty of obtaining particulars which can be substantiated by the names of the parties communicating the same, as in most cases the information could only be obtained under promise of strict secrecy. "The amount of corruption which the evidence before the Committee shows to exist may appear to some to be so great and complex as to render it hopeless to struggle towards purity." The Committee, however, do not take this view and believe that the discussion of the subject will do much good. If legislation is attempted the Committee recommend that it should render criminal the payment, the receipt, the offering and the solicitation of any corrupt payments. The recommendations of the Committee are of a practical nature, and will be read with interest. Some startling facts are published in a series of appendices dealing with the practice of paying these commissions.

Sedgley.—The Council have come to terms with the British Electric Traction Co. as to the construction of electric tramways in the district. The company have agreed to construct and equip a system of tramways within two years.

Shoreditch (London).—The Electric Lighting committee on Tuesday, reported that in considering the estimate of income and expenditure chargeable to the general rates during the ensuing quarter, they had decided to transfer the sum of £1,000 from the profit account of the electricity undertaking for the relief of the general rates. Approval of this suggestion was deferred.

Mr. A. Simmons, clerk of works in connection with the extension of the electricity works, has resigned and Mr. C. N. Newton Russell, chief electrical engineer, will supervise the finishing of the structure.

The Vestry have sanctioned an expenditure of £3,700 in connection with additional arc light circuits.

Stirling.—The Police Commissioners have received the sanction of the Secretary for Scotland for borrowing £25,000 for electric lighting purposes.

Stoke.—At a recent meeting of the Council it was decided to obtain estimates for the electric lighting of the village of Bucknall.

Telegraph to Dawson City.—The Dominion Government have decided to construct a telegraph line from Lake Bennet to Dawson City. The former place is already in telegraphic communication with Skagway.

Telephone in the Colonies.—The telephone system of South Australia has been extended from Melbourne to the gold fields, and the daily press are thus enabled to obtain their gold field letters by telephone instead of by telegraph. Concessions have been made to newspaper proprietors, and the rates charged have been fixed at 9d per five minutes' conversation during the day hours and 9d. per ten minutes' conversation between 8 p.m. and 8 a.m.

Telephone Trunk Line Extensions.—Ton-yr-efail (Glam.) has been placed on the telephone trunk system of the country, and North Berwick and Salisbury were, on the 9th inst., similarly connected up to the Post Office telephone trunk system.

Trade Reports.—The *Bristol Mercury* has issued in pamphlet form a report on the industrial progress of the Bristol district during 1898, which covers a review of the varied industries of the town and district. The publication of similar reports for other districts might be adopted with advantage.

Tunbridge Wells.—The assessment of the electricity undertaking has been reduced, on appeal, from £800 to £650. The electrical engineer (Mr. H. L. P. Boot) has prepared a report upon the proposed extensions of the electric lighting plant.

United States Cable to Hawaii.—We referred last week to a clause in a Bill before the United States House of Representatives providing funds for a cable to be laid to Hawaii. This clause of the Bill has been struck out.

West Ham (London).—The tender of Messrs. S. Z. de Ferranti, Limited, has been accepted by the West Ham Corporation for the supply of electric lighting plant for the extensions recently decided upon, but a question has arisen as to the rate of wages paid by Messrs. Ferranti, and an attempt has been made to introduce into the tender the Manchester scale of pay for electrical workmen. Messrs. Ferranti, however, decline to accept this scale on the ground that their works are not in Manchester, and consequently not subject to the Manchester rate. The Works border upon Oldham district, and these rates Messrs. Ferranti are prepared to pay. The matter was discussed at the last meeting of the West Ham Corporation, and a motion waa carried that, unless Messrs. Ferranai agreed to pay the Manchester scale, the tender should be re-advertised. There was, however, a strong feeling expressed by some members that Messrs. Ferranti had met the conditions, as to the scale of pay, in a fair and considerate manner.

Wednesbury.—The Council have appointed a committee to conduct negotiations for the purchase of the tramways of the South Staffordshire Tramway Company in the district of Wednesbury.

Worcester.—The accounts for the electricity department for 1898 show a great improvement upon the 1897 figures. The figures cover the period of Mr. Ruthven-Murray's control at Worcester and reflect credit upon his management. The capital expenditure to date is £74,397. 3s, as against £67,293 at the end of 1897, the increase being chiefly for mains, meters, &c. The revenue account shows gross receipts £7,154. 3s. 8d., compared with £6,291 in 1897, and expenditure £3,943, against £4,096. The gross profit on the year's working amounted to £3,210. 10s. 9d , compared with £2,195. 0s. 10d. The sinking fund amounted to £1,724. 11s. 10d., and interest £1,946, leaving a deficiency of £460. 1s. 1d., compared with £1,474 in 1897, and £1,616. 7s. 10d. in 1896. The number of new customers connected in 1898 was 80, representing the equivalent of 3,637 8-c.p. lamps. We are glad to see that the Borough electrical engineer (Mr. C. J. Sutherland) the newly-appointed borough electrical engineer at Worcester, anticipates a substantial profit on this year's working.

Workhouse Lighting.—The Pontefract Guardians have adopted the report of their consulting engineer (Mr. R. Holiday) recommending the adoption of electric lighting. The estimated cost of the installation is put at £900; maintenance (including interest), £136, compared with £233. 9s., at present paid for gas lighting—a saving of £97 per year.

York.—The Electric Lighting committee has been authorised to extend the electric light mains to Micklegate at an estimated cost of £2,000.

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COMPANIES' MEETINGS AND REPORTS.

Chelsea Electricity Supply Co. (Limited).

The annual ordinary general meeting of this Company was held at the head office, 19, Cadogan-gardens, Chelsea, on Monday, under the presidency of Mr. J. IRVING COURTENAY.

The SECRETARY (Mr. S. J. Cluer) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN then said: As you will have noted, we recommend a dividend of 6 per cent. for the year, which is at the same rate as that of the previous year, but on a capital larger by £40,000—the amount of the last issue of Ordinary shares. When I come to deal with the accounts I shall be able to show you that, though there is no increase in the dividend, we have been looking ahead and seeking to consolidate the position of the Company. A matter of great interest in our work in 1898, and of much benefit for the future, is the passing of our Act for the compulsory purchase of land. You may recollect that when I had the pleasure of meeting you last year I said that it was reasonable that electric light companies having statutory obligations to the public should have powers to enable them to duly perform those obligations, and I am glad to be able to say that Parliament has confirmed that view. A Joint Committee of the Houses reported in favour of the principle of compulsory purchase, and the Bill passed successfully through each House. A mass of evidence was given for and against, and we were strongly opposed by local authorities and by those who had private interests to subserve, but the Commons' Select Committee, through its Chairman, declared that, upon the evidence, the Committee was satisfied that the Company's present powers do not, and the additional powers given by the Bill will not, if used with due and reasonable care and skill, and by means of modern machinery and appliances which the Company may be reasonably required to employ, cause any sensible physical damage to the structure of the buildings in which the petitioners have interests, or any such discomfort to occupiers of these buildings as might be reasonably complained of by such occupiers. The result of the passing of this Act, the first of its kind, is not only to give us powers to purchase sites necessary for our stations at reasonable figures, but also to free our works and operations from the hardship of what is commonly known as the nuisance clause of the Provisional Order, under which the production of electricity was liable to be stopped by a private owner or resident through an action at law, although we might be using the best known method of working and the newest and most scientific appliances. It is now necessary for a complainant to show that we are not exercising reasonable care, and not using the best known methods in our machinery. One immediate effect was the satisfactory settlement of an action brought by a resident, which had been hanging over us since 1897, and it has enabled us to proceed with our Alpha-place generating station. In connection with the procedure of the Parliamentary Committees, I may also mention that the question of Vestry competition was satisfactorily dealt with. The decision in regard to the Marylebone Vestry, whose Bill was thrown out, shows, I think, that Parliament disapproves of competition by a Vestry, which, by declining to do the work itself and consenting to a company's Provisional Order, has practically given the Company a lease of 42 years, unless, of course, the Company neglects its duty and does not fulfil its obligations. The Chelsea Vestry, for some occult reason, has not manifested towards us that spirit which we have a right to expect from a public body whose parish has largely benefited from our operations, but their action will have no effect on the conduct of our business in the interests either of our customers—the public—or our shareholders. The Directors have under consideration various plans with the object of bringing the advantages of the electric light within the reach of those of the public who are able to use it only on a small scale, and who also desire to spread the capital outlay over several years. I have dealt at length with these matters because they are of vital importance, and now I will pass on to the financial situation. The business of the Company is steadily increasing, there having been an increase of nearly 16,000 lamps of 8 c.p., or their equivalent during the year. The revenue has not increased in the same proportion, owing mainly to the fact that the two winter quarters were exceptionally bright and fine, while consumers, who evidently live and learn, practised economy. The revenue per lamp during 1898 was just under 5s. 7½d., whereas during 1897 it was 5s. 9½d., the lamps in 1898 using an average of only 11½ units each; thus from these causes there was a reduction of current used per lamp in the year of over 2d. per lamp. This is the main difficulty we have to contend with in the supply in Chelsea. In consequence of such a large number of the most important houses remaining unoccupied, except during the London season, the average amount earned by each lamp is very low—the lowest, I believe, of any of the London supply companies. The working costs for the year under review do not show any diminution, indeed there is a small fractional increase, but this is largely due to the reduced consumption, and also to the extra cost of fuel, consequent on the South Wales coal strike, and the fact that our fuel economising arrangements had been delayed in delivery as the result of the engineers' strike. There is also a small increase in the wages account, which in these days one seems always to expect. Of the whole capital expenditure nearly £100,000 has been spent in land and freehold and leasehold buildings. You could not have a better security. A good deal, however, of this expenditure is not by any means so productive as it will be. Some of the land is not yet occupied by our works, and some of the buildings are scarcely occupied by machinery, while in others there is room for much more machinery. We have erected and are constructing and equipping distributing sub-stations of dimensions large enough to supply the maximum demand expected in their respective districts—such are Pond-place, Carlyle-square, and Slaidburn-street sub-stations, and we have carried out various extensions of the mains, including the western portion of the parish. Again, the accommodation for meter testing, repairing shops, stores, general offices, and residence for assistant engineers at Alpha-place generating station will, when that station is completed, suffice for any extension of business in our own district for many years. From this it will be seen that some considerable portion of the capital expenditure must be considered as at present not earning its quota, and that the further increase of demand should be supplied at a reduced capital cost. The balance of premium on issue of Debenture stock, after deducting costs of issue and various other special charges, has been added to reserve fund, which now stands at £46,818. 3s. 4d. For the reasons given. I consider the position of the Company is stronger than ever it was, and that we may anticipate increased prosperity. I now move—

"*That the report of the Directors and statement of accounts for the year 1898, now before this meeting, be and they are hereby adopted, and that the payment of dividends of 6 per cent. on the Preference and on the Ordinary share capital of the Company for the year 1898 be and is hereby approved, the dividends to be payable forthwith.*"

Major-General WEBBER seconded the motion, and remarked that there was little for him to add to what the Chairman had said, except that he wished to point out the very prominent way in which Mr. Courtenay and the staff of the Company had worked in connection with the obtaining of their Bill in Parliament. The gratitude, also, of the other electricity supply companies was due to the Chelsea Company for being the first to bear the brunt of this struggle.

Mr. DAWES thought the reserve fund was very large and asked whether the fund was invested partly in the business of the Company or in securities. As a founders' shareholder, he also wished to know why one-third of the sum of £923, which was carried forward, had not been distributed among the holders of the founders' shares.

Mr. DEVONSHIRE desired, from the shareholders' side of the table, to express their appreciation of the efforts of the Directors in connection with the struggle in the Houses of Parliament.

Sir DANIEL COOPER warmly supported the strengthening of the reserve fund for meeting extensions and emergencies, and thought it was safer to employ their reserves in the business of the Company than to put money into investments of which they knew nothing.

The CHAIRMAN, in reply, said the reserve fund was invested in the Company's business. If it had been invested in outside securities, the fact would have been shown in the balance sheet. He fully agreed with the remarks of Sir Daniel Cooper in respect to the reserve fund. A portion of their 42 years' tenure had expired, and at the end of their time they would expect to receive more than £5 a share for their capital. The reserve would then come in, and go into the pockets of the then shareholders. They had earned 6 per cent. with the reserve fund, and he thought this was the best investment for it. Some considered that a reserve fund was not necessary, but he was in agreement with those who considered that the fund was necessary, gave strength to the company possessing it, and increased the value of that company's shares. As to the balance carried forward, it had practically gone into the depreciation fund. In the opinion of some they did not put sufficient to that fund, but he contended they put all they could, and it was wise and prudent to do so. In regard to the question of the founders' shares and the sum carried forward, they had taken the best legal advice, and the eminent counsel whom they had consulted had confirmed the Directors in their view. As to the way in which they had presented their accounts and the manner in which they had distributed the revenue, they would be only too glad to make a payment to the founders as that meant an increased dividend to the ordinary shareholders. They wanted to act prudently and not to divide everything up to the hilt.

The motion was then carried unanimously.

Mr. Nugent Daniell and Mr. Emil Garcke were re-elected Directors of of the Company, and the auditors, Messrs. Cooper Bros. and Co,. were re-appointed.

An extraordinary general meeting followed to consider resolutions for increasing the capital of the Company by the creation of 40,000 Ordinary shares of £5 each. The resolutions were carried unanimously, and it was resolved that the new issue should be offered to existing shareholders.

A hearty vote of thanks was accorded the Chairman and Directors for their conduct of the Company's affairs.

The CHAIRMAN, in acknowledging the vote, referred to the indebtedness of the Directors to their consulting and resident engineers, Mr. Frank King and Mr. Percy Still, and to the staff.

The proceedings then terminated.

House-to-House Electric Light Supply Co. (Limited).

The eleventh ordinary general meeting of this Company was held yesterday, Mr. WILLIAM PAGE (managing director) presiding.

The SECRETARY (Mr. Thos. J. Owens) read the notice calling the meeting.

The CHAIRMAN: In the unavoidable absence of our Chairman, Mr. Beeton, who was unexpectedly called away yesterday to Paris, I have been asked to preside to-day, and I have now to move the adoption of the report and accounts. I am happy to say that I need not detain you very long on this occasion as there is nothing very special to tell you beyond what is stated in the report. Our chairman last year, I may remind you, drew your attention to the satisfactory features in the development of the Company's business, during the last few years especially. He mentioned the increase which had taken place in our sales of current, and referred also to the continued decrease in the cost of the output. He also mentioned that to obtain the results which had been secured

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it had been necessary to substitute new plant, thus antiquating a certain portion of our plant, and he explained how this affected our capital to some extent; but what was lost in that way had been, probably, more than counterbalanced by the increased value of the goodwill of the Company. He also drew attention to the fact that the system had been introduced by this Company of free wiring—of wiring people's houses for a certain number of lamps, and fixing those lamps free of all charge, without enhancing the cost of the current to them thereby. These various points, he remarked, were largely due to the energy of our manager and engineer, Mr. Bowden, who deserves considerable credit. I may say that all these points pretty well hold good to-day, and, therefore, we are able to propose an increased dividend at this meeting. Last year the dividend was 4 per cent., and this year, for the whole of the twelve months under review, it is 6 per cent. The development of the business since the end of 1898 has continued equally satisfactory, a steady demand for new customers continually coming in. I think attention was also directed last year to how very favourably we compared with other companies in London in various respects. There are eight metropolitan companies, and though we have the smallest output, possessing the smallest area in respect of our works cost, we share the honour of being the second with the Westminster, the St. James's Company taking the first position, they having the cream of the London areas in Clubland. We are a long way behind all the other companies in works cost, and I may just mention that the Westminster Company's output is something like five times as large as ours, so that, if we were on the same basis as regards output, our position would doubtless, be a great deal better than theirs is. Our total working expenses, I see, figure out at 43½ per cent. of our total income, so that our profits are 56½ per cent. of our income. In the report, we again give the usual table, showing the gradual increase which has taken place in our business from the beginning. I need not go through it in detail, but you will see that our gross receipts have now reached £24,906, while the total expenditure is £10,840, leaving the net receipts at £14,066, which, we trust, you will deem satisfactory. I have mentioned our free wiring system, and I think I may say that a large proportion of the new business we are getting is due so this system. Many people will not have the electric light in their houses because of the initial cost of wiring their houses, of which, in many cases they are only tenants. Since the introduction by us of the system of free wiring our customers have grown in number at a greater rate than before. All this, of course, necessitates continual preparation for additional business, and during the year we have completed a large boiler house, and we have plant almost always on order, for it takes a very long time to get delivery of plant of the kind that we want. At the present time we have on order two units of plant, and our stations are about large enough to take another 2,000 H.P., which, I believe, is nearly enough to double our present output. We need not, therefore, to be looking out for a fresh station just yet, but that may be necessary in the future. We have had certain negotiations with the authorities with a view to public street lighting.

A SHAREHOLDER: May I ask what authorities?

The CHAIRMAN: Of the parish. We supply Kensington; at least, only a portion of it. We are now fitting up half a dozen street lamps there, and we propose to supply them with current for nothing for twelve months, and that may lead to a considerable amount of business in future. The cost of production is a fraction higher than last year, although the efficiency of our plant is greater, but the reason for the small increase—and you will find that the same thing has occurred in the case of other companies—is that coal has been dearer, and other expenses, especially the rates, have been higher. Our Chairman has usually referred at these meetings, and we have had a paragraph in the report about it, to the Construction Estate. We have said nothing about it this time because there is little to say. The business went into liquidation, or something of that kind, several years ago, and we have not been able to get anything out of it, at any rate we have not been able to get any money. With these remarks I beg to move—

"*That the Report and accounts be adopted.*"

Mr. W. F. LEESE seconded the motion, and it was agreed to without discussion.

The proposed dividends at the rate of 7 per cent. on the Preference shares, and at the rate of 7 per cent. on the Ordinary shares, for the half-year, making 6 per cent. on the latter for the year, were then agreed to; the retiring Directors, Mr. W. R. Davies and Mr. W. F. Leese, were re-elected; and the auditors, Messrs. Miall, Wilkins, Randall, and Co., were reappointed.

The proceedings terminated with a vote of thanks to the Chairman.

Norwich Electricity Co. (Limited).

The annual meeting of this Company was held at Norwich on Thursday last, Sir C. R. GILMAN presiding. The Directors' report stated that the amount received from the sale of current during the past year showed an increase upon 1897, and fresh customers were coming in. Two new 300 H.P. engines and an additional boiler had been erected, and four miles of new mains had been laid. It would be necessary to provide further plant in view of the increased demand for current. Parliamentary powers had been obtained, enabling the Company to extend its operations where desirable into the suburbs of the city, and mains had been already laid to the village of Thorpe. It had been found impracticable to continue the system hitherto adopted of charging half-price for current during certain hours of the day, and they were compelled to adopt a uniform price of 5d. per unit, as from January 1st, instead of 7d. and 3½d. as heretofore. This would be found to compare favourably with the cost of current in other large towns. The system of "free" wiring, introduced at the end of 1897, had proved very successful, nearly 200 new consumers having been acquired by this means during the year. A prepayment meter, similar to the "penny in the slot" meters so largely used by gas companies, but available for silver coins only, the invention of Mr. Long, the Company's engineer, and Mr. E. Schattner, formerly in their service, was being introduced with very satisfactory results. The premium on new shares issued during the year amounted to £1,522. 10s., and had been placed to reserve. Including £202. 3s. 4d. brought forward, and allowing for interest on Debentures, bank interest, and depreciation, the net revenue account showed a credit balance of £3,922. 1s. 11d., out of which the Directors proposed a dividend of 6 per cent, free of tax, and to place £477. 10s. to reserve, carrying forward £575. 1s. 11d.

The CHAIRMAN said that he hoped the shareholders would consider the report and accounts satisfactory, as they both showed continued progress. Their income was increasing, but not to the extent it would have done had they not made a reduction in the price of current last year. But, in spite of the reduction, there was an increase in the sale of current. They were steadily adding to the number of their customers; during the past year they had added 371 new ones, making a total of 1,267 current in Norwich. This continued increase necessitated an increase in plant and machinery. Mains had been laid to Thorpe, where they already had a number of customers, and they were likely to increase. With regard to the reduction in the price of current, that had necessarily reduced their income, but there was one feature in connection with it, with regard to the altered terms which they had found it necessary to charge for the price of current, on which he would say a word. He believed the Norwich Company was the only one that tried to make a differential rate of charging—that was to say, for a certain portion of the time to make a full charge, and for the remainder of the day and night to make a half charge. The Norwich Company had tried it, but after the experience of several years they found that it was impracticable to continue the arrangement, and therefore they had had to fall back on the usual system of charge for the actual current that was consumed, and to fix the price at as low as 5d. per unit. The new "penny-in-the-slot" meter was working steadily and successfully, and was likly to extend. The Directors proposed to ask for powers to make an issue of shares and Debentures to meet the increased capital requirements of the Company.

The report and accounts were adopted, and an extraordinary meeting decided to increase the capital of the Company to £100,000, by the creation of 5,000 additional shares of £10 each.

Hove Electric Lighting Co. (Limited).

The annual general meeting was held on Wednesday, under the presidency of Col. A. J. FILGATE, R.E.

The SECRETARY (Mr. Francis Reeves) having read the notice calling the meeting,

The CHAIRMAN, in moving the adoption of the report, congratulated them on their continued progress. The further capital expenditure last year was £10,641, increasing the total outlay to £77,450. They had increased the power of their generating plant to 1,090 H. P., and had added 2½ miles of new mains to their system, increasing the length of the mains to 14½ miles. The continued increase in their business necessitated their spending further capital. They foresaw some months ago that they must add considerably to their generating plant, and as the demand for electric plant all over the country was still increasing, they ordered two additional Willans-Crompton sets of 350 and 250 H.P. respectively for delivery next summer and another boiler. They had also entered into a contract for extending the station to the full capacity of their present site, the works to be completed by July 31. To provide for the outlay incurred last year, and part of that to which they were now committed, they had issued 2,000 of the new shares sanctioned at the last meeting—1,000 at £2 premium and 1,000 at £2. 10s. premium. The amount thus obtained would not be sufficient to meet their requirements for this year, and as the undertaking showed signs of expanding to considerable dimensions, they considered it desirable to ask the shareholders' sanction now to increase the share capital from £50,000 to £100,000. Their gross revenue for 1898 had been £9,480, or £2,210 more than for 1897, while the working expenses had been £4,390, an increase of £724; The net revenue had been £5,089, an improvement of £1,486. As their revenue from current supplied to customers amounted to less than the low figure of 5s. 1½d. per 8 c.p. lamp per annum, he thought they would agree that their business had been carried on economically. Adding to the net revenue the balance brought forward they had a total of £5,304. They proposed to write £247 off preliminary expenses, reducing the balance of this account to £1,000, to transfer £1,000 to reserve, and to pay a final dividend at the rate of 8 per cent. per annum, making 6½ per cent. for the year, and to carry forward £400. The benefits they had derived from reducing the price charged for current clearly pointed to the desirability of making a further reduction in the near future, but any such reduction must be postponed until they were able to meet the demand on their works which would probably arise from such action. There was apparently no present intention on the part of the Hove Corporation to adopt electric lighting in the streets of the town.

The report was adopted unanimously.

The retiring Directors and auditors were re-appointed, and the proposed increase in the capital of the Company to £100,000 was also approved.

Metropolitan Electric Supply Co. (Limited).

The report of the Directors of this company for the year ended Dec. 31 states that the capital expenditure, which, at end of 1897 amounted to £850,831. 10s. 9d., has now reached a total of £993,761. 13s. 9d., an increase of £142,930. 3s. The principal items are mains and plant, and the expenditure on the new works at Willesden. The balance of capital in

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hand at end of year was £5,197. 15s. 10d. The gross revenue for the year amounted to £151,605. 12s. 3d., against £138,267. 14s. 6d. in 1897, an increase of £13,337. 17s. 9d. The cost of generation, which in 1897 was £58,604. 5s. 4d., amounted in 1898 to £76,736. 8s. 7d., an increase of £18,132. 3s. 3d.

Although the sales of current during the past year increased, the profits have not been in proportion. This is principally accounted for by necessary considerable reductions in rates of charge, by the coal strike in South Wales, and by the fire at the Manchester-square works, which for a time incapacitated this important station.

During the year, negotiations were carried on with the holders of Founders' shares which resulted in the rights attaching to these shares being extinguished on the terms submitted to and approved by the shareholders.

The bill authorising the company to erect generating works at Willesden, and to supply current therefrom, was passed by Parliament. The bill promoted by the Marylebone vestry to enable them to obtain competitive powers of supply to this company was successfully opposed.

The balance to credit of revenue, before providing for depreciation, is £53,553. 14s. 3d. The Directors have set aside £13,000, as an addition to depreciation and reserve, carrying to credit of net revenue account £40,563. 14s. 3d., which, with balance brought forward and other receipts, makes a total of £44,473. 18s. After deducting debenture and share interest and other charges, there is a balance of £17,872. 6s. 4d. An interim dividend of 5s. per share on the Ordinary share capital was paid on Sept. 23rd, 1898, and the Directors recommend that a further dividend of 5s. per share be now paid, making a total distribution of 5 per cent. The dividend upon the new shares will be at the same rate per cent. calculated from due dates of the instalments. This will leave £1,452. 2s. 1d. to be carried forward.

The number of 8 c.p. lamps supplied by the Company increased during the year 1898 from 360,000 to 430,000. The present number of lamps connected is 440,000, and applications show no signs of decrease.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 2, 1899). Price of silver 27 7/8d. per oz. (March 9). Consols (2¾ per cent.) 110—110¼ for money, 110¼—110⅜ for account; 2½ per cent. 103¼—103¾ (March 9), Stock Exchange Settling Days: Consols, April 6; Stocks and Shares Continuation Day, March 27; Ticket Day, March 28; Pay Days, March 10 and 29; Mining Share Carry over Day, March 25.

BARCELONA TRAMWAYS CO. (LIMITED).—Negotiations have been entered into for the sale of this company's undertaking at Barcelona, and the arrangements are likely to be satisfactorily concluded at an early date.

BIRMINGHAM ELECTRIC SUPPLY CO. (LIMITED).—The annual meeting of this company was held on Wednesday. In moving the adoption of the report, which appeared in our last issue, the Chairman (Mr. G. S. Albright) said that the net profit on the year's transactions was £17,526, against £12,613 in 1897; the depreciation for 1898 amounted to £3,507, compared with £4,460. They would notice how large a proportion of the depreciation bore to the net profit, showing that they had dealt with that matter in a very liberal way. The number of lamps on the company's books reduced to 16 c.p. at the end of 1897 was 39,232, and at the end of 1898 50,985. The number had been increased during the present year to 52,546. The total number of units of electricity sold in 1898 amounted to 1,720,771, against 1,183,539 in 1897, an increase of more than 50 per cent. The company had, during the past year, made considerable additions to the plant at the Water-street power station, while at Dale End the offices, stores and works accommodation had been considerably increased by buildings completed during the year, A very considerable number of motors had been added to the company's mains, and were now forming a respectable day-load. Although their average net selling price had somewhat gone down, the cost of production had also gone down in about the same amount. Altogether they could feel that they were handing over to the Corporation a very satifactory business. They had fully earned the 6 per cent. dividend which the agreement with the Corporation allowed them to pay, and they carried forward as large a balance as they did in the previous year. The report was then adopted.

BOURNEMOUTH AND DISTRICT ELECTRIC SUPPLY CO. (LIMITED).—The Directors' report for the year ended Dec. 31 states that expenditure on capital account during the year amounted to £17,557. 4s. 3d., chiefly upon machinery, mains and transformers, making the total expenditure £103,965. 17s. 10d. The balance net revenue, after payment of interest charges, commission and reserve for depreciation, was £1,500. 17s. 6d., against a loss of £92. 1s. 7d. for 1897. The directors recommend a dividend on the Ordinary shares at the rate of 5 per cent. for the year, less tax, leaving £117. 6s. 8d. to be carried forward. The equivalent of 33,732 8 c.p. lamps were connected to the company's mains at Dec. 31, an increase equivalent to 7,619 3 c.p. lamps for the year, compared with 2,910 for the previous year, and applications representing a further 1,769 9 c.p. lamps were awaiting connection. Additional plant had been installed at the station, and this must be still further extended during the present year.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY CO. (LIMITED.)—The directors' report for the year ended Dec. 31 states that the business of the company was satisfactory. A further 21 shares of the Bournemouth and District Electric Supply Co. (Limited) had been acquired, so that the company now holds the whole of the share capital of that company. The premiums received on the first issue of Preference shares had been applied to reduction of the preliminary expenses, and the remaining balance of that account had been written off out of revenue. The balance to credit of net revenue, after payment of the full year's dividend on the Preference shares, was £3,468. 9s. 10d., and the directors recommend the payment of a dividend on the Ordinary shares at the rate of 4 per cent. for the year, less tax, leaving £1,206. 9s. 10d. to be carried forward. The equivalent of 8,752 8 c.p. lamps were applied for during the year, compared with 3,482 during 1897. Application has been made to the Board of Trade for a transfer to this company of the undertaking of the Bournemouth and District Electric Supply Co. (Limited).

BRITISH INSULATED WIRE CO. (LIMITED).—The report of the directors for the year ended Dec. 31 states that the gross profits amount to £72,185. 1s. 6d., the net profits to £54,709. 19s. 11d. This amount has been charged with depreciation, according to scale, £5,958. 5s. 8d.; amount written off goodwill and patents, £9,344. 6s. 11d., and balance of preliminary and reconstruction expenses, £3,800. 19s. 6d., a total of £19,103. 12s. 1d., leaving a balance to be dealt with of £35,606. 7s. 10d. The following dividends have already been paid, viz., on Preference shares, £5,121. 8s. 9d., and interim on Ordinary shares at the rate of 10 per cent. per annum, £8,999. 19s. 6d., leaving £21,484. 19s. 7d. The directors now recommend that a further dividend of 10 per cent. be paid to the Ordinary shareholders, making 15 per cent. for the year, which will absorb £19,499 19s. 9d., carrying forward £1,984. 19s. 10d. During the year 7,500 additional Preference shares have been issued. The results of the year's working have been most satisfactory, and have fully justified the extension of the works and the introduction of additional capital. Though a much larger quantity of goods was sent out during the year, the amount of orders on hand at the end of 1898 is so greatly increased that a larger business may be anticipated for the current year.

CAPE TOWN.—In an advertisement, inviting applications for the issue of £288,000 Three and a-Half per Cent. Debentures, the Corporation of the city of Cape Town, South Africa, puts its electric light installation down as an asset value £125,000, and the gross receipts from the supply of current for 1897 at £12,238.

CITY AND SOUTH LONDON RAILWAY CO.—The prospectus will be found on another page of an issue of £375,000 Ordinary share capital, in shares of £10 each, in this company. The issue is made to provide capital for the completion of the extension of the company's service from Finsbury-pavement to the Angel, at Islington. This is an important step in the history of the company, and will connect up its service with the southern suburbs of Kennington and Stockwell; so that the line becomes, when opened a few months hence, a continuous one from the Angel, in North London, through the heart of the City, on to Stockwell, connecting the company's line with all the principal existing railways engaged in metropolitan traffic in Central, South and North London. Interest at the rate of 3 per cent. per annum will be paid half-yearly on the amounts paid up until the opening of the Angel extension. The price of issue is £6. 18s. for each £10 share (equal to £69 for £100 of Ordinary stock), and is payable—10s. on application, £1. 10s. on allotment, £1. 10s. July 3, £1 Oct. 3, £1 Jan. 3, 1900, and £1. 8s. April 3, 1900; or subscriptions can be paid in full, with interest at the rate of 3 per cent. per annum. The list closes at noon on Tuesday next.

COMMERCIAL CABLE CO.—A quarterly dividend of 1¾ per cent. has been declared payable April 1, out of the net earnings of this company. The transfer books will be closed from 21st inst. to April 3 inclusive.

DOVER ELECTRICITY SUPPLY CO. (LIMITED).—The report of the Directors for the year ended Dec. 31 states that further capital expenditure, amounting to £7,714. 1s. 9d., has been incurred in order to meet increased demand for current. The result of the year's trading shows steady progress, the gross profit of £1,127. 17s. 5d. earned in 1897 having been increased to £2,133. 7s. 11d., after setting aside a sum for the formation of a depreciation reserve. The gross profit is more than absorbed by interest charges, but the Directors state that by the issue of the balance of the ordinary share capital, arrangements have been made to pay off the loans on which the larger part of these interest charges arise. The profits of the current year will thus, after meeting debenture interest, be available for the payment of dividend. Applications have been received for the equivalent of 2,407 8 c.p. lamps, increasing the connections to approximately 12,500 lamps, exclusive of the supply of power to the Corporation tramways, which now reaches a maximum of 250 H.P. daily. A contract has been entered into for the supply of current for a term of years, for both lighting and power, to the contractors for the National Harbour works. The demand for current for the Corporation electric tramways is steadily increasing, and the service gives general satisfaction. On 1st of July last a modification of the Company's tariff was introduced, based on a maximum of 7d. per unit for a period of 1½ hours per day, and 3d. per unit thereafter. This reduction has given general satisfaction, and is resulting in a steady accession of business.

EDISON ELECTRIC ILLUMINATING CO. (NEW YORK).—The gross receipts of this Company for the year 1898 amounted to $2,898,000, an increase of $432,000. The net profits amounted to $409,000, an increase of $95,000.

KILLARNEY ELECTRIC LIGHTING CO. (LIMITED).—This Company, which has a share capital of £6,000 (divided into £3,000 7 per cent. Preference and £3,000 Ordinary shares) are inviting applications for £2,000 Preference shares and £1,000 in debentures.

GIANT'S CAUSEWAY, PORTRUSH AND BUSH VALLEY RAILWAY AND TRAMWAY CO. (LIMITED.)—The directors' report, presented at a recent meeting of shareholders, stated that there was a slight falling off in the receipts compared with the previous year (from £2,487. 6s. 2d. to £2,405. 8s. 9d.), and this had arisen chiefly owing to the decrease in the number of passengers carried during the year from 79,015 to 74,877. In addition to the inclemency of the season, the closing of the Giant's Causeway to the public as a place of free resort was responsible for the fall.

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The credit balance on the year's working was £502. 5s. 5d., against £650. 16s. 1d. in 1897. The number of miles run by electricity during the year have been 11,333, against 4,721 in 1897; and the miles run by steam have been reduced from 17,797 to 13,979, making the total miles run last year 25,312, against 22,518 in 1897. In their last report the directors stated that they had received an advantageous offer for the erection of the overhead system of electric traction. The supply of the steel tubular poles and fixtures, and the copper trolley wire, as well as the new electric cars, with all the latest improvements, were ordered from American firms, but owing to the war with Spain there was a delay of six months in delivery. Everything required has now arrived, and the poles have been erected for nearly the entire length of the line, and the rest of the work is going on rapidly, with every prospect of being in good time for the present season. When completed, the water power at the generating station on the river Bush will become available to its full extent, giving increased electric current along the line which could not hitherto have been used with safety, owing to the present conductor rail being so near the ground. Mr. William Traill, who has acted as engineer to the company from the first, and given his whole time to the undertaking without fee or reward, has undertaken this contract for the sum of £8,000, to be paid partly by debentures and partly by shares, enabling the directors to get over the difficulty of raising capital to carry out this work. The estimates from several electrical firms for a complete electrical installation, sufficient to dispense with steam power altogether, have varied from £15,000 to £17,400, to be paid in cash; but as the steam engines belonging to the company were in excellent order (two of them being comparatively new) they would be serviceable for 10 or 15 years more, so that it was not considered necessary to go in for so large an expenditure, but care has been taken in the present contract to ensure that everything now done will be an integral part of such complete scheme, should it become advisable at any future time to carry it out.

ROYAL ELECTRIC CO. OF MONTREAL.—The Directors have declared a dividend of 2 per cent. for the quarter ended 28th ult., being at the rate of 8 per cent. for the year.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has ordered the further issue of £500,000 3½ per cent. Preference stock of the *Eastern Telegraph Co.* (*Limited*) (in lieu of provisional certificates now quoted), and the further issue of 4,000 £5 fully-paid ordinary shares (Nos. 15,762 to 19,761) of the *House-to-House Electric Light Supply Co.* (*Limited*) to be quoted in the official list. The Committee has also been asked to appoint a special settling day in and to grant a quotation to the further issue of 2,500 £10 Ordinary shares of the *W. T. Henley's Telegraph Works Co.* (*Limited*), and to allow 20,000 £5 shares (Nos. 1 to 20,000) of the *Calcutta Electric Supply Corporation* (*Limited*), to be quoted in the list.

TRAMWAYS UNION CO. (LIMITED).—The directors' report for the year ended Dec. 31 states that the revenue shows a net profit of £14,049, making (with £351 brought forward) £14,400. An interim dividend of 2s. 6d. per share was paid on Aug. 2 last, and the directors recommend a further dividend of 2s. 6d. per share, making 5 per cent. for the year, free of tax. At Madrid the work of installing electric traction has been completed, and the traffic is now worked entirely by electricity. Negotiations have for some time been proceeding for the sale of the company's three undertakings at Madrid, Bremen and Bucharest, and the directors announce the sale of the Bucharest and Madrid undertakings and the payment of the first instalment of the purchase money. The gross price agreed upon for the two properties is upwards of £600,000.

UNION ELECTRICITATS GESELLSCHAFT.—A dividend of 12 per cent. for the year 1898 has been declared.

WESTERN UNION TELEGRAPH CO.—The usual quarterly dividend of 1½ per cent. has been declared. The statement for the quarter ending March 31, gives the estimated net receipts at $1,250,000, an increase of $50,000 on last year's estimates.

WEST INDIA AND PANAMA TELEGRAPH CO. (LIMITED).—The estimated traffic receipts of this company for the half-month ended Feb. 28 were £1,941, compared with £1,621 in the corresponding period of 1898.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Mar. 4	3,742	+ 325	8	33,769	+ 2,417
Blackpool Corporation...	„ 2	150	+ 32	48	17,480	+ 2,568
Blackpool and Fleetwood	„ 4	196	...	9	1,463	...
Bradford Corporation ...	„ 5	263	...	31	7,834	...
*Bristol Trams & Carriage	„ 3	2,499	+ 176	9	22,340	+ 1,201
City & South London Ry.	„ 5	1,111	+ 22	10	11,108	+ 388
Dover Corporation	„ 4	139	+ 40	48	8,481	...
DublinUnited(Southern)	„ 3	659	+ 303	9	5,446	+ 1,894
*Glasgow Corporation ...	„ 4	8,000	+1,104	...	...	....
Liverpool Corporation						
Dingle Route	Feb. 25	461	...	15	7,982	...
Prince's Park Route...	„ 25	314	...	6	1,764	...
Liverpool Overhead Rly.	Mar. 5	1,288	– 79	10	12,909	– 585
*Sheffield Tramways.....	„ 5	1,147	+ 241	9	10,798	+ 2,201
*South Staffs. Trams.....	„ 3	631	+ 72	9	5,346	+ 90

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price March 1.		Price Wednesday, March 8.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Week Ending March 8.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	101	104	100	104	3 16 11	January and July	..	..
25,000	10	–	Amazon Telegraph	3	4	3	4	–	–	–	–
£125,000	100	5%	Do. 5 per Cent. Debentures	87	92	87	92	5 6 5	–	–	–
£905,560	Stock	24/0	Anglo-American	67	69	65	68	5 2 0	Feb., May, Aug., Nov.	68	66½
3,047,220	Stock	30/0	Do. Preferred	119	120	117½	118½	5 1 8	„ „	119⅜	118½
3,047,220	Stock	18/0	Do. Deferred	14½	15	14½	14⅝	6 2 0	„ „	14⅝	14⅜
275,151	10	3/0	Brazilian Submarine	16	16½	16	16½	4 4 10	Mar., June, Oct., Dec.	16⅝	16⅜
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	110	114	110	114	4 7 9	June and December	..	..
10,000,000	$100	$2½	Commercial Cable Capital Stock	190	200	190	200	4 0 0	Jan., Apr., July, Oct.	..	..
£1,332,523	Stock	4%	* Do. 4 per Cent. Debenture Stock	105	107	105	107	3 15 2	„ „	106½	105⅝
16,000	10	8/0	Cuba Submarine Ordinary (Deferred)	9½	10½	9½	10½	6 13 4	February and August	10⅛	9⅞
6,000	10	10/0	Do. Preference 10 per Cent.	17½	18½	17½	18½	5 8 1	„ „	..	..
12,931	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October	..	–
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	„ „	..	–
430,000	50	4½%	Do. 4½ per Cent. Debentures	104⅞	107⅞	104⅞	107⅞	4 4 1	January and July	–	–
60,710	20	3/0	Direct United States Cable	12¼	12⅝	12½	12⅝	5 2 0	Jan., Apr., July, Oct.	12⅞	12⅞
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	103	106	103	106	4 5 6	–	..	–
£4,000,000	Stock	5%	Eastern Ordinary	180	185	180	185	3 16 1	Jan., Apr., July, Oct.	183	182
£1,795,000	Stock	3½%	Do. 3½ per Cent. Pref. Stock	104	107	104	107	3 5 7	„ „	105⅝	..
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	126	130	126	130	3 2 0	May and November	126½	..
£89,900	100	5%	* Do. 5 per Cent. Debentures, 1899	99	102	99	102	4 18 0	February & August	–	–
250,000	10	2/6	Eastern Extension	18	18½	18	18½	3 15 8	Jan., Apr., July, Oct.	18½	..
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	128	125	129	3 2 3	February & August	..	–
£16,200	100	5%	* Do. 5 p. c.(Austin.Gov.Sub.)Deb.1901(reg.)	99	103	99	103	4 17 1	January and July	..	–
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	..	–
£35,100	100	5%	*Eastern and S. African 5 p.c. Mor. Deb.,1900(reg.)	99	103	99	103	4 17 1	„ „	–	–
£46,500	100	5%	Do, (Bearer)	100	103	100	103	4 17 1	„ „	–	–
£300,000	100	4%	* Do. 4% Mortgage Debentures,1909	102	105	102	105	3 17 8	February & August	..	–
£200,000	25	4%	Do. 4% Mauritius Sub. Debs. (red.)	104⅞	107⅞	104⅞	107⅞	3 15 2	May and November	..	–
180,227	10	1/9	Globe Telegraph and Trust	12¾	13½	12¾	13½	3 17 4	Jan., Apr., July, Oct.	13⅞	12¾
180,042	10	6%	Do. 6 per Cent. Preference	17	17½	17	17½	3 8 7	„ „	17	..
150,000	10	5/0	Great Northern of Copenhagen	30	31	30	31	3 4 6	January, April, July	..	–
150,000	100	5%	* Do 5 per Cent. Debs., 1883 issue Series "B"	98	102	..	..	4 18 0	March & September	–	–
£97,800	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red)	100	103	100	103	4 8 0	June and December	..	–
17,000	25	12/6	Indo-European	58	61	57	60	4 3 4	May and November	..	–
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904.	107	110	108	111	5 8 1	March & September	–	–
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs.(red)	105	108	105	108	3 14 5	June and December	–	–
11,889	8	4/0	Reuter's	6½	7½	6½	7½	5 6 8	April and October	7½	6⅝
3,381	£100 Cert.	6%	Submarine Cables Trust	139	144	139	144	4 4 8	„ „	..	..
15,609	10	–	West African Telegraph	–	–	2½	3½	..	–	–	–
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	97	100	98	101	4 19 0	March & September	98½	–
30,008	2½	–	West Coast of America	½	1	½	1	..	–	–	–
£150,000	100	4%	* Do. 4 per Cent. Debentures	103	106	103	106	3 15 9	June and December	–	–
88,321	10	1/6	West India and Panama	1⅞	2⅛	1⅞	2⅛	–	May and November	2 1/16	1 15/16
24,563	10	6/0	Do. 6 per Cent. 1st Preference	10½	11	10½	11	5 9 1	„ „	10⅞	..
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	„ „	..	–
£80,000	100	5%	* Do. 5 per Cent. Debentures	105	108	105	108	4 13 3	January and July	..	–
64,269	15	5/0	Western and Brazilian Ordinary	12½	13	12⅞	13	4 11 3	May and November	..	–
33,129	7½	3/0	Do. 5 per Cent. Preferred Ordinary	8¼	8¾	8¼	8¾	4 5 8	„ „	..	–
33,129	7½	1/3	Do. Deferred Ordinary	4	4½	4	4½	–	„ „	–	–
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	107	110	107	110	3 13 2	June and December	–	–
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.)	98	103	98	103	6 16 6	March & September	–	–

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price March 1.		Price Wednesday, March 8.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending March 8.	
								£ s. d.		Highest	Lowest
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	2⅜	3½	2⅜	3½	6 8 1	August	–	–
£124,850	£1 10s.	1¼d.	Consolidated Telephone Const. & Manufacturing	1/16	3/16	1/16	3/16	6 7 0	July	–	–
28,000	5	4/0	Monte Video Telephone 5 per Cent. Preference	–	–	1/16	1	5 0 0	October	–	–
£490,000	5	3/0	National	5⅜	5⅝	4⅛	5	6 0 0	February & August	5⅛	4⅛
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	14	16	13	15	4 0 0	" "	15	14⅛
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	14	16	13	15	4 0 0	" "	13	–
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	5½	5½	4½	5	5 0 0	" "	5 1/16	4⅜
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	100	102	99	101	3 9 9	June and December	101½	99½
£171,504	1	0/4	Oriental	⅜	⅝	⅜	⅝	6 18 4	April and October	–	–
58,000	5	6/0	United River Plate	4½	5½	4½	5½	5 14 3	July	–	–
£151,788	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	104	107	107	107	4 13 11	June and December	–	–
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	–	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (10s. pd.)	⅜	⅝	⅜	⅝	–	–	–	–
16,000	10	..	Bournemouth and Poole Electricity Supply Ord.	13	13½	13	13½	–	–	–	–
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10⅝	11½	10⅝	11½	4 4 0	–	11	–
80,000	5	3/0	Charing Cross & Strand Electricity Supply Corp.	11½	12½	11⅛	12⅛	3 4 0	February & August	12⅛	–
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6½	6	6½	3 9 3	" "	–	–
£34,000	5	2/6	Chelsea Electricity Supply Ordinary	8½	9⅜	8½	9⅜	3 3 2	March	9	–
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	114	116	114	116	3 18 1	June and December	–	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red)	103	105	103	105	4 15 3	–	105	104⅜
50,000	10	5/0	City of London Elec. Lighting Ord. 40,001 to 90,000	19½	20⅜	12½	20½	2 18 6	February & August	20½	19½
10,000	10	1/9	Do. Ordinary 90,001 to 100,000	19	20	19	20	..	–	–	–
40,000	10	6%	Do. 6% Cumulative Pref.	15	16	15	16	3 15 0	January and July	–	..
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	124	129	124	129	3 17 10	June and December	125⅛	..
30,000	10	..	County of London & Brush Prov. Ord. (1 to 30,000)	12⅛	13⅛	12	13	–	–	12 1/16	12⅜
10,000	10	..	Do. (30,001 to 40,000)	12⅛	13⅛	12	13	–	–	..	..
20,000	10	6/0	Do. 6% Cumulative Preference	14⅛	15⅛	14⅛	15⅛	4 0 0	March & September	15⅛	14 1/16
19,661	5	2/6	House-to-House Electric Lighting Supply Ord.	9	10	9	10	2 0 0	–	..	..
12,000	5	3/6	Do. 7 per Cent. Preference	9½	10½	9½	10½	3 6 8	March & September	10	9⅜
15,000	5	10%	Kensington and Knightsbridge Ord.	13	14	13	14	3 18 7	–	–	–
10,000	5	6%	Do. 6% 1st Pref.	7⅜	8⅛	7⅜	8⅛	3 12 9	January and July	–	–
110,000	3	–	London Electric Supply Ordinary	3⅛	4	3⅛	4	–	–	3 1/16	3⅜
48,050	5	–	Do. Preference	6½	7	6½	7	–	–	6 1/16	6⅜
£100,000	Stock	..	Do. 4% 1st Mort. Deb.	104	108	104	106	3 15 6	Mch., June, Sept., Dec.	–	–
62,500	10	5/0	Metropolitan Electric Supply Ordinary	16½	17⅛	16⅛	17⅛	3 8 7	April and October	17⅜	16½
22,500	10	–	Do. (£7 paid)	13½	14½	12½	13½	..	–	–	–
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	118	121	118	121	3 14 7	June and Decembe	–	–
6,452	10	6/0	Notting Hill Electric Ordinary	16½	17½	16⅛	17⅛	3 8 7	March	–	–
10,000	5	–	Oxford Electric Ordinary	6⅝	7⅛	⅛	¼	–	–	–	–
275,000	1	–	Rand Electric	⅜	1⅜	⅜	1⅜	–	–	–	–
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb	88	93	88	93	5 8 1	–	–	–
150,000	$100	$2	Royal Electric Company of Montreal Shares	160	180	160	180	4 9 5	–	–	–
130,900	100	4½%	* Do. 4½% 1st Mort. Debs.	107	109	107	109	4 3 9	April and October	–	–
31,980	5	9/6	St. James and Pall Mall Electric Ordinary	16½	17½	16⅛	17⅛	4 2 9	February & August	17 1/16	16⅛
20,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	" "	9⅜	..
65,000	5	..	South London Electric Supply Ordinary (£3 paid)	3⅛	3⅜	3⅛	3⅜	..	–	3 1/16	3⅜
79,900	5	7/0	Westminster Electric Supply Ordinary	15½	16½	15½	16½	3 12 9	March & September	16	15 13/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	2	1/2½	Brush Electrical Engineering	2	2⅛	1⅞	2⅛	2 16 5	–	2	1⅞
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	–	2⅜	2⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	110	114	110	114	3 19 2	February & August	–	–
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101	104	101	104	4 6 7	June and December	–	–
£20,000	5	5/0	Callender's Cable Construction	12½	13½	12⅛	13⅛	5 0 0	" "	13	12 1/16
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	114	117	114	117	3 17 5	November and May	..	–
300,000	1	9⅜	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 16 5	–	..	..
50,000	1	..	Chadburn's Ship Telegraph Ordinary	1⅛	1⅜	1⅛	1⅜	–	–	..	..
50,000	1	7½d	Do. 6 per Cent. Cumulative Pref.	1	1⅛	1	1⅛	4 16 0	–	–	–
£32,098	3	1/6	Crompton and Co. (Nos. 1 to 32,098)	3⅛	3⅜	3⅛	3⅜	4 0 0	–	3⅜	..
£82,850	100	5%	* Do. 5% First Mort. Deb. (red.)	98	101	98	101	4 19 8	January and July	..	..
99,261	5	1/9⅜	Edison and Swan United ("A" Shares) (£3 paid)	2⅛	2⅜	2⅛	2⅜	7 1 8	February & August	2⅜	..
17,139	5	2/9⅜	Do. (£5 paid)	4	5	4	5	6 10 0	" "	–	–
£544,023	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	98	100	98	101	4 0 6	June and December	98½	–
17,400	5	5%	Edmundson's Electric Corporation Ord (fully pd)	5⅛	5⅜	5⅛	5⅜	4 6 11	Half-yearly	..	–
112,100	2	1/2⅜	Electric Construction Co. (Limited)	2⅛	2⅜	2⅛	2⅜	4 12 0	January & July	2 1/16	–
25 000	2	2/9⅜	Do. 7 per Cent. Cumulative Pref.	3	3⅛	3	3⅛	4 0 0	July	3 1/16	–
£140,300	Stock	4%	Do. 4% First Mortgage Deb. (red.)	103	106	103	106	3 15 10	January and July	105⅛	104
91,196	1	–	Elmore's Patent Copper Depositing	⅝	¾	⅝	¾	..	–	–	–
12,500	10	8/0	Henley's Telegraph Works Ordinary	26½	27½	27	28	4 12 10	February & August	27⅜	27½
8,000	10	7/0	Do. 7 per Cent. Preference	18½	19½	18½	19½	3 11 10	" "	–	–
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	113	116	113	116	3 19 1	" "	–	..
50,000	10	15/0	India Rubber, Gutta Percha, &c., Works	22	23	22	23	4 6 11	" "	22⅜	22⅛
300,000	100	4%	Do. 4% First Mortgage Debentures (red.)	102	106	102	106	3 15 6	March & September	..	..
27,250	12	12/0	Telegraph Construction and Maintenance	40	44	40	44	4 1 10	March and July	40½	–
£150,000	100	..	Do. 4 per Cent. Deb. Bonds	104	107	104	107	3 15 4	–	..	..
£13,400	5	..	Do. Manufacturing Ordinary	9½	9⅝	9½	9⅝	–	–	9⅛	9⅜
13,400	5	–	Do. 5% Cum. Pref.	5⅝	6⅛	5⅝	6⅛	4 0 0	–	–	–
£30,000	5	4/0	Willans and Robinson Ordinary	8½	9	8½	9	4 8 11	April and October	–	–
£30,000	5	3/0	Do. 6% Cumulative Preference	7	7½	7⅛	7⅝	3 17 5	" "	–	–
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	106	108	106	108	3 18 8	May and November	–	–
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	8/0	Blackpool and Fleetwood Tramways	23	24	23½	24½	3 5 4	–	24½	24
50,000	10	7%	Bristol Tramways and Carriage	23⅝	24½	23⅛	24⅛	2 18 1	–	–	–
£90,410	Stock	4%	Do. 4% Debenture	120	121	120	121	3 6 2	–	–	–
80,000	10	..	British Electric Traction Ordinary	16⅛	17⅛	17⅛	18⅛	..	–	17⅜	17⅛
10,000	10	6/0	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm. pd.)	13⅛	13⅜	13⅛	13⅜	4 7 3	–	13⅜	13⅛
£100,000	Stock	6/2·3	Do. 5% Perp. Deb.	125	127	125	127	3 19 4	–	..	..
40,000	5	..	Buenos Ayres & Belgrano 6% Cum. Pref. (£3 paid)	3⅛	3⅜	3⅜	3⅞	..	..	3⅜	3 1/16
27,500	5	..	Do. do. do. (fully paid)	4⅜	4⅝	4⅜	5	..	..	5	4 1/16
£260,000	..	5%	Do. do. 5% Deb.	107	110	108	111	4 10 11	..	109⅛	109
£35,250	10	3/0	Central London Ordinary	9⅜	10⅛	9⅜	10⅛	2 18 6	June and December	10⅜	10 1/16
178,303	10	1/9⅜	Do. (£8 paid)	7⅞	8⅛	7⅞	8⅛	2 18 2	" "	8	–
£630,000	Stock	2%	City and South London Railway Con. Ordy.	71	73	70	72	2 19 3	January and July	71	70⅛
22,500	10	..	Do. Ordinary (£5 paid)	4⅜	5⅛	4⅜	5⅛	..	–	5	–
9,251	10	5%	Do. 5% Perpetual Preference	14⅛	15⅛	14⅛	15⅛	3 5 7	January and July	–	–
£137,701	Stock	4⅞*	Do. 4% Perpetual Debenture	133	135	133	135	2 19 7	May and November	–	–
20,000	10	6%	Imperial Tramways Ordinary xd	24	24½	24⅜	25½	2 7 6	March & September	25½	24½
10,000	10	6%	Do. 6% Preference xd	16	16½	16	16⅜	3 12 9	" "	16⅜	15⅜
£70,000	Stock	4½%	Do. 4½% Debenture	119	120	119	120	3 15 0	–	–	..
£37,500	10	4%	Liverpool Overhead Railway Ordinary xd	10⅛	10⅜	10	10⅜	3 6 8	February & August	–	–
10,000	10	5%	Do. 5% Preference xd	14⅛	15	14⅛	15	3 6 8	" "	–	–
125,000	Stock	4%	Do. 4% Debenture	106	108	106	108	3 14 1	January and July	–	–
30,000	5	3/3⅜	New General Traction 6% Cumulative Pref	4⅜	5⅛	4⅜	5⅛	5 14 3	–	–	–
£540,000	Stock	3%	Waterloo and City Ordinary	109	112	109	112	13 7	June and December	–	–

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

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CONTENTS OF THE CURRENT NUMBER.

NOTES	711	Obituary	725
Meetings of Scientific Societies	714	Wireless Telegraphy. — *Discussion*	725
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe	715	Dr. Wehnelt's Electrolytic Current Interrupter	728
The Government Telephone Bill	716	The Induction Motor. By Ernest Wilson. Illustrated	729
Electrically-driven Pumps at Glasgow Corporation Station. Illustrated	716	Correspondence	731
Canterbury Corporation Electric Supply Works. Illus.	718	Legal Intelligence	733
Physical Society	720	Trade Notes and Notices	734
Electricity Works Accounts	721	Companies' Meetings and Reports	738
HERTZIAN TELEGRAPHY	724	New Companies, &c.	741
		City Notes	742
		Companies' Share List	744

NOTES.

THE Electric Lighting (Clauses) Bill which Mr. RITCHIE is now steering through Parliament is, in the main, a measure which will probably meet with little or no opposition, for its principal object is to effect a considerable economy in printing Provisional Orders under the Electric Lighting Acts. It has hitherto been necessary, where the model clauses have been adopted—as, in the majority of cases, they are—to insert all these clauses *in extenso* in each individual Order. Thus the printing of Lighting Orders under the Board of Trade has entailed vain and useless repetition *ad nauseam*, and it is mainly with the object of allowing of the model clauses being adopted *en bloc* as a matter of course, and without printing them in each Order, that this new and useful measure is brought forward.

So far as the schedule of the Bill is concerned, we note no important departure from the model Orders up to the present time in use for companies and local authorities seeking powers to supply electricity. The Bill, however, goes farther than the reiteration, substantially and almost literally, of these clauses; it includes, as an Appendix, a number of sections of the Electric Lighting Act, 1882, and the Gasworks Clauses Acts, 1847. This, however, imposes no new restriction on "undertakers," for the sections thus absorbed are all in force under existing arrangements, and they are all duly specified in the Electric Lighting Act, 1882. Should the new measure be passed, as there is every prospect of happening, it will become law on October 1st next, and may be cited as the Electric Lighting (Clauses) Act, 1899.

THE anxiety of local authorities to possess Lighting Orders is, in the aggregate, a quantity always considerably less than the desire to put the Orders to practical use. In the House of Commons on Friday last Mr. RITCHIE stated that the Board of Trade had given a gentle hint to no less than 30 local authorities, to the effect that if they did not forthwith exercise their powers the Orders would be revoked. It was found that in nearly every case the authority thus, metaphorically speaking, dug in the ribs responded as smartly as is usual under such treatment and announced its intention of mending its ways and preparing to break up its roadways. If the Board of Trade continues in this praiseworthy policy of keeping local authorities up to the mark, one of the evils of municipal ownership of Orders—the pigeon-holing of the Orders—will, we are thankful to say, come to an abrupt termination.

WE print in another note the report and rider of a Committee of the Institution of Electrical Engineers on the telephone question. It will be seen that, "in the opinion of this Committee" electrical engineering progress bids fair to be retarded if the "purely local telephone industry" is to be held as a monopoly. The Committee also thinks it undesirable that legislation should discourage independent enterprise in local telephony. So far as we have been able to fathom its delphic phraseology, we gather from the report that, on the one hand, monopoly is deprecated, while, on the other, telephone companies and other forms of "independent enterprise" are to be encouraged. The Institution is thus seen to have discovered an altogether original and hitherto unknown side of the fence, and to have evolved a policy resembling nothing advocated by anyone else. An exclusively Postal telephone service would displease it as much as the existing company does, in that both mean monopoly; yet, control by local authority would also displease it, inasmuch as this would exclude "independent enterprise." We give it up—what *does* this committee mean?

REFERRING to Mr. PROVAND'S letter in our Correspondence columns, we may mention that our acquaintance with the telephone system of the United States is not solely derived, as Mr. PROVAND'S appears to be, from a letter from a "well-informed correspondent." We grant that there may be telephone exchanges in that country affording limited facilities for intercommunication, and to which the subscription rates are as low as the figures mentioned;

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but a comparison of telephone areas of the same size will show that, as a rule, rates in America are higher than in this country. Further, as the 1,500 or 2,000 exchanges Mr. PROVAND refers to are not under municipal control, we fail to see that his argument can carry any weight. It would also be interesting to know how Mr. PROVAND and other advocates of municipal telephony reconcile their support of competition in telephony with their deprecation of it in electricity supply business.

A GLANCE through our pages this week shows that scientific circles during the past week or so have been greatly interested in Dr. WEHNELT'S electrolytic current interrupter. There is no doubt whatever that this apparatus has come to stay—its function in X-ray work alone is sufficient to ensure this. In future the expense and weight of induction coils can be considerably reduced by its adoption, and the steady action of the interrupter has to be seen to be appreciated. The exhibitions of this interesting device which have so far taken place are likely to give a wrong impression as to its utility for X-ray work. As a matter of fact the contact-breaker will work quite smoothly on a 50-volt circuit, and the spark length is thoroughly under control, provided a variable resistance is inserted. That the effect depends upon a particular value of self induction and capacity is evident—the inductance of the induction coil itself being, with advantage in some cases, supplemented by an extra solenoid containing an iron core. Mr. SWINTON appears to have found that the interrupter will not work when the central wire is made the cathode; but that is not the case, at any rate, for low voltages. The interrupter works very much better when the central wire is the anode; nevertheless, a considerable spark is obtained at the secondary when the connections are reversed. This fact does not seem to bear out the idea that the effect depends upon oxygen atoms bombarding the live central wire. There is no doubt a great deal yet to be done before the apparatus is in a practical form and working to the best advantage, but its success so far has been sufficient to make it very acceptable to all whose work lies in the direction of electrical discharge research.

THE keynote of Prof. CALLENDAR'S discourse at the Royal Institution last Friday was "extrapolation;" its subject—"Measuring Extreme Temperatures." A prefatory remark destroyed any hope the audience may have had of hearing about extremely low temperature; for it seems that to go from one extreme to the other of the temperature scale is too much for one evening's discourse. Extrapolation was cited as a means of deducing a temperature not obtainable by direct experiment, and the waywardness of the process gave rise to some brilliant sarcasm. Radiation curves relating to solar temperature were displayed "all soaring away on the wings of extrapolation," but all going a different way. The moral was, do not extrapolate unless you know; and the only way to know was to extend the range of actual observation and measurement.

UPON this foundation Prof. CALLENDAR proceeded to build up the edifice of experimental measurement of high temperatures; and, in an able and interesting discourse, he described the various methods that have been employed in the best and most recent work. Several practical methods used in high temperature research were actually shown, and it was interesting to see, even in this branch of physics, that the universal servant "electricity" has to be called in to assist. Amongst the apparatus exhibited upon the lecture table was an ingenious contrivance for imitating with flowing gases the device known electrically as Wheatstone's bridge. It occurred to us that that apparatus might be useful in teaching the Wheatstone bridge principle to students. Of course the galvanometer was replaced by a sort of differential wind vane, which would indicate, by the motion of a reflected beam of light upon a scale, the presence of a gas flow sufficient to disturb it. Electrical resistance methods, where possible, appear to be the best for measuring high temperatures.

Erratum.—The price charged per unit for motive power and heating by the Hove Electric Lighting Co. (Limited) is 3d. and not 4d. per unit as stated in our issue of the 10th inst.

Blackburn Corporation Electric Tramways.—These tramways have passed the Board of Trade inspection, and will be opened for traffic on Monday next.

Cable Interruptions.	Date of Interruption.
Dakar—Bathurst	Feb. 9, 1899
Paramaribo—Cayenne	Feb. 10. 1899
Cayenne—Pinheiro	Mar. 10, 1899

Electromagnets for Raising Sunken Steel.—It is proposed to use electromagnets for recovering a large load of steel rails, which was sunk in the Ohio River. A crane boat will be equipped with waterproof magnets capable of lifting 4,000lb. each.

Consolidation of Carbon Manufacturers.—A meeting of carbon manufacturers was recently held in Chicago, and it is rumoured that, as a result, a carbon trust is to be formed with a capital of £2,000,000, which will include a number of American manufacturers and own a half interest in the largest Canadian carbon works.

Institution of Civil Engineers.—The annual dinner of the Institution of Civil Engineers took place on Wednesday evening last, in the Hall of Lincoln's Inn, the President, Mr. W. H. Preece, C.B., F.R.S., occupying the chair. Among the speakers were Lord Wolseley, Lord Claud Hamilton, Sir James Sivewright, and Mr. W. L. Jackson, M.P.

Royal Society.—At the Royal Society yesterday, Prof. J. Burdon Sanderson delivered the Croonian lecture, "On the Relation of Motion in Animals and Plants to the Electrical Phenomena which are associated with it." A Paper was also down for reading on "Experiments in Micro-Metallurgy: Effects of Strain," by Prof. Ewing and Mr. W. Rosenhain.

American Naval Electricians.—The *Electrical World* of New York states that preparations are being made by the United States Navy Department for the establishment of a school of electricity for enlisted men at the Brooklyn navy yard. It is proposed to train former apprentices or men acquainted with a machine trade, so that a capable corps of qualified electricians can be organised.

Iron and Steel Institute.—The annual meeting of this institute will be held at the Institution of Civil Engineers on Thursday and Friday, May 4th and 5th, commencing each day at 10:30 a.m. The Council will present their report, and Papers will be read and discussed. A number of members have already promised Papers. We are also able to announce that the annual dinner of the Institute will be held at the Hotel Cecil on May 4th, and that the autumn meeting will take place at Manchester, Aug. 15th to 18th.

The "Electrical World" and "Electrical Engineer."—Our two leading electrical contemporaries in America have effected a "combine," to use a popular American expression, and

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from the 11th inst. will be issued weekly as one publication, to be known as the *Electrical World and Electrical Engineer*, under the joint-editorship of Mr. T. Commerford Martin and Mr. W. D. Weaver. Mr. W. J. Johnston, who for 25 years past has devoted his energies to the building up of the *Electrical World*, has decided to retire from the field of technical journalism, and the management of the joint publication will be entrusted to Mr. J. M. Wakeman and Mr. A. C. Shaw. We wish all success to the publication in its new form.

Röntgen Society.—There was nothing particularly new in Dr. Lowe's Paper relating to practical radiography which he read on Tuesday, the 7th inst. The numerous examples of his radiographic work exhibited in illustration of his Paper were well finished and showed considerable clearness of detail. In most cases, however, the exposure had been somewhat long in consequence of the smallness of the apparatus employed. Dr. Lowe laid stress on the advantage of being able to have the apparatus sufficiently portable to take to a patient's house if necessary. During the discussion numerous curious matters were referred to by different speakers. Mr. Webster, for example, said that in his experience a flexed muscle was easier to radiograph than an unflexed one—a statement somewhat out of harmony with Dr. Lowe's remark that full blooded persons were more difficult to penetrate with the rays than others of an anæmic disposition.

Wireless Telegraphy.—Replying to the petition of the Dover Corporation, that all lightships shall be connected with the shore by means of the system of wireless telegraphy, the Trinity House states that experiments are still being conducted, and that the Corporation's suggestion will be considered in due course. On Saturday last the first practical application of wireless telegraphy on the occasion of a shipwreck was made between the East Goodwin light vessel and the South Foreland lighthouse. A vessel, the "Elbe," went ashore at the south of the Goodwin Sands, and the South Goodwin light vessel fired signals, a thick fog prevailing at the time. The signals being heard at the East Goodwin lightship, communication through the wireless telegraph apparatus at that lightship was made with the lighthouse, from whence telegraphic messages were sent on to Kingsdown and Ramsgate for lifeboats to put out.

The Institution and the Telephone Service.—We stated some weeks ago that the Council of the Institution of Electrical Engineers had appointed a Committee of Members of the Institution to consider and report on the future of electrical engineering in these kingdoms in the branch of telephony. At the ordinary meeting of the Institution on the 9th inst. it was announced that the Council had adopted the following report and rider thereto, submitted by the Committee:—"That, in the opinion of this Committee, it is undesirable, from the point of view of the progress of electrical engineering, for the purely local telephone industry throughout the country to be held as a monopoly; or that legislation on the future of telephony in these kingdoms should discourage the undertaking of exchange systems within telephone areas by independent enterprise." "The Committee is therefore of opinion that the Council should strongly urge on the Government that such legislation may have the further effect of removing existing disabilities to the carrying out of the recommendation." It was also announced that a copy of this report had been forwarded to the Government.

The Late Dr. John Hopkinson.—It is proposed that a portrait of the late Dr. John Hopkinson should be placed in the Hopkinson Memorial Wing of the Engineering Laboratory at Cambridge, the cost to be defrayed by subscription. A chimney-piece which Mrs. Hopkinson has presented for use in one of the principal rooms contains a panel in which such a portrait could appropriately be placed. Mr. T. B. Kennington, who painted a portrait of Dr. Hopkinson some years ago, has suggested that instead of simply copying that picture he could produce a better representation of Dr. Hopkinson as he was shortly before his death by painting an original portrait based on a recent excellent photograph and following the colouring of the previous portrait. Subscriptions are limited to two guineas in the expectation that a considerable number of Dr. Hopkinson's friends, not resident in the University as well as residents, will wish to contribute. Among those who have already subscribed are the Vice-Chancellor, the Master of Peterhouse, the Master of Trinity, Sir Benjamin Baker, Sir J. Wolfe Barry, Sir Frederick Bramwell, Sir Douglas Fox, Sir James Kitson, Sir G. G. Stokes, Sir William White, Lord Kelvin, Lord Rayleigh, Lord Lister. Prof. Ewing is treasurer of the fund, and he will receive subscriptions, or they may be paid to the Hopkinson Portrait account at Barclay & Co.'s Cambridge branch.

The Sullivan Galvanometer.—A modification of the Sullivan galvanometer has been made, which would seem to be of considerable practical utility, its object being to render receiver condensers unnecessary, even when signalling through very long cables. With ordinary galvanometers receiver condensers have hitherto been needed on long cables, in order to secure definition of signals and prevent troublesome wandering of the spot of light or instability of the zero position of the moving system of the instrument. We understand that reports of trials made by an important submarine cable company testify to the success of the arrangement on a submarine cable nearly 3,000 miles long, on which excellent signals wers obtained. Signals on ordinary mirror speaking-galvanometers, under the same conditions, were almost imperceptible and quite unreadable. Briefly speaking, the object is secured by an alteration in the control and the electromagnetic and mechanical damping of the suspended coil, the modification in question involving only the addition of a special and interchangeable suspension frame for each instrument. In view of the attention now being directed to the equipment of our war vessels with the means of communicating in war time through long submarine cables when the occasion may arise, this modified instrument should be favourably received by the Admiralty, as it considerably simplifies the establishment of telegraphic communication through long cables.

Electroplating the Hulls of Vessels.—After a series of tests on copper plating the hulls of vessels, a favourable report has been rendered to the United States Government. The craft which has been under test is the tug "Assistance," an ocean-going boat. She was electroplated and launched on Feb. 22, 1895. A few days ago the "Assistance" was hauled out of the water on a dock opposite the Norfolk Navy Yard. The vessel's bottom was found to be absolutely free from barnacles or marine growth of any kind. For the year just past she has been towing in the lower waters of the Chesapeake, and, while other tug boats were hauled out every four weeks, the "Assistance" remained constantly at work. She early gained the reputation of being the fastest tug. The *Electrical Engineer* of New York states that the method consists primarily in the use of flexible shallow, box-shaped baths, open at one side. Each bath contains a copper electrode and the plating solution, the bath being made water-tight by suitable flexible packing at the edges. Several of these baths are used in the plating of the vessel when in dry dock or upon the stocks, the cleaning of the hull at any one time being only necessary in the places where the baths are to be applied. The baths, which are made flexible in order to follow the curvature of the vessel, are readily supported against its side, on its bottom and along its keel and in other difficult situations, by comparatively simple means, such as tension ropes, screw shores or by magnets attached to the frame of the bath. The vessel is made the negative pole by connection with an electric generator; the plating bath furnishes the positive electrode, and the plating of the entire hull is readily accomplished by shifting the baths from the plated to the unplated sections, and slightly overlapping upon the sections already placed so as to form a continuous coating. A current of $7\frac{1}{2}$ amperes per square foot and a difference of potential of $1\frac{1}{2}$ volts are sufficient to deposit a perfectly uniform, smooth and adherent coating to the metallic surface of the vessel. In order that the density of the solution may be kept uniform during the plating process, circulation is effected by permitting the solution to flow into the bottom and out near the top of the bath. A vessel 400ft. long, drawing 20ft. of water, has about 24,000 sq. ft. of surface below the water line. Assum-

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ing that one-half of this surface is plated at one time, the current required at 7½ amperes per square foot would aggregate 90,000 amperes, which would be furnished by several dynamos if desired, and the power required to deposit the copper would be equivalent to about 185 H.P. A single deposit of suitable thickness can be made in less than three days, and the whole bottom of the ship can thus be plated in eight or nine days, using about 55,500lb. of copper.

Practical Points Concerning Electric Vehicles.—In a Paper read before the North-western Electrical Association, in America, Mr. Percy Maxim states that since the type of battery giving the greatest capacity per pound, apart from other considerations, is probably some form of pasted cell, this type is likely to be the traction battery of the future, but owing to its delicacy and short life at present, the foremost American makers have adopted a combination type of cell. To meet existing requirements, it should have a capacity of from 3·5 ampere-hours per lb. of complete cell, at a discharge rate of at least 1·3 amperes per lb., and be capable of discharging at 4 or 5 amperes per lb. without injury, for short periods. With such a battery, a phaeton for two people should have a mileage of 35, under favourable conditions. High capacity, short life cells in Paris have run 92 miles. The usual American practice is to equip a vehicle with 44 cells in rubber jars, divided into four groups of 11, and thus enabling three speeds to be obtained by changing the grouping of the cells alone. Series motors are in general use, some carriages having two motors mechanically separate, but connected in series, and each driving its own wheel through gearing. This obviates the necessity of balance gear. Coming to the question of delivery vans for a heavier class of work, Mr. Maxim says that a waggon of this class rarely has to travel more than 18 miles during a single trip. Actual tests of the power consumption of this heavier class of electric vehicles showed that 65 watt-hours per 1,000lb. per mile, at a speed of 10·5 miles per hour, is the utmost that might be expected on suburban roads, and the expenditure necessary to recuperate the batteries may, therefore, be liberally estimated at 100 watt-hours per 1,000lb. per mile. Considering a "dry goods type" of delivery waggon actually built, weighing 4,500lb. loaded (including weight of two drivers and 1,000lb. of useful load), the maximum mileage was 25 with 1,300lb. weight of batteries. The energy required for a 15-mile trip would from the above be 6·75 kilowatt hours, or, allowing two trips a day, the yearly energy 4,050 kilowatt hours. The cost of the equivalent horse service is estimated by the author at $500 per year in large Eastern cities in the States. An extensive use of such electric vans, and also the introduction of good services of electrically-propelled omnibuses would, the writer thinks, greatly improve a supply station's load curve. Quite an important and novel feature in this connection is the use which will shortly be made in New York of a so-called charging "hydrant." This is now being perfected by a prominent electric company, and consists of a coin-controlled mechanism with a wattmeter, voltmeter, rheostat, switch, and terminals, such that the driver of an electric vehicle after having deposited the necessary coin in a slot can draw upon it for a certain number of watt hours. The station of the Central Railway and Electric Co., at New Britain, Conn., it is stated, provided itself with facilities for charging itinerant vehicles nearly two years ago.

Motor-Car Design.—In a Paper read before the Liverpool Self-Propelled Traffic Association, on February 28th, Mr. Thos. H. Parker described a motor-car he had built. After experimenting with a brougham drawn through a spring balance by a horse, he found that an electric car for six passengers would have to weigh some 25cwt. The car actually built weighed about 30cwt., and carried nine people. Two motors were used, each supported on a separate frame, and double reduction gear, the rear wheels being the driving wheels. The first reduction was made by means of spur wheels running in oil, and chains were employed for the second reduction, necessitating the use of eccentrics to take up the stretch of the chains. At first the motors were series-wound, designed to run at 950 revolutions per minute, and to give a torque effort of 30lb. on the periphery of each armature, with a current of 25 amperes. The 40 Blot cells were arranged in two groups of 20. The three forward movements were obtained as follows:—First, batteries in parallel, motors in series, giving two miles per hour; second, batteries series, motors series, four miles per hour; and third, batteries series, motors parallel, eight miles per hour. The one backward movement, batteries parallel, motors in series, with current in the armatures reversed, two miles per hour. The steering gear moves both front and hind wheels in opposite directions at the same time and through the same angle. It enables the car to be turned in its own length without turning the wheels under the body, and is naturally double as sensitive as a single bogie or broken axle gear. Another great advantage is that it admits of all four wheels being driven, and the load being equally divided on all four wheels. It gives a good support to the bottom of the vehicle, which in most cases is made quite flat. A trial ten-mile trip, with nine people aboard, was made. During the journey some very stiff gradients were descended, and, although there were powerful brakes upon the car, it was with great difficulty that it could be restrained. After the trip the motors were dismounted and shunt wound. The motors were then re-hung, and the car again tested. Instead of the sudden rush of current as at starting with the series motors, viz., 50 amperes, the car moved steadily away with less than ten amperes, although the current was about the same when the rate of travelling accelerated. Some tests were then made on a road with nothing but gradients varying from 1 in 120 to 1 in 15. The work of manipulating the car was very much reduced, it only being necessary to set it to the required speed and look out for obstacles. On descending the stiffest hill the speed did not increase 5 per cent., and the ammeter read 20 amperes to the good, charging the batteries. In case of need, it was found possible to bring the car to a stand from full speed ahead in 3ft. on a 10 per cent. gradient, without the use of the brake or reversing the motors, an impossibility with the series motors. This original car has been running almost daily for the past 18 months exactly as it was made, and without a single breakdown.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, March 17th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "The Electric Fish of the Nile," by Prof. Francis Gotch, F.R.S.

SATURDAY, March 18th.

INSTITUTION OF ELECTRICAL ENGINEERS.

11 a.m. Students' Visit to the Langdon-Davies Electric Motor Co.'s Works, 101, Southwark-street, S.E.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture—VI.: "The Mechanical Properties of Bodies," by the Right Hon. Lord Rayleigh, F.R.S.

TUESDAY, March 21st.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. The following Paper is down for reading: "Alloys of Iron and Nickel," by R. A. Hadfield.

WEDNESDAY, March 22nd.

INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Students' Meeting at 28, Victoria-street, S.W. Paper to be read: "The Synchronising of Alternators," by R. P. Howgrave-Graham and M. R. Gardner.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "Electric Traction," by Philip Dawson.

THURSDAY, March 23rd.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read: "The Hissing of the Electric Arc," by Mrs. Ayrton.

FRIDAY, March 24th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Papers to be read: (1) "On the Criterion for the Oscillatory Discharge of a Condenser," by Dr. Barton and Prof. Morton; (2) "The Minor Variations of the Clark Cell," by A. P. Trotter.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Transparency and Opacity," by the Right Hon. Lord Rayleigh, F.R.S.

SATURDAY, March 25th.

INSTITUTION OF JUNIOR ENGINEERS.

3 p.m. Visit to the Testing Station of the British Fire Prevention Committee at Hanover Gate, Regent's Park, N.W.

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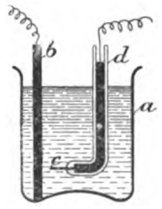
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Source of Atmospheric Electricity.—The evaporation of the moisture of the earth's surface has for over a century been considered to account for the electric charge of the atmosphere, but, strange to say, it has been found almost impossible to prove that even a highly charged body of water, in evaporating, loses any of that charge with the vapour that rises from its surface. Lecher, indeed, proved such a loss with a potential of 25,000 volts, but then, as he says himself, the liquid was practically "pulverised," and was at any rate widely removed from ordinary conditions, such as they exist at the earth's surface. H. Pellat has now succeeded, however, in demonstrating a loss of 40 to 60 per cent. of the original charge in an hour's evaporation from a very shallow dish connected with a quadrant electrometer, and negatively charged by a battery giving 116 volts. Applying this observation to the negative charge of the earth, it appears that there must be a loss of that charge, and a gain of negative electrification by the air, during the first warm hours of the day, and the reverse process must set in after sunset. This is actually the case in all published observations. But these observations also show a minimum at 4 a.m. and a maximum at 8 p.m. Neither of these are yet accounted for. They are probably due to some influence as yet unknown.

[Pellat, *Comptes Rendus*, Jan. 16, 1899.]

An Electrolytic Interruptor.—A discovery of more than ordinary interest has been made by A. Wehnelt. Starting from the well-known fact that a current passing through a liquid between two electrodes of very unequal area is capable of producing luminosity on the smaller electrode, and that these luminous effects show signs of intermittence, the author



determined whether there was a true interruption of the current, or only a variation between a maximum and minimum value. On inserting a lead plate, *b* (*see* diagram), and a platinum electrode, *c*, in a beaker, *a*, filled with dilute sulphuric acid, taking care to conduct the current to the wire through a tube, *d*, filled with mercury, to prevent spluttering, he found that such a cell, with the wire as anode, acted as a very perfect interruptor of frequency about 1,000 per second, giving sparks over 40cm. long with 6 amperes and 12 volts. A condenser is superfluous, and there is nc need to eliminate self-induction. The interruptions occur with remarkable regularity, as may be judged by the constant pitch of the tone emitted. The new interruptor should be very useful for purposes of wireless telegraphy.

[Wehnelt, *Elektrotechnische Zeitschrift*, Jan. 26, 1899.]

Vacuum Tubes.—It is well known to all users of X-ray apparatus that under the discharge from an induction coil the tubes rapidly rise in vacuum, and the current, after a longer or shorter time, ceases to pass, and the usefulness of the tube is at an end. C. C. Hutchins maintains that it is probably incorrect to assume that the molecules are bodily driven through the walls of the glass tube. For cracked tubes and radiometers often work well for a considerable time. This argument is, of course, not by any means conclusive, but whatever may be the cause of this annoying defect, it is important to find what kind of gas is least readily absorbed by the electrode metals or by some other unknown process at work within the tube. As the result of a number of experiments made with zinc cyanide, lead ferrocyanide, iodine, and oxide of mercury, the author found that the oxygen derived from the last-named substance yielded the best results. In order to construct an X-ray tube in which the vacuum may be maintained at the most efficient point, he attaches near the anode terminal a short tube having a sealed-in platinum wire packed around with oxide of mercury. The regulation may be made automatic by shunting some of the current through the platinum wire, and inserting in the shunt a spark gap of suitable size, so that whenever the vacuum becomes too high a little oxygen may be given off to restore it.

[Hutchins, *Amer. Jour. of Science*, January, 1899.]

Condenser Losses.—The resonance method employed by E. B. Rosa and A. W. Smith (see *The Electrician*, p. 600), for measuring the energy dissipated in condensers subjected to an alternating E.M.F., is not sufficiently delicate to give accurate values in the case of paraffined paper condensers. The same authors have, therefore, constructed a special calorimeter for the purpose of measuring the total quantity of heat produced in the condensers. Tests made with a number of Stanley paraffined-paper condensers showed that they could easily stand 500 volts alternating E.M.F., as indicated by the makers; but that the loss of energy in the condensers was incalculable, and varied in different specimens within wide limits. At a frequency of 140 per second, the smallest loss observed was 0·74 per cent. One lot of condensers gave a nearly uniform loss of 1·5 per cent., while another lot went as high as 10 per cent. on high frequencies. In beeswax-and-resin condensers the loss was 6 or 8 per cent. As in the experiments with the resonance method, the energy loss was found to be highest at 40°C., and that temperature also represented the maximum for residual charge. The authors maintain that the singing or hissing of a condenser is not connected in any way with its efficiency.

[Rosa and Smith, *Phil. Mag.*, Feb., 1899.]

Anode Rays.—It is not surprising that the major portion of modern electrical research deals with vacuum discharges. After 50 years of constant study, the vacuum tube still presents a large number of problems, and these problems are of such a nature that their solution must exert a pronounced influence upon the practical applications of electricity. It may safely be said that the future of electrical engineering is sealed up in a vacuum tube. Any experiments throwing further light on vacuum phenomena must, therefore, be of great interest. A. Broca has simplified matters by mounting two pointed electrodes of platinum, 2mm. thick, in the centre of a spherical vacuum bulb, and surrounding the stems of the electrodes with glass tubes. The distance between the points was only half a millimetre. With a sparking distance in air of about 12cm, a very small and very brilliant spark was obtained at every discharge. After some time, a small crater was formed in the anode, resembling the crater formed in the positive carbon. This distinctly proves the discharge of some material particles, and thus furnishes another proof of the emission theory. Ordinarily, whatever material disintegration there is is found in the cathode. But that is simply due to the fact that in the ordinary tubes the potential gradient is steepest at the cathode. In the spherical tubes described the potential gradient is probably concentrated near the anode, or, if it is uniform, the metal, being electropositive, naturally escapes from the anode. That it is projected with considerable force is shown by the fact that no metal is deposited on the cathode, but that it goes to the glass wall. When the bulb is introduced into a magnetic field, the "anode rays" are deflected in a sense opposed to the deflection of cathode rays. They also show a left-handed screw motion where the cathode rays show a right-handed twist. Hence we have here again a "Zeeman effect on a large scale," but more complete, since the direction of the twist corresponds to that of Zeeman's metallic ions.

[Broca, *Comptes Rendus*, Feb. 5, 1899.]

Radiation in a Magnetic Field.—In a previous Paper, T. Preston pointed out that while the majority of spectrum lines became triplets when the source of light was placed in the magnetic field, and viewed across the lines of force, this did not hold good of all the lines, for some were resolved into quartets, or sextets, or other forms by the magnetic field under

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precisely the same circumstances. His idea, enunciated at that time, that these anomalous forms might be derived from the standard triplet by reversal, has been shown to be erroneous by experiments made with more powerful magnetic fields. According to the electromagnetic theory, the separation, $d\lambda$, of the side-lines of a magnetic triplet should, under the same conditions, vary directly as λ^2 as we pass from line to line of the same spectrum. This is not the case, but the results so far obtained confirm the supposition that the lines of any one substance may be thrown into groups, for each of which $d\lambda$ varies as λ^2, and each of these groups may be produced by the motion of a single ion. The number of such groups in a given spectrum thus gives us an idea of the number of ions in the atom or molecule. The Zeeman effect is therefore a valuable means of inquiry into the hidden nature of the events which bring about the radiation from a luminous body.

[PRESTON, *Phil. Mag.*, February, 1899.]

Secondary X-rays.—According to G. Sagnac, the bundle of transformed rays emitted by a body under the influence of X-rays constitutes a mixture of various rays whose powers of penetration, inferior to those of the X-rays which generate them, form a series which is the longer the more profoundly the original X-rays are modified. The heavy metals especially emit very heterogeneous secondary beams. The more easily absorbed rays are absorbed by a few millimetres of the air itself. The author calls the secondary rays S-rays. He describes an interesting experiment made by laying a sensitive film upon a metallic plate exposed to X-rays, and gently inclining the film with respect to the metal. The X-rays, of course, produce a blackening which is uniform all over the film. But where the layer of air between film and metal is not thicker than 1mm., the blackening is intensified by the action of the S-rays. Quite close to the edge of the film, however, where the thickness of air is not more than 0·1mm., there is a distinct brightening. The author suspects here the presence of some S-rays capable, like ordinary light, of neutralising the photographic effect of X-rays, and recalls Schumann's discovery of extreme ultra-violet rays of $0{\cdot}1\mu$ wave length, which also possess this property, and are absorbed by a layer of air 0·1mm. thick.

[SAGNAC, *Comptes Rendus*, Jan. 30, 1899.]

THE GOVERNMENT TELEPHONE BILL.

The Government Bill "to make further provision for the improvement of telephonic communication, and otherwise with respect to telegraphs" was read a first time on Thursday last week. Its full text is as follows:—

1. The Treasury may issue out of the Consolidated Fund or the growing produce thereof such sums, not exceeding in the whole the sum of two million pounds, as may be required by the Postmaster-General for the purpose of the Telegraph Acts, 1863 to 1897, according to estimates approved by the Treasury, and Sub-sections 2 and 3 of Section 1 of the Telegraph Act, 1892 (which relate to the mode in which money may be raised) shall apply with respect to the sum so authorised to be issued.

2. (1) Where the council of a county borough are licensed by the Postmaster-General to provide a system of public telephonic communication, they may defray the expenses of exercising the powers conferred by the licence out of the borough fund or borough rate, and may borrow money for the purpose in accordance with the Public Health Acts, but any money so borrowed shall be borrowed on the security of the borough fund or borough rate, and the council may, subject to the provisions of the Telegraph Acts, 1863 to 1897, and of the licence, exercise their powers under the licence throughout the area for which it is granted, although part of that area may be outside the borough.

(2) In the application of this Act to Scotland, a Royal or Parliamentary burgh having a population of over 50,000, according to the last census for the time being, shall be substituted for a county borough, and the town council or commissioners thereof for the council of a county borough, and the police or borough general assessment or rate of the like nature for the borough fund or borough rate: and the council or commissioners may, with the consent of the Secretary for Scotland, borrow for the purposes of this section on the security of that assessment or rate, but subject to the conditions for the repayment of loans prescribed by the Public Health (Scotland) Act, 1897.

(3) In the application of this section to Ireland, the Public Health (Ireland) Acts, 1878 to 1896, shall be substituted for the Public Health Acts.

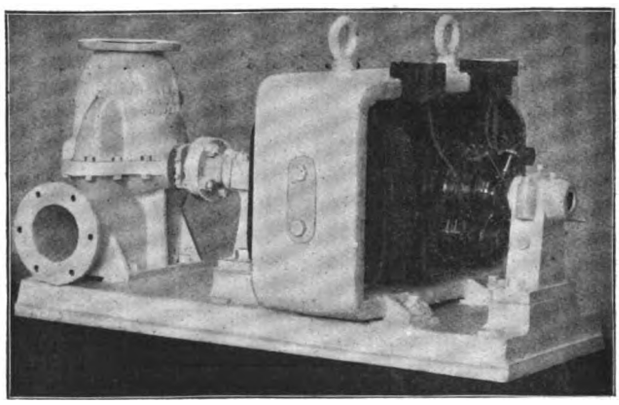
3. This Act may be cited as the Telegraph Act, 1899, and may be cited with the Telegraph Acts, 1863 to 1897.

The chief feature of the Bill is its shortness, the pledges and safeguards mentioned by Mr. Hanbury, in his recent speech in the House of Commons, having, it appears, been studiously omitted. Thus, nothing is said of the purchase "of all that is good and useful" in the municipal and National Telephone Co.'s exchanges at the end of 1911; there is no clause to prevent agreements, prejudicial to the public interest, between the Company and local authorities, and no mention is made of wayleaves or royalties. This has already attracted the attention of Sir James Fergusson and Mr. Provand. In reply to questions by them, Mr. Hanbury stated on Tuesday that it was evident that the House should be possessed of adequate information as to the proposed mode of giving effect to Clause 2 of the above Bill when it came on for a second reading, and that probably the best method of giving this information would be by a Treasury Minute.

It is to be hoped that the matters mentioned above, if not included in the Bill in the committee stage, will at least be explicitly dealt with in a Treasury Minute, as suggested by Mr. Hanbury, and that none will be left to be disposed of in the individual licenses to be granted by the Postmaster-General. The wayleave facilities conditionally promised to the National Telephone Co. may be accorded by allowing certain clauses of their private bills to pass. The supporters of the Company, and of fair play, will no doubt remember that, if the Government Telephone Bill is passed in its present form, no opposition can be raised to the subsequent granting of telephone licences to local authorities in whatever terms the Postmaster-General may fancy, and they should do their utmost to oppose the passage of this Bill unless the promised guarantees are previously secured by additional clauses in the Bill itself, or in the form of a Treasury Minute. In any case this Treasury Minute should be forthcoming before the Bill is proceeded with—it will not do, on this occasion, to rely on mere verbal assurances.

ELECTRICALLY-DRIVEN PUMPS AT GLASGOW CORPORATION STATION.

We have received from the manufacturers, Messrs. W. H. Allen, Son and Co., some interesting particulars of recent tests of the electrically-driven pumps supplied by them for



DIRECT-COUPLED ELECTRIC CENTRIFUGAL PUMP AT GLASGOW CORPORATION NEW ELECTRIC SUPPLY STATION.

the condensing plant at the Glasgow Corporation new electric supply station. An illustrated description of this station appeared in our issue of February 3rd, and embodied an account of the condensing plant outfit. Two of the illustrations accompanying this article are from photographs of the electrical pumps, the larger one showing an electric motor geared by Hollick's friction gear to a three-throw air pump, the other showing a direct-coupled centrifugal pump. Each condensing set consists of one surface condenser, together with one set of three-throw single-acting air pumps, on Edwards' principle, and one "Conqueror" centrifugal circulating pump. The circulating pump and its motor are mounted

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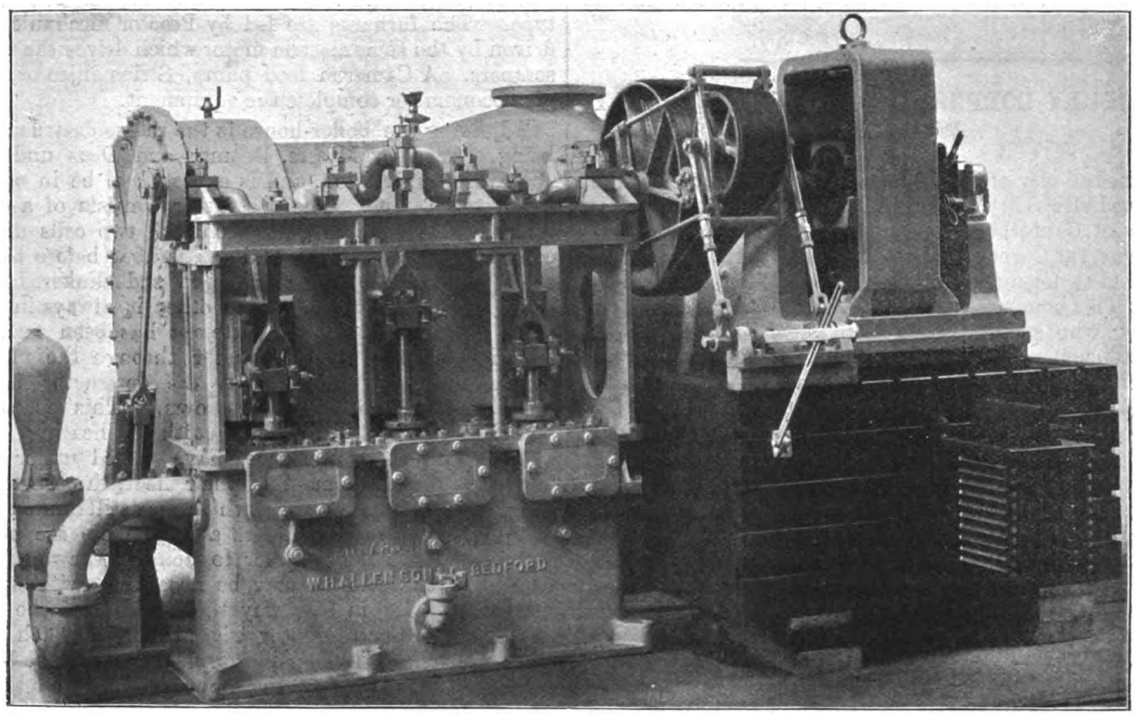
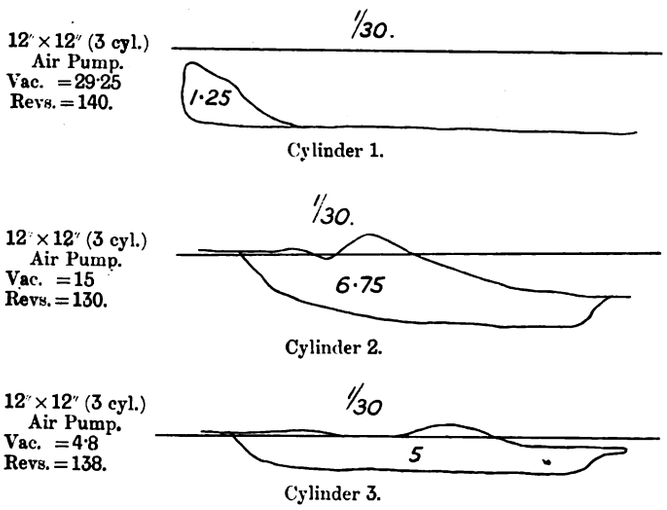
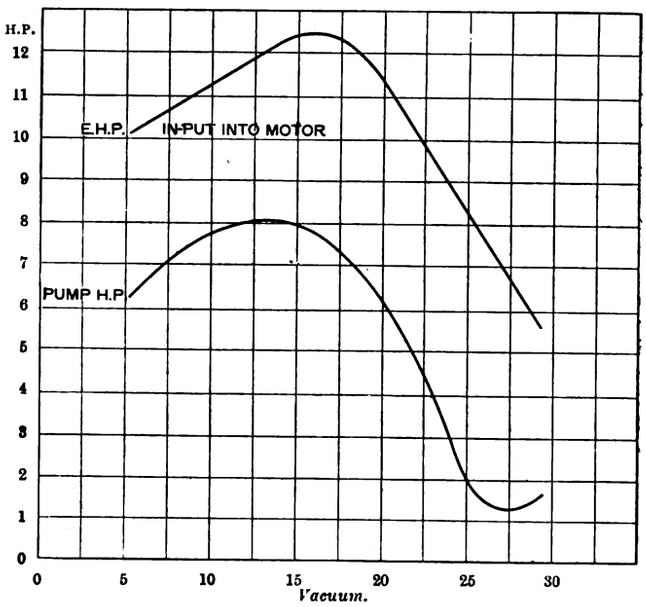
on one bedplate. Each surface condenser has a tube surface of 1,250 square ft., and is one of Messrs. W. H. Allen, Son and Co.'s standard sets. It consists of a circular cast iron shell, with the supporting feet and all the necessary branches cast on. It is fitted with bronze tube plates and solid drawn bronze tubes $\frac{3}{4}$in. external diameter. The holes in the tube plates through which the tubes pass are drilled and tapped so as to form recesses for tape packings, which are screwed up tight by means of bronze ferrules, making the joints round the tubes thoroughly steam- and water-tight. The ferrules are made with shoulders, which allow the tubes to expand freely, but at the same time do not allow them to slip out of place. The steam circulates round the outside of the tubes, and the cooling water passes through the lower half of the tubes in one direction, then in the opposite direction through the upper half of the tubes. Two large doors, one at each end of the condenser, give easy access to the tubes for cleaning and repacking.

The air pumps, as mentioned above, are of the Edwards type. Each set consists of three pumps; the body of the pumps is in one casting; the three plungers are each 10in. in diameter, with a stroke of 10in.; the liners, plungers and top delivery valves are all of gunmetal. The body of each pump carries a framing, in the top part of which are the main bearings for the three-throw crankshaft. Each plunger is connected with its crank by means of a crosshead and connecting rod, and the weight of each set is identically the same, to ensure good balance and even turning. The large friction wheel of the Hollicks gear is keyed to the crankshaft, while the smaller wheel is carried by a vibrating frame centred on the crankshaft in such a way that by elevating or depressing a handle the two wheels can be put out and into gear with the small pulley on the dynamo spindle. A great feature in this system of driving is the fact that the motor can be started by itself, and when running at the correct speed the pumps can be put into operation by means of the friction levers. The pumps when doing full duty run at a speed of 150 revolutions per minute, and the motor at 800 revolutions per minute, and at



ELECTRICALLY-DRIVEN THREE-THROW AIR PUMP AT GLASGOW CORPORATION NEW ELECTRIC SUPPLY STATION.
Built by Messrs. W. H. Allen, Son and Co.





12 × 12 (3-cylinder) Air Pump, 150 revs.

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this speed each plant deals with 15,000lb. of steam per hour. Tested on the condenser only, and with a little water passing through the pumps, they will maintain a vacuum only ¼in. to ½in. below the absolute.

The centrifugal circulating pumps have 7in. suction and discharge branches, the revolving discs are 13in. in diameter; each pump is capable of discharging about 1,000 gallons of water per minute through the condenser, against a total head of 10ft. at 530 revolutions per minute. The motors for driving the air pumps as well as the circulating pumps are wound for 500 to 600 volts.

CANTERBURY CORPORATION ELECTRIC SUPPLY WORKS.

The cathedral city of Canterbury now possesses a small but well-designed electricity works, which was formally opened by the Mayor of Canterbury on Friday last. As usual in provincial towns, the Corporation itself did not think of acquiring a Provisional Order until a private company had set them the example. This company was the Gas and Water Company of Canterbury, who sought, when bringing in a Bill for the further extension of their plant, to obtain powers to supply electrical energy as well as gas and water. Following on the refusal of these powers, the Brush Company gave the Corporation notice of their intention to apply for a Provisional Order, and this spurred the latter body into action, and the Town Council obtained its own Order in June, 1891. Negotiations between the Brush Company and the Corporation for the transfer of the Order to the Company were entered into, but were abandoned, a hitch occurring at the last moment before the agreement was signed. It was not until September, 1895, that the Council appointed Mr. Robert Hammond to draw up a report on the question of a public supply of electricity. Mr. Hammond recommended the Corporation to undertake the work themselves, and was of opinion that it might be done profitably. He also recommended the erection of a dust destructor, from which some of the steam required for the works could be generated. After considerable discussion the report was adopted, and an application was made to the Local Government Board to sanction a loan of £20,000 to carry out the initial work. Owing to opposition, however, the Local Government Board inquiry did not occur until May, 1897, so that it was only in November of that year that Mr. Hammond issued his specification and that tenders were invited.

Mr. Hammond chose the low-pressure three-wire system, with a voltage of 440 between the outers, Lancashire boilers, direct coupled dynamos and mains laid directly in the ground. In order to obtain consumers as quickly as possible, the Corporation issued a circular offering to carry service mains into premises free of charge, provided that the request for connection was made before the trench in front of the house in question was closed. Several took advantage of this offer, with the result that over 100 consumers were connected to the mains on the first night of the supply. In fact, the plant which has been erected is already fully loaded, and Mr. Hammond has drawn up a specification for a 150 kilowatt extension, involving a further expenditure of £12,000. Tenders for the additional plant have recently been invited. The cathedral is at present lighted by gas, but it is hoped that it will not be long before electric light is introduced there.

The following are the contractors for the various parts of the plant:—

Buildings and foundations	A. J. Brewster, Canterbury.
Boiler house plant	Robert Taylor and Sons.
Engine room plant	India Rubber, Gutta Percha and Telegraph Works Co.
Overhead travelling crane	James Spencer and Co.
Switchboard and instruments...	Crompton and Co.
Battery	Chloride Electrical Storage Synd.
Mains	Western Electric Co.
Public lamps.....	Crompton and Co.
Meters	S. Z. de Ferranti.

As seen in the map, the generating station lies at some distance from the centre of the town. This is, perhaps, as well, in view of the dust destruction which is to take place there. There is an ample supply of condensing water and an easy approach for coals. The detailed plans for the buildings were made out by the City surveyor Mr. A. H. Campbell, and the building contract was let to a local firm. The steam raising plant, erected up to the present consists of two Lancashire boilers, each 30ft. long and 7ft. in diameter, designed for working up to a pressure of 140lbs. per square in. The boiler fittings comprise a dead-weight safety valve, high steam and low water valves, junction valves, &c.; and the water gauges and blow-off valves are of the Hopkinson type. The furnaces are fed by Proctor mechanical stokers, driven by the same electric motor which drives the economiser scrapers. A Cameron feed pump, Sirius injector, and a 96 pipe economiser complete the equipment.

Adjoining the boiler-house is the refuse destructor which is being erected by Messrs. Beaman and Deas under the city surveyor's supervision, and is expected to be in operation in a few weeks' time. The destructor consists of a double-cell furnace, in which the gases from the two cells meet in one common combustion or mixing chamber before they pass to the boiler, each cell being charged and clinkered in turn, so that the charge in one or the other is always in an intense stage of combustion. No attempt has been made to pass the hot gases of the destructor through the main boilers of the electricity station, but the destructor is provided with a steam boiler of its own. This is a Babcock and Wilcox 140 H.P. boiler with a heating surface of 1,620 sq. ft. After the gases have passed under the boiler and have given up most of their heat, they traverse a dust chamber, in which any dust, which may still remain suspended in them, is deposited. Doors and dampers are provided in connection with the chamber to facilitate the removal of this final dust as often as may be necessary, without seriously inconveniencing in any way the working of the electricity station. An electric motor drives the hoist which carries the refuse up to the tipping platform, and from the latter there is a gangway leading to above the coal bunkers in the boiler house, so that the coal is also brought into the works by this means. A 30in. fan is provided to supply the forced draught to the furnace; this fan and also the hoist will be worked by one of Messrs. D. Bruce Peebles and Co.'s protected motors, the fan motor and feed pump being installed in a glazed enclosure in the destructor house.

The generating plant consists of two Belliss-Silvertown high-speed sets, the engines being of the usual two-crank Belliss compound type, and the dynamos of the single horse-shoe under-type. One dynamo is fixed at each end of the crank shaft. Each double set is capable of giving an output of 75 kilowatts at a pressure of from 220 to 250 volts, but it can be overloaded to 84 kilowatts if necessary. The working pressure is 125lb. per square inch at the stop valve when condensing, or 140lb. when non-condensing. Each set is fitted with a Körting condenser, capable of maintaining a vacuum of 26in. when the engine is working at full load. The condenser is fitted with a non-return valve, and a Blake and Knowles automatic valve is fixed in the branch pipe leading to the open air. By an arrangement of levers, an air cock on the condenser is interlocked with the water valve in such fashion that the air cock must be opened, and the vacuum broken, as soon as the water valve is partly closed. By this means the full head of water on the condenser is ensured. The steam range is comprised entirely of lap-welded steel pipes. From each boiler there is a 5in. branch leading into a cast-iron tee-piece fitted with a steam trap. These tees are connected by a 6in. steel pipe, fitted with a parallel slide valve with outside screws, and from these are led the 4in. steel branches to the engine separators, each branch being furnished with a stop valve, which can be manipulated from the engine room floor level. The steam, after leaving the engines, is exhausted either direct into the atmosphere or into the condenser. The atmospheric exhaust pipe and the discharge pipe from the condenser are laid side by side under the engines, passing through separate tunnels in the concrete foundations. Outside the building, the atmospheric pipe, rising to a height of 10ft. above the roof, and the discharge pipe terminates in a brick sump, from whence the condensed

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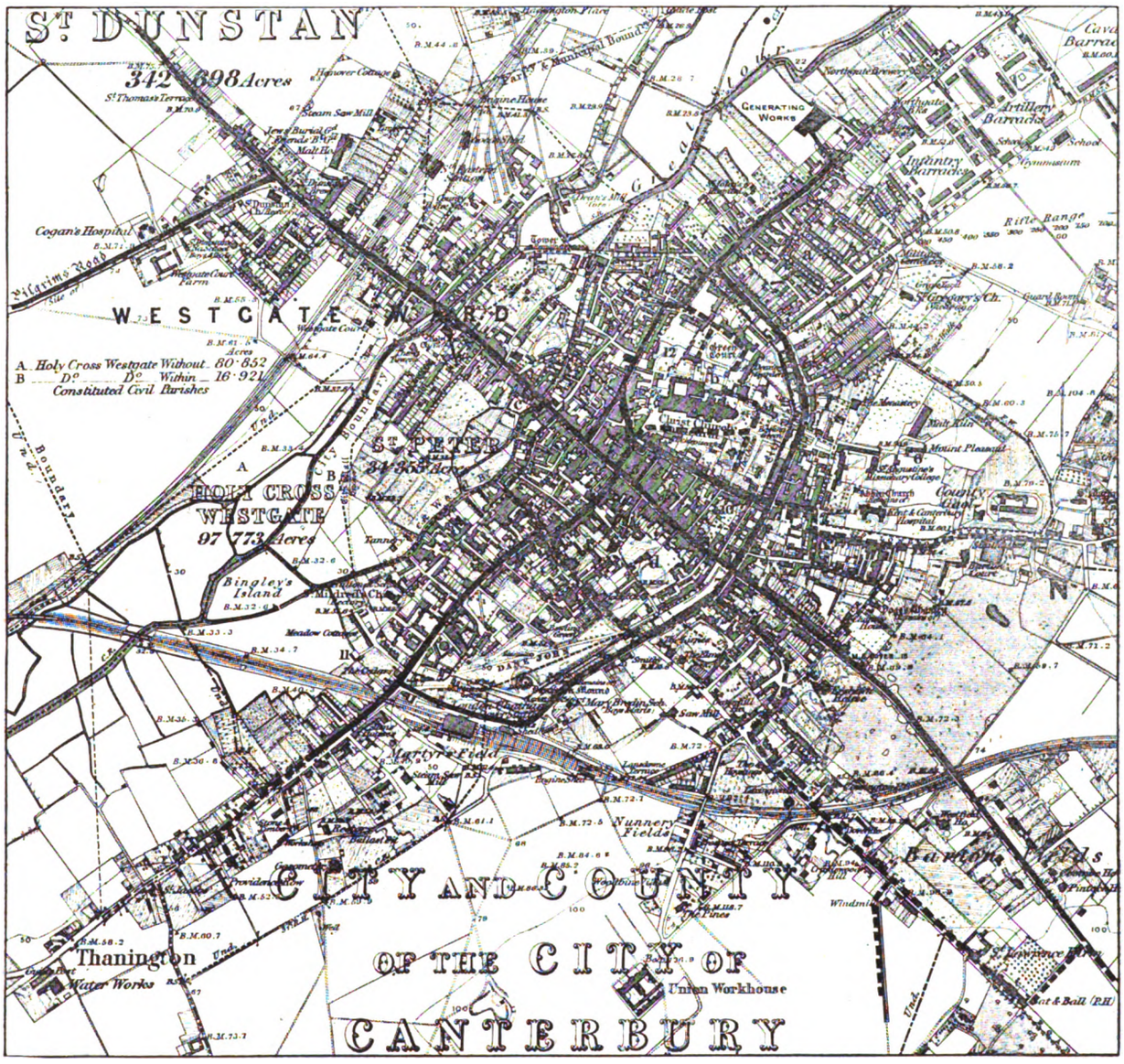
steam and water are returned to the river. The drain pipes from the engines follow the same course.

The water for boiler feed and for condensing purposes is pumped from a sump outside the building by means of two electrically-driven centrifugal pumps, each capable of lifting 5,000 gallons per hour, the total lift being about 30ft. The pumps are of Messrs. Evans's make and are driven by Silvertown motors. Both pumps deliver into a cast-iron water storage tank, which serves as a roof to the economiser chamber. The tank has a capacity of 20,000 gallons, and a float and index show in the engine room the height of water in the tank. The town's water supply can also be pressed into service if required. The feed water is drawn from a small underground tank connected to the larger tank through a Kennedy meter, the level in the smaller tank being kept constant by means of a ball valve. The exhaust steam from the feed pump is utilised to raise the temperature of the feed water, a flat condensing coil being fixed in the feed water tank for this purpose. The feed pump has two deliveries, and from it to the boilers there is a complete double range of 9in. cast iron feed pipe, one for hot feed (through the economiser), and the other for cold. The injector can also deliver water into either the hot or cold feed range.

In addition to the steam dynamos there is a variable ratio motor-generator. The generator side is designed for a current of 90 amperes, with a variable pressure of from 20 to 100 volts, the motor being driven at a pressure of 220 to 250 volts.

The whole of the engine house plant and pipework has been erected by the India Rubber Company. An overhead travelling crane, capable of lifting up to 10 tons, spans the engine house.

The storage battery consists of 280 Chloride cells of the R type. They are in glass boxes, and have a capacity of 630 ampere-hours, being capable of maintaining a discharge continuously for 10 hours with a terminal E.M.F. of 500 volts. It is, however, only intended to charge 240 cells at the start, the remainder being held in reserve and for spare, and added as required. The cells rest on wooden trays supported on glass insulators, and arranged on pitchpine stands, of which all horizontal parts are protected from acid spray by sheet lead bent along the edges in the form of an inverted U. The connections from the cells to the switchboard are made with lead-covered cable. The battery is charged direct from the 'bus bars, a somewhat novel feature of the arrangement being the position of the regulator cells which are not fixed on the extremities, as is usual, but in the centre of the battery on either side of the middle wire. The object of this arrangement is to enable all the regulator cells to be charged by the motor-generator at the same time that the main battery is being charged.



MAP OF MAINS.

Existing Mains. Extensions in hand.

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The work in connection with the switchboard and regulating gear has been carried out by Messrs. Crompton and Co. The switchboard is on a gallery overlooking the engine room, and is divided into three sections: the positive on the right, the battery and middle wire in the centre, and the negative on the left. It is arranged for dealing with the four dynamos, arranged two on either side of the three-wire system, and five feeders, and has the necessary gear for charging the battery. The side sections are divided horizontally into three panels, devoted to dynamos, plug bars and feeder circuits respectively, reckoning from the bottom panel. In circuit with each dynamo is placed, on the lowest of the three panels, an ammeter, a Crompton minimum cut-out and a combined duplex switch and fuse, the switch being arranged with a special sparking piece in order that its main contacts may not suffer damage should there be any current passing when the switch is opened. A Kelvin multi-cellular voltmeter in the centre of the panel is common to the two dynamos. The slate above contains the plug bars, which are of massive construction, and are so arranged that either dynamo or battery may be connected on to any one of the five feeders or on to the works circuit. On the top panel are the five duplex switches and fuses and ammeters for the feeders. The negative and positive sections of the board are exactly similar.

A sloping slate shelf, at a convenient height, runs the entire length of the board, and on it are mounted the shunt breaking switches and also the rheostats for the dynamos and the motor generator. The starting switch for the latter is placed on the wall of the engine-room close to the machine itself.

The centre section of the board contains the battery and middle wire connections. There is a charging switch, whose contacts are on the board, and a 30-way discharge switch. The handle and indicator only for the latter are on the board, the switch itself being bolted to the battery room wall, a few feet behind the back of the switchboard, and operated from the front of the board by a long spindle, for the battery room is on the first floor, just behind the switchboard gallery.

The motor side of the motor-generator is wound for 220 volts, and can be switched on either side of the system. On the top panel of the middle section are Kelvin multi-cellular voltmeters for reading the voltages at the omnibus bars and feeding points, and of the battery and motor-generator, the switches for these voltmeters being placed within easy reach below. At the top of the board are placed the two battery ammeters, the middle wire ammeter and also the ammeter for reading the charging current of the motor-generator.

All ammeters on the board are of the Crompton shunted pattern, the shunts being placed at the back of the board, and the multi-cellular voltmeters were manufactured by Messrs. James White, of Glasgow. The whole board is contained in a wrought iron frame, the slates being held in position by bolts passing through ebonite bushes. A brass strip is screwed on to the front of the framework in order to hide the joints.

Underground Mains.—The mains laid up to the present are shown in the map. The Western Electric Co., manufacturers of the cable, also performed the laying, but the "making good" was done by the Corporation. All the cables are triple concentric, lead covered and armoured, and are laid directly in the ground, without conduits. The neutral wire of the system is placed on the outer of the cable. The insulation between the inner and outer conductors is composed of paper and jute, the remaining insulation of jute only, the whole being impregnated with Fowler-Waring insulating compound and covered with lead $\frac{1}{8}$in. thick. The lead-covered cable is then served with Hessian tape, armoured with two steel ribbons each 0·040in. thick, and finally served again with two Hessian tapes.

The distributing network, consisting of 0·125 sq. in. and 0·1 sq. in. triple concentric cables, is so arranged that it embraces the whole of the principal streets, making a total length of 5½ miles. This network is fed at five points by triple concentric feeder cables, terminating in specially-designed boxes, and there are pilot wires back to the works. Wherever possible the pilot wires have been made up, forming 6-core and 9-core cable. Three-way and two-way disconnecting boxes have been fixed at various points in brick pits, so that any sections can be fed independently from any of the five-feeder cables if necessary.

The house connections are made to the mains by means of a split form of box made by the Western Electric Co. These boxes are filled with insulating compound. The end of the service cable is finished off in a newly designed single pole fuse box made by the same firm, who undertook the connection of consumers' wires to the mains, the fixing of meters and the connection of the cables to meter-board and switchboard in the works.

Very little street lighting by electricity has been done in Canterbury up to the present. Thirteen arc lamps have been erected, but 16 c.p. incandescent lamps are to be substituted for gas lamps along the whole length of the mains. The posts and brackets for the latter are being made specially, and will number 170. The lamps will be enclosed in Frédereau lenses. The arc lamps are arranged to run in a series of nine off the 440 volt mains, controlled from the works, and one series of four at 220 volts, with a controlling switch and resistances, at the Police Station. They are of the Crompton-Pochin type, burning 17 hours and taking 10 amperes. As is usually done, each lamp is arranged with an automatic switch, which throws a substitution resistance into circuit if the lamp "hangs up" for any reason. The incandescent lamps will be controlled from six centres, and connected to one of the outers of the distributors. Each lamp, therefore, has one terminal connected to the middle wire of a distributor, and the other terminal connected to a single armoured common return cable through the switch to the outer wire. These connections are arranged in a special junction box. The lamps and pillars have been supplied and fitted up by Messrs. Crompton and Co., the lamp and switch pillars being cast by Messrs. James Allan, sen., and Son, and Messrs. McKenzie Bros.

PHYSICAL SOCIETY.

At an ordinary meeting on March 10th, Prof. Oliver Lodge, F.R.S. (President) in the chair, Mr. A. A. Campbell Swinton described and exhibited the Wehnelt current interrupter. A glass cell contains a large cylindrical negative electrode of lead, and a small positive electrode consisting of a platinum wire about $\frac{1}{16}$in. or ¾in. in length, in a solution of one part sulphuric acid to about five parts water. The platinum wire may project from the top of the shorter arm of a J-shaped ebonite tube, so that it can point upwards immersed in the solution. Or it may be fused into a similar glass tube; but glass is apt to crack in the subsequent heating. Wehnelt's interrupter replaces the make-and-break apparatus of an induction coil; it also replaces the ordinary condenser of that apparatus. In its present form it requires rather a strong current. The resulting spark at the secondary terminals differs in character from the ordinary spark of an induction coil; it is almost undirectional, and in air takes a V-form, bright, continuous and inverted—somewhat like a pair of flaming swords rapidly crossing and recrossing one another at their points. By blowing upon the V it breaks up, and then more nearly resembles the customary discharge of a coil. The sound emitted by the spark has a pitch that varies with the conditions of the circuit. As the self-induction of the circuit is diminished the spark-pitch rises; it becomes infinite when the self-induction vanishes, *i.e.*, the Wehnelt interrupter will not work in a circuit devoid of self-induction. As the applied potential difference diminishes the spark-pitch diminishes. In Mr. Campbell Swinton's experiments 25 volts was the minimum primary voltage at which his apparatus would work. The spark-pitch also varies with the length of the platinum wire electrode in the solution. If the circuit is closed by dipping this electrode into the solution, the apparatus will not work; the wire must be dipped in before closing the circuit. After working for about a quarter of an hour the action often ceases; this fatigue effect is not due to heating of the solution, for it is not obviated by keeping the temperature constant by a water bath. It is supposed that the oxygen generated at the platinum electrode forms a more or less insulating film which interrupts the current until absorbed by the surrounding water. The fact that oxygen is more easily absorbed than hydrogen may explain why it is necessary to connect the platinum electrode to the positive pole of the battery or dynamo. When the platinum electrode is dipped gradually into the solution, the wire gets red hot, and the interruptions do not take place. Again, when the apparatus stops, from fatigue,

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the platinum gets red hot. The action is further complicated by a series of small explosions, and by the formation of a kind of electric arc at the platinum electrode. The coil exhibited was connected to the 100-volt electric light mains at Burlington House; in this case the potential difference at the terminals of the primary was 30 volts, and that across the interrupter 150 volts—a total of 180 volts, showing the effect of impedance. For Röntgen-ray work the apparatus would be very effective, but unfortunately the sparks produce great heating, so that the cathodes of tubes are melted. Mr. Campbell Swinton suggested that as the sparks were more nearly contiuuous than ordinary discharges they might produce Hertz waves less rapidly attenuated than those now applied to wireless telegraphy; the trains of waves would also follow one another at shorter intervals than those from the sparks at present employed.

The PRESIDENT said he was rather surprised that the self-induction of the primary coil was not sufficient of itself to form the induction factor in the impedance necessary for perfect working. He would like to know how the apparatus behaved when an alternating current was used. Did the secondary coil become damaged by over heating? Did reversal of the current assist the recovery from the fatigued condition of the apparatus? The natural period of the circuit depended upon its capacity and its self-induction. There was undoubtedly capacity at the surface of the platinum electrode in the liquid; this capacity acted together with the auxiliary self-induction, and the self-induction of the rest of the circuit, in the orthodox way, and there was automatic adjustment of resonance to the frequency of the interruptions, probably by variations of the capacity at the electrode. The heating effect, when a wire was made to close a circuit with a liquid, was discovered many years ago.

Prof. G. M. MINCHIN thought that the usefulness of the apparatus would be greatly increased if it could be made to work with less current. He had himself succeeded with 12 applied volts, but not with 10 volts. As a tentative experiment, he had used a horizontal lead plate, with disastrous effect, for the apparatus went suddenly to pieces. Explosions were frequently obtained, but they were not attended with much real danger. In a later and safer apparatus, he used a platinum wire about $\frac{3}{4}$in. long, projecting from a glass tube, around which the lead plate was bent. There appeared to be a definite depth of immersion of this wire, at which the apparatus worked with minimum current. In his apparatus this critical position was when half the wire was below the surface of the liquid, the other half projecting into the air. He attributed the fatigue to the presence of gas about the electrodes, for he observed that a mechanical tap to the base of the apparatus restored the working condition.

Mr. ROLLO APPLEYARD pointed out that the improved result at half immersion, observed by Prof. Minchin, taken together with the phenomena described by Mr. Campbell Swinton as to the effect of dipping the electrodes into the solution, suggested that the liquid immediately around the submerged part of the wire was at some instants in the spheroidal state. The breaking down of the spheroidal state would be facilitated by heat lost by the immersed part to the non-immersed part of the wire. The capacity for heat of the non-immersed part, and the degree of roughness or smoothness of the immersed part would thus appear as factors in the explanation. No doubt the evolved gases were the primary cause of the interruption of current, but the wire having once become red hot, the spheroidal condition would introduce a further cause of electrical separation between the wire and the liquid.

Prof. V. BOYS asked whether it was the liquid or the electrodes that became fatigued. Experiments should be made to determine the effect of variations in the hydrostatic pressure around the platinum electrode.

Mr. T. H. BLAKESLEY said that the rise of potential at the terminals of the interrupter proved that the arrangement possessed capacity. Such a rise of potential could not occur without there being capacity, any more than it could without self-induction.

Mr. D. K. MORRIS described experiments he had made with a Wehnelt interrupter, using a 1-kilowatt transformer with a transformation of four to five, intended for 10 amperes at 100 volts. The anode of the interrupter was designed to have an adjustable surface to correspond with the load on the secondary—a platinum wire at the end of a copper wire could be projected, more or less, through the drawn-out lower end of a glass tube containing oil. The best results with the interrupter were obtained with about 45 volts on the primary circuit. At this pressure an average current of 1 ampere sufficed to give 125 (alternating) volts very steadily on the secondary. As measured by an electrostatic instrument, the "no-load" loss was only 45 watts. The secondary could then be loaded up with lamps, provided that the exposed surface of platinum wire was proportionately increased. The energy delivered to the lamps, however, was not at any load much greater than 45 per cent. of that taken from the mains. By connecting the interrupter with a condenser of $\frac{1}{2}$ microfarad the efficiency at small loads was increased to nearly 60 per cent. He had observed that the fatigue of the interrupter could be temporarily remedied by reversing the current.

Mr. C. E. S. PHILLIPS asked whether Mr. Campbell Swinton had tried other liquids than dilute sulphuric acid. So far as his own experiments went, he had only obtained good results with that electrolyte.

Mr. CAMPBELL SWINTON, in reply, said that with the apparatus arranged in a simple circuit an alternating current applied to the primary of an induction coil through a Wehnelt interrupter produced only about half the effect of the corresponding direct current—apparently only half the alternations got through. But if two interrupters were connected in parallel circuits it was possible so to arrange them that one took one half and the other the second half of the alternations. It might, therefore, be possible to design an induction coil with two primary windings to correspond to the two interrupters, so as to give an additive effect. The induction coil he had used had suffered no damage from the currents employed in the experiments exhibited; there was extremely little heating of the secondary. He could not with his apparatus restore the working condition by any mechanical disturbance of the interrupter. Hydrochloric acid failed, but a saturated solution of potassic bichromate gave fair results.

The PRESIDENT, in proposing thanks, said he did not agree with Mr. Campbell Swinton's remarks as to the chances of improving Hertzian telegraphy by the use of these interrupters. The rate of interruption with this apparatus was something like 1,000 per second, but the vibrations corresponding to Hertz waves were of the order 100,000 per second. The wave trains from oscillators excited by the new interrupter would still be a series of damped vibrations; the amplitudes would not be maintained. It might be advantageous to have sparks following one another so rapidly, but he doubted it. For Hertzian telegraphy, the spark at the oscillator should "crackle;" to produce the best effect, the air about the oscillator should be in a non-electric condition.

A Paper by Mr. A. GRIFFITHS, on

"An Apparatus for the Determination of the Rate of Diffusion of Solids Dissolved in Liquids"

was then read. The apparatus consists of a cylindrical glass vessel sub-divided about midway by a horizontal non-porous partition, into which are fitted a number of vertical tubes. The lower section of the vessel is filled with a liquid, such as an aqueous solution of cupric sulphate, and the upper one contains pure water. The method consists in determining, by chemical analysis, the quantity of cupric sulphate transmitted up the tubes. The Paper gives the theory of the method with very few experimental results. Ordinary diffusion observations are affected by the flow of liquid in the tubes due (1) to changes of temperature of the apparatus as a whole, (2) to differences of temperature throughout the liquid, (3) to local variations in volume produced by the process of diffusion, (4) to inequalities in the lengths of the tubes. Equations are given for determining the magnitudes of the sources of error, and certain numerical cases are worked out.

The same author also contributed a Note on

"The Source of Energy in Diffusive Convection."

Diffusion tends to produce local changes of density, causing gravitational currents, which currents can be made to do work. By "diffusive convection," the author means these gravitational currents. The heat equivalent of the work done is determined in a particular case, *i.e.*, for a sub-divided vessel, as in the above Paper, having two tubes of unequal length. He points out that the heat absorbed, owing to diffusion through one of the tubes, is independent of the mechanical motion of the liquid in that tube, and it is also independent of the length of the tube.

The PRESIDENT proposed a vote of thanks, and, in doing so, described an apparatus he had used for a thermostat. A double-walled cylinder of copper sheet, with a little water in the inter-space, is exhausted at atmospheric temperature, until the water boils. It is then sealed. Water-vapour is a powerful equaliser of temperature, and a vapour-jacket of this kind is very efficient when it is required to maintain uniform temperature—not constant temperature.

Mr. WATSON described the method of Mr. E. H. Griffiths, who used tap-water as a negative source, and a gas-flame as a positive source, with extremely good results as a thermostat for constant and for uniform temperature. The meeting then adjourned until March 24.

BOOKS RECEIVED.

"*Journal* of the Institution of Electrical Engineers," No. 137, Vol. XXVII. February, 1899. Edited by W. G. McMillan. Index to Vol. XXVII. (London: E. and F. N. Spoon.) Price 7s. 6d.

"Fortschritte der Elektrotechnik." Edited by Dr. Karl Strecker. 1896. Part I. (Berlin: Julius Springer).

"*Official Gazette* of the United States Patent Office," No. 8, Vol. LXXXVI. Published by authority of Congress. (Washington: Government Printing Office.)

"Fortschritte der Elektrotechnik." Edited by Dr. Karl Kahle. 1898. Part III. (Berlin: Julius Springer.)

"The Internal Wiring of Buildings." By H. M. Leaf. (Westminster: Archibald Constable and Co.). Price 3s. 6d.

ELECTRICITY WORKS ACCOUNTS.

Charing Cross and Strand Electricity Supply Corporation (Limited).

It is gratifying to find from the 1898 accounts of the Charing Cross Company that the highly flourishing condition of the undertaking is being so well maintained, not only in respect of increase in business, but also as regards financial results; despite the fact that with one of the lowest average tariffs this Company furnishes its patrons with a service that has gained an excellent reputation for uniformity of pressure.

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It will be noticed from our table that the capital has been increased by the borrowing of an additional £53,500 on a 4 per cent. temporary loan. It is proposed to increase the Ordinary share capital by the issue of 20,000 £5 shares at a premium. The increase of business has necessitated modified plans for the station at Lambeth; the engine room and boiler house have been extended in length about 90ft., and additional steam raising and generating plant installed. Further enlargements are in prospect. An additional 18½ miles of mains have been laid, including seven miles in the new districts of Holborn and St. Giles, making a total, already laid, of 101¼ miles.

The expended capital has increased during 1898 from £357,770 to £409,384, or by more than £50,000. The total expenditure per kilowatt capacity of generating plant is £131.

With an increase in the number of consumers of 237, the equivalent of an additional 26,694 8 c.p. lamps have been added to the circuit, raising the total lamp connection to 134,236—an increase of 24·8 per cent. Corresponding with this the output has reached 3,246,231 units sold, being an increase of 24·2 per cent. over the output of 1897. The total revenue stands at 8s. 11d. per (8 c.p.) lamp connected, or at 4·435d. per unit sold, as against 4·49d. in 1897.

The coal strike has had its effect here, as elsewhere, on the costs which, in total, have risen about 0·056d. per unit. It is stated that, owing to the lower grade coal employed, 7½ per cent. more coal was used. The items of fuel and repairs and maintenance at the station, and also rents, rates and taxes, are chiefly responsible for the rise in the costs. A working profit of £28,511, representing 7·46 per cent. of the mean capital, has been made. Out of this and the balance of £3,015 from 1897 the depreciation fund has absorbed £7,184, and interest on loans £4,600, leaving a balance available for distribution of £19,792, from which has been paid an ordinary dividend of 8 per cent. in addition to one on the Four and a-Half per Cent. Preference shares. This leaves a balance, carried forward, of £3,292.

The table given below indicates the progress made since 1892:—

Year.	Equiv. (8 c.p.) lamp connection.	Units sold.	Ordinary dividend.
1892	29,500	652,703	5%
1893	34,570	934,276	4½%
1894	41,216	1,115,609	4½%
1895	51,302	1,383,813	5%
1896	73,464	1,944,402	6%
1897	107,542	2,615,508	7%
1898	134,236	3,246,231	8%

Notting Hill Electric Lighting Co. (Limited).

Our second table this week refers to the accounts of the working during 1898 of the Notting Hill Electric Lighting Co. This is the seventh complete year of working, supply having commenced in May, 1891. As the figures in the table show, there is no falling off in the good progress made in the past in the matter of accession of business.

By the further issue of Four per Cent, First Mortgage Debentures to the extent of £21,000, in addition to the £10,000 already issued and paid up, an additional £16,000 of capital has been raised, bringing the total capital received (share and loan) up to £126,000. The total amount expended has reached £128,004, representing £160 per kilowatt of generating plant installed.

With 217 new consumers, there has been added to the circuit the equivalent of 13,066 8 c.p. lamps, raising the total to 46,066—an increase of nearly 40 per cent. There was also a large—but scarcely a corresponding—increase in the output, the number of units sold during 1898 exceeding that of 1897 by 100,902, or 28·4 per cent., and although the plant capacity has been increased 25 per cent., the units sold per 8 c.p. lamp capacity has also slightly increased. The revenue per 8 c.p. lamp connected was, in 1897, 7s.; the figure for 1898 is, however, only 5s. 10d. This is, no doubt, chiefly due to the reduced tariff, which has had the further effect of reducing the total revenue per unit sold from 7·86d. to 7·065d.

The costs have gone up slightly—about 0·027d. per unit. The scarcity and high price of steam coal is stated to have raised the fuel charge £200. Other items of generation show increases, except wages, which have sensibly fallen, as has also the item of rents, rates and taxes.

Coming to the financial results of the year's working, the gross profit made amounts to £7,252. Out of this, £825 has been placed to the depreciation and renewal fund account, £50 to leasehold redemption, and £717 paid in interest on loans. The balance of £5,678 has afforded a dividend on the Six per Cent. Preference shares, and of 6 per cent. on the Ordinary shares.

The capital expenditure on plant during the year includes the cost of a new boiler and generating set, which practically take up the whole of the remaining available space in the works, so that another station appears imperative to meet further demand for electricity.

The increase during the year in the lamp connections of close on 40 per cent., which has already been referred to, created a record in this respect, compared with any previous year in the history of the concern, as the table given below shows. Many of the lamps were, however, only connected towards the end of the year, so that the benefit accruing from them is not to be looked for till this current year. Other reasons for the small comparative increase in the output are a very light season and the absence of the usual November fogs, combined with the fact that the contractor's account for current on the local electric railway was £650 less than in 1897. The Company are to be congratulated on recognising the necessity of reducing their tariff for current. It is proposed to reduce the price charged per unit supplied at 200 volts' pressure from 6d. to 5d. More than two-thirds of the consumers are being supplied at the higher pressure of 200 volts.

Year.	No. of consumers.	Equiv. 8 c.p. lamp connection.	Units sold.	Revenue (total).	Working profit.	Total costs per unit sold.	Ord. div.
1891	77	6,056	30,162	£1,623	– £555	17·34d.	nil
1892	124	9,438	75,667	3,513	+ 112	10·78d.	nil
1893	173	12,153	107,580	4,329	+ 1,481	6·355d.	nil
1894	234	15,669	130,266	5,123	+ 2,102	5·565d.	1%
1895	307	20,307	182,327	6,940	+ 3,228	4·885d.	2%
1896	396	25,716	230,787	8,552	+ 4,736	3·966d.	4%
1897	571	33,000	354,969	11,626	+ 6,854	3·220d.	6%
1898	788	46,066	455,871	13,418	+ 7,252	3·247d.	6%

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	1899	Jan. 6	
Ayr (Municipal)	1898	Nov. 11	
Bedford (Municipal)	,,	Mar. 4	
Belfast (Municipal)	,,	Sept. 23	
Birmingham (Company)	,,	Dec. 16	
Blackpool (Municipal)	,,	Oct. 7	
Bournemouth (Company)	,,	June 3	
Bolton (Municipal)	,,	Dec. 9	
Bradford (Municipal)	,,	May 20	
Brighton (Municipal)	,,	May 6	
Bristol (Municipal)	,,	July 29	
Burnley (Municipal)	,,	Sept. 16	
Burton-upon-Trent (Mun.)	,,	April 15	
Bury (Municipal)	,,	Nov. 25	
Cambridge (Company)	1899	Mar. 10	
Cardiff (Municipal)	,,	Jan. 6	
Charing Cross (Company)	1898	April 22	
Chelsea (Company)	,,	May 20	
Cheltenham (Municipal)	,,	Oct. 7	
Chester (Municipal)	,,	Oct. 14	
Clerkenwell (Company)	,,	Mar. 18	
Derby (Municipal)	,,	Dec. 9	
Dewsbury (Municipal)	,,	Nov. 25	
Dover (Company)	,,	Mar. 11	
Dundee (Municipal)	,,	Nov. 4	
Eastbourne (Company)	,,	July 22	
Edinburgh (Municipal)	,,	Oct. 14	
Exeter (Municipal)	,,	Aug. 5	
Glasgow (Municipal)	,,	Aug. 12	
Guildford (Company)	,,	May 13	
Halifax (Municipal)	,,	Nov. 18	
Hammersmith (Vestry)	,,	June 10	
Hampstead (Municipal)	,,	Sept. 9	
Hanley (Municipal)	,,	April 8	
Harrogate (Municipal)	,,	Dec. 30	
Harrow (Company)	,,	Sept. 9	
Hast'gs & St. Leonard's (Co.)	,,	April 29	
House-to-House Co. (K'ns'gt'n)	,,	Sept. 30	
Hove (Company)	1899	Mar. 10	
Huddersfield (Municipal)	1898	Mar. 25	
Islington (Vestry)	,,	June 24	
Kens'gton & Knightsbr' (Co.)	'99	Mar. 3	
Kingston-upon-Hull (Mun.)	1898	Aug. 19	
Kingston-on-Thames (Mun.)	,,	Mar. 25	
Lancaster (Municipal)	,,	Oct. 21	
Leeds (Company)	1899	Mar. 3	
Leicester (Municipal)	,,	Jan. 20	
Leyton (Municipal)	1898	Sept. 23	
Liverpool (Municipal)	,,	Aug. 12	
Manchester (Municipal)	,,	July 29	
Newcastle and District (Co.)	,,	Dec. 2	
Newcastle-upon-Tyne (Co.)	,,	April 29	
Northampton (Company)	,,	April 15	
Norwich (Company)	,,	Dec. 2	
Notting Hill (Company)	,,	Mar. 11	
Nottingham (Municipal)	,,	Oct. 28	
Oldham (Municipal)	,,	Nov. 18	
Oxford (Company)	,,	April 1	
Portsmouth (Municipal)	,,	Nov. 4	
Preston (Company)	,,	Oct. 28	
Reading (Company)	,,	Sept. 16	
Richmond (Company)	,,	Mar. 4	
Scarborough (Company)	,,	April 1	
St. James' & Pall Mall (Co.)	1899	Feb. 24	
St. Pancras (Vestry)	1898	May 13	
Sheffield (Company)	,,	Dec. 16	
Shoreditch (Vestry)	,,	May 27	
Southampton (Municipal)	,,	June 3	
Southport (Municipal)	,,	Dec. 23	
Stafford (Municipal)	,,	Oct. 21	
Sunderland (Municipal)	,,	Aug. 19	
Taunton (Municipal)	,,	Aug. 5	
Tunbridge Wells (Mun.)	,,	July 22	
Walsall (Municipal)	,,	Nov. 11	
Wandsworth (Company)	,,	Mar. 18	
Westminster (Company)	1899	Feb. 24	
Whitehaven (Municipal)	1898	Dec. 23	
Windsor (Company)	,,	Dec. 30	
Wolverhampton (Municipal)	,,	July 15	
Woolwich (Company)	1899	Jan. 13	
Worcester (Municipal)	1898	May 13	
Yarmouth (Municipal	,,	June 17	

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	CHARING CROSS.		NOTTING HILL.	
Undertaking Worked by	The Charing Cross and Strand Electricity [Supply Corporation (Ltd.)		Notting Hill Electric Lighting Co. (Limited).	
Date of Commencement of Supply	1890.		May, 1891.	
System of Supply	Three-wire, continuous-current.		Continuous-current, three-wire, with batteries.	
Chief Engineer	W. H. Patchell.		George Schultz.	
YEAR ENDED	DEC. 31, **1897.**	DEC. 31, **1898.**	DEC. 31, **1897.**	DEC. 31, **1898.**
QUANTITIES—				
Units generated	—	3,985,481	378,205	479,371
„ **SOLD (TOTAL)**	2,615,508	3,246,231	354,969	455,871
„ sold to consumers	2,615,508	3,241,331	354,969	455,871
„ sold for public lighting, &c.	nil	4,900	—	—
„ used on works	—	709,865	8,500	9,700
UNITS SOLD PER 8 C.P. LAMP CAPACITY	32·7	33·3	17·7	18·2
Maximum supply demanded	1,377 kilowatts	2,176 kilowatts	310 kilowatts	460 kilowatts
Number of public lamps	nil	13 arcs	nil	nil
Number of consumers	719	956	571	788
Connections to mains in 8-c.p. lamps	107,542	134,236	33,000	46,066
CAPACITY OF PLANT IN 8-C.P. LAMPS	80,000	97,500	20,000	25,000
CAPACITY OF PLANT IN KILOWATTS	2,540	3,120	600	800
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£400,000 / £157	£400,000 / £128	£150,000 / £250	£150,000 / £187·5
Share	250,000 / 98·4	25,000 / 80·2	100,000 / 167	100,000 / 125
Loan (including Debenture charges)	150,000 / 59·0	150,000 / 48·1	50,000 / 83·3	50,000 / 62·5
RECEIVED (TOTAL)	324,000 / 128	377,500 / 121	110,000 / 183	126,000 / 157·4
Share	250,000 / 98·4	250,000 / 80·2	100,000 / 167	100,000 / 125
Loan (including Debenture charges)	74,000[a] / 29·1	127,500[e] / 40·9	10,000 / 16·7	26,000 / 32·5
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	76,000 / 29·9	22,500 / 7·22	40,000 / 66·7	24,000 / 30·0
Share (unissued)	— / —	nil / —	— / —	— / —
Share (uncalled)	— / —	nil / —	— / —	— / —
Loan (including Debentures)	76,000 / 29·9	22,500 / 7·22	40,000 / 66·7	24,000 / 30·0
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	— / —	9,609[f] / 3·08	— / —	— / —
DEPRECIATION FUND	13,000 / 5·12	20,000 / 6·41	3,340 / 5·57	4,500 / 5·63
EXPENDED (TOTAL)	357,770 / 141	409,384 / 131	113,184 / 189	128,004 / 160
Lands and buildings	160,871[g] / 63·4	172,553[g] / 55·3	18,295 / 30·5	22,306 / 27·9
Plant	73,515[b] / 28·9	107,085 / 34·3	20,906[a] / 34·9	30,841[a] / 38·5
Mains	103,883 / 40·9	123,089 / 39·5	64,408 / 107	69,934 / 87·5
Miscellaneous	19,501 / 7·68	6,657 / 2·13	9,575 / 16·0	4,873 / 6·09
BALANCE OF CAPITAL ACCOUNT	−33,770[c] / −13·3	−31,884[c] / −10·2	−3,184[b] / −5·31	−2,004[b] / −2·51
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£48,915 / 4·490d.	£59,973 / 4·435d.	£11,626 / 7·860d.	£13,418 / 7·065d.
Revenue from supply	48,027 / 4·410d.	58,985 / 4·360d.	10,231 / 6·920d.	12,239 / 6·445d.
„ meters, &c.	582 / 0·053d.	777 / 0·057d.	519 / 0·351d.	487 / 0·256d.
„ public lighting	— / —	— / —	nil / —	nil / —
„ sale of lamps, &c.	214 / 0·020d.	— / —	573 / 0·387d.	412 / 0·217d.
„ miscellaneous sources	92 / 0·008d.	210 / 0·016d.	303 / 0·205d.	281 / 0·148d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£24,761 / 2·270d.	£31,462 / 2·326d.	£4,771 / 3·220d.	£6,167 / 3·247d.
WORKS COSTS	19,337 / 1·780d.	24,540 / 1·814d.	2,252 / 1·520d.	3,123 / 1·644d.
Generation of electricity	*17,069* / *1·570d.*	*22,235* / *1·645d.*	*2,222* / *1·500d.*	*3,078* / *1·620d.*
Fuel (including cartage, &c.)	10,350 / 0·950d.	13,354 / 0·988d.	982 / 0·664d.	1,472 / 0·775d.
Oil, waste, water, stores	997 / 0·092d.	1,202 / 0·089d.	138 / 0·093d.	241 / 0·127d.
Wages at station	4,010 / 0·368d.	5,052 / 0·374d.	485 / 0·328d.	532 / 0·280d.
Repairs and maintenance at station	1,713 / 0·157d.	2,626 / 0·194d.	618 / 0·418d.	832 / 0·438d.
Distribution of electricity	*2,268* / *0·208d.*	*2,305* / *0·171d.*	*30* / *0·020d.*	45 / *0·024d.*
Wages, &c.	1,101 / 0·101d.	841 / 0·062d.	30 / 0·020d.	45 / 0·024d.
Repairs, renewals of mains, &c.	1,167 / 0·107d.	1,464 / 0·108d.	nil / —	nil / —
Public lighting	— / —	— / —	— / —	— / —
Attendance	— / —	— / —	— / —	— / —
Renewals	— / —	— / —	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	5,422 / 0·498d.	6,922 / 0·512d.	2,519[c] / 1·700d.	3,044 / 1·603d.
Royalties	*nil* / —	— / —	*nil* / —	*nil* / —
Rent, rates, taxes	*1,929* / *0·177d.*	*2,657*[h] / *0·197d.*	*394* / *0·266d.*	*222* / *0·117d.*
Management	*3,493* / *0·320d.*	*4,265* / *0·315d.*	*1,978* / *1·340d.*	*2,822* / *1·485d.*
Salaries	2,639 / 0·242d.	3,109 / 0·230d.	1,640[d] / 1·110d.	2,298[g] / 1·210d.
Stationery, &c.	218 / 0·020d.	224 / 0·017d.	57 / 0·038d.	76 / 0·040d.
Establishment charges	389 / 0·036d.	418 / 0·031d.	115 / 0·078d.	140 / 0·078d.
Law charges, &c.	247[d] / 0·023d.	514[i] / 0·038d.	166[e] / 0·112d.	308[h] / 0·162d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap.exp'ndec	Total. / % to mean cap.exp'nded	Total. / % to mean cap.exp'nded
WORKING PROFIT FOR YEAR	£24,154 / 7·24%	£28,511 / 7·46%	£6,854 / 6·46%	£7,252 / 6·01%
Sum carried to Depreciation Fund	5,247 / 1·57%	7,134 / 1·86%	1,050[f] / 0·99%	875[f] / 0·726%
Sum carried to Reserve or Sinking Fund	— / —	— / —	155 / 0·146%	717 / 0·595%
Net interest on loans (incl. Debenture charges)	4,140 / 1·24%	4,600 / 1·20%	4 / 0·004%	14 / 0·012%
BALANCE FROM LAST ACCOUNT	2,997 / 0·898%	3,015 / 0·786%	5,657 / 5·33%	5,673 / 4·70%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	17,764 / 5·33%	19,792 / 5·16%	— / —	— / —
Deficit	— / —	— / —	6% / —	6% / —
ORDINARY DIVIDEND PAID	7% / —	8% / —		
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	50·6%	52·5%	41%	46%
Expenditure per kilowatt capacity	£9. 14s. 10d.	£10. 1s. 7d.	£7. 19s. 0d.	£7. 14s. 2d.
REVENUE PER KILOWATT CAPACITY	**£19. 4s. 10d.**	**£19. 4s. 0d.**	**£19. 8s. 0d.**	**£16. 15s. 7d.**
Expenditure per 8-c. lamp capacity	6s. 2¼d.	6s. 5½d.	4s. 9d.	4s. 11½d.
REVENUE PER 8-C.P. LAMP CAPACITY	**12s. 3d.**	**12s. 3½d.**	**11s. 7d.**	**10s. 9d.**
REVENUE PER 8-C.P. LAMP CONNECTED	**9s. 1½d.**	**8s. 11d.**	**7s. 0½d.**	**5s. 10d.**
Price charged for lighting, per unit	6d.	6d. to 4d.[j]	8d. to 4½d.	6d.
Price charged for power, per unit		4d. to 2d.[j]	—	4d.
Price charged for public lighting	—	—	—	—

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HERTZIAN TELEGRAPHY.

Wireless telegraphy of the sort involving the action of Hertzian ether waves upon a coherer has occupied the attention of the Institution of Electrical Engineers during its last two or three meetings, and, incidentally, has provided for members and their friends an unusually sensational programme. It is too early yet, especially in view of the fact that Mrs. Ayrton has yet to read her Paper on the electric arc, to say that the reception of Mr. Marconi's Paper is the most brilliant feature of the session; but we can assert that nothing approaching it has occurred in the history of the Institution, not even excepting the memorable occasion when Nikola Tesla gave his lecture in the theatre of the Royal Institution. Yesterday's overflow meeting at Exeter Hall, when Mr. Marconi repeated his discourse, was an event absolutely unique in the annals of the Institution of Electrical Engineers. A much smaller room had originally been acquired for the purpose; but ere members had had for 24 hours an opportunity to ask for tickets, the number of applications was overwhelmingly greater than the accommodation arranged for; so that quite late on Thursday in last week, as we announced in our last issue, the Council was compelled to engage the Lower Exeter Hall, the larger dimensions of which even fell short of sufficiency.

Whether wireless telegraphy as a practical art will be advanced by recent proceedings of the Institution remains to be seen. A Paper, mainly in the form of a popular narrative of what was already known, followed by a discussion largely interrogatory and speculative, can only effect a practical advance through secondary and indirect issues; Mr. Marconi himself is not likely to have received therefrom any new inspiration; and members thirsting for knowledge have been left to obtain it from a reconsideration, possibly in a new light, of facts previously published. As we write this we are in ignorance of the nature of Mr. Marconi's reply, which he promised to make last night; and if he gave detailed answers to one half of the questions put to him during the discussion, it is scarcely possible but that some new fact of importance has been added to the stock of common know-

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ledge on this fascinating branch of telegraphic science. Nevertheless, even if we have gleaned nothing absolutely novel, it has been a distinct gain to have had this Paper and its discussion: for ascertained facts and principles have thereby been ranged in a more logical and orderly fashion, and speculative hypotheses have had a chance of being tried, though in some cases at the risk of being found wanting.

Dealing, first, with the practical questions that arose in the discussion, and leaving matters of theory until afterwards, we may first notice the able speech of Mr. JOHN GAVEY, a lucid and business-like exposition of the experience thus far acquired by the Post Office. The law of the product of the heights—sometimes called the square of the height, owing to poles of the same height being used at the two stations—had been confirmed, and an essential difference had been discovered between land and sea telegraphy, the greater facility in the latter case being attributed to plane reflection from the surface of the water. At the receiving end a capacity might be substituted for the earth connection, without diminishing the effect, but at the transmitting end an earth connection was essential to good signalling. Reflectors had at first given satisfactory results, but on extending their application the effect was not so good; nevertheless, although reflectors had been abandoned, Mr. GAVEY saw great advantages in endeavouring to apply them successfully, as they would allow of a directive rather than a diffusive action between two or more stations.

A propos of the earth connection, the question asked by Mr. SULLIVAN as to whether or not the Marconi system requires an earth of little or no resistance is one of great importance in such cases as communicating with outlying and practically non-conducting rocks, such as the Fastnet. The conduction system, which was installed at the Fastnet some time ago, involves the employment of two submerged earth plates of low resistance at the rock itself, and, as will be remembered from Mr. GRANVILLE'S recent interesting remarks before the Institution, notwithstanding every possible precaution and care in submerging and securing these earth plates, communication has from time to time been interrupted in stormy weather through the plates being thrown up on the rock by the violent action of the sea. If the Fastnet and the numerous other rocks of a similar nature offer in themselves sufficient earth conduction for Mr. MARCONI'S system, thus doing away with the necessity of submerging earth plates, it would seem that he has solved the problem of establishing and maintaining in all weathers a reliable system of communicating with lighthouses on rocks under the severest possible conditions. Amongst other places where difficulty has been experienced in finding a sufficiently good earth for telegraphic purposes, Valentia, on the coast of Ireland, and parts of Nova Scotia and Newfoundland may be mentioned. All these have given trouble in submarine telegraphic working owing to their geological formation and non-conducting nature.

Theorists will find food for thought and, in some cases, for amusement in the speculations advanced to explain various aspects of wireless telegraphy as practised by Mr. MARCONI. Dr. ERSKINE MURRAY ventured upon an hypothesis of "discharge from fine points," and adopted an analogy between the vertical transmitter rod and the points on the prime conductor of a frictional electricity machine. Mr. MERVYN O'GORMAN declined to believe that Hertzian ether waves were essential, and advanced a theory that the Marconi telegraph could be worked by electrical currents oscillating through the earth between the two stations. We are not impressed with the necessity for any such hypotheses as the above, nor do we regard either as having the least degree of probability. Prof. SILVANUS THOMPSON'S optical analogy between reflection from a plane mirror and the effect of earthing MARCONI'S vertical wire requires support both from theory and from practice before it can be accepted as more than a pretty—but fanciful—illustration. In the first place the logical nexus seems to be wanting: we do not perceive the link between (1) a plane mirror reflecting an end-on stick in contact with it, (2) a slab of iron in end-on contact with a bar magnet, and (3) the Marconi wire perpendicular to the earth's surface. But even were there an *à priori* similarity of action in these three cases, it would still be necessary to show that earthing the Marconi wire really *doubles* its virtual length. It is insufficient to show that the earth intensifies the action; the effect, if the analogy is to hold, must absolutely follow the law of lengths found to be applicable to vertical wires. We fail to discover that it does so.

Telegraphic practice and theory, in times to come, will probably look back upon Mr. MARCONI'S Paper and its discussion as marking an important point in the history of wireless telegraphy—important, that is to say, in the same sense that a pillar of stone acquires importance when it becomes a landmark or a milestone.

OBITUARY.

DOUGLAS GALTON.

We announce with great regret the death of Sir Douglas Galton, K.C.B., which took place on Friday afternoon last, at his town residence, 12, Chester-street, S.W. By electrical scientists and engineers Sir Douglas Galton will be chiefly remembered on account of his active association with numerous scientific societies and committees thereof, and especially in connection with his secretaryship to the British Association, from 1874 to 1895, and his presidency of that Association in the last-named year.

Douglas Galton was born in 1822 and was educated at the Royal Military College, Woolwich, receiving a commission in the Royal Engineers in 1840. One of his earliest associations with electricity was in connection with the removal of the wreckage of the "Royal George" in 1842, when electricity was used for firing the charges of powder. A more important service to electrical enterprise, however, is found in his association with the development of submarine telegraphy; for, at the time when this important branch of telegraphy was decidedly under a cloud, viz., after the breakdown of the 1858 Atlantic cable, and when the Red Sea and Indian telegraph had proved a failure, Sir Douglas Galton was appointed chairman of the Special Committee of Parliament, formed to investigate the whole question of submarine cable enterprise. Between Dec. 1, 1859, and Sept. 4, 1860, 22 sittings were held, with the result that in 1861 a report was published which has been characterised as the "most valuable collection of facts, warnings and evidence ever compiled concerning submarine cables." In consequence of this report, further proceedings in the Red Sea were abandoned, and a section of the cable, already constructed but not laid, was successfully put down between Malta and Alexandria. Sir Douglas was also a member of the consultative committee (of which Lord Kelvin is now the only survivor) appointed to advise the Atlantic Telegraph Co. on the electrical and mechanical questions connected with the projected cable of 1865.

Although thus prominently connected with an important department of electrical engineering, Sir Douglas Galton's principal associations with engineering are to be found in his relations with sanitary science and practice, and also, to some extent, with railway commissions. As a sanitary scientist he was regarded as a high authority, while his services to railway engineering include the secretaryship to the Railway Commission, in 1847, appointed to investigate the application of iron to railway structures; also an inspectorship of railways, and subsequently the secretaryship of the Railway

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Department of the Board of Trade. This latter position he gave up in 1860, but his resignation did not sever his connection with railway work, for in 1866 he served on the Royal Commission on Railways, at which time he gave evidence of strong opposition to the State purchase of the railways of the United Kingdom. Many important questions connected with railway traction have been experimentally investigated by Sir Douglas Galton, notably those connected with the friction of rolling and rapidly moving surfaces, also on the use of automatic brakes.

In 1860, Sir Douglas Galton became Assistant Inspector-General of Fortifications, and, two years later, Assistant Under-Secretary for War, the latter post being held until 1870. From 1870 to 1875, he was Director of Public Works and Buildings under Her Majesty's Board of Works. For 25 years he acted as general secretary to the British Association, an office which he resigned in order to become President of that Association at its Ipswich meeting in 1895. He was elected a Fellow of the Royal Society in 1860, and was also a member of the Institutions of Civil, Mechanical and Electrical Engineers as well as of numerous scientific societies. From Oxford he received the honorary degree of D.C.L., and from Durham and Montreal that of LL.D. In 1865 he was made a C.B., and he became a K.C.B. in 1887.

SAMUEL TROTT.

We regret to record the death, on 11th inst., of Capt. Samuel Trott, at Miami, Florida. His friends will remember that he returned to England at the end of last year so ill that he contemplated giving up command of the "Minia," but he rallied sufficiently to take over charge of his ship. At the beginning of the present year he had, however, to be landed at Halifax and taken to the hospital there, whence he went to Florida. Samuel Trott was born in 1832, and when about 15 years of age went through a full course of navigation and astronomy. At the age of 17 he was apprenticed to the sea for a four-years' term, but long before its expiration he was put in charge of a watch, the captain having recognised the young sailor's sterling qualities. In his 27th year he was placed in command of a sailing ship. The command of a large steamer of an important line speedily followed, and during the next ten years he commanded several of the best mail and passenger steamers of that day. It is, however, in the Atlantic Telegraph cable service that Capt. Trott did that work which most appeals to our readers. In 1874 he had charge of the cable steamer "Faraday," and remained her captain for six years. During that time he laid the Direct and French Companies' cables. In the winter of 1875-6 he crossed the Atlantic three times and made three repairs for the Direct United States Cable Co. In telegraph circles this was looked upon as a remarkable feat, as up to that time it was considered impossible to repair Atlantic cables in the stormy season between the months of October and May. These and other notable achievements in cable work attracted the attention of the late Henry Weaver, of the Anglo-American Company, and in 1880 the services of Capt. Trott were secured for the "Minia," which Capt. Trott commanded for nearly 20 years, and within that period she has made 195 repairs without a single failure, although many of them were in the deepest water of the Atlantic, at depths of 2,530 to 2,597 fathoms. In June, 1897, Capt. Trott broke his own record, having effected a repair on one of the Western Union cables in 11 days, in 2,530 fathoms water, with an expenditure of only 38·6 miles of cable. Capt. Trott was of an inventive turn of mind, and held several valuable patents. These deal not only with ships and shipping appliances, submarine cable-laying and repairing, but also with electric railway work. He was a member of several scientific societies, Fellow of the Royal Metereological Society, and an Associate Member of the Institution of Electrical Engineers.

JULIUS VOGEL.

At Hillersdon, East Molesey, near London, Sir Julius Vogel passed away on Sunday last. The deceased knight was born in London in 1835, and after attending London University School, he became, at the age of 16, a pupil in Dr. Percy's laboratory at the Royal School of Mines, where he studied the chemical arts, especially in their relation to metals. He ultimately went out to Melbourne, and was a leading figure in colonial governmental life for many years. He negotiated with the Eastern Telegraph Co. for the construction and maintenance of a submarine cable between New South Wales and New Zealand, and in the early history of telephony took a considerable interest in the development of telephonic communication and the advancement of the telephone industry.

A. M. RYAN.

Mr. A. M. Ryan, Superintendent of the Eastern and South African Telegraph Co. at Mozambique, died suddenly at that place on the 3rd inst. of fever. Mr. Ryan joined the Eastern Company's service in 1882, and, on account of his electrical knowledge, received early promotion, occupying successively the posts of clerk-in-charge and superintendent on the East Coast of Africa. He was to have left for England by first mail, which only arrived at Mozambique four days after his lamented decease.

M. SECRETAN.

The death of M. Secretan at the age of 63 is announced as having taken place during the past week. M. Secretan will be remembered by electrical engineers chiefly as having been the promoter of the huge copper ring, in 1888, a movement which was set on foot in Paris with a view to corner the entire copper market of the world. The collapse of the ring and the financial disaster which ensued are matters more of general history than of personal biography. Lately M. Secretan was associated with a scheme to amalgamate certain French copper interests with the Elmore companies.

WIRELESS TELEGRAPHY.

The following is an abstract of the discussion that took place at the Institution of Electrical Engineers in connection with Mr. Marconi's Paper on "Wireless Telegraphy":—

Thursday, March 2.

Dr. J. A. FLEMING, in opening the discussion, congratulated Mr. Marconi upon the success he had attained with his system, and thought he had added to their debt of gratitude to him by giving such an exceedingly lucid and interesting Paper. He (Mr. Marconi) was in complete possession of the subject, and everything that he had done was so much in advance of anything that others had attempted that they could only hope to follow after him by asking some questions and endeavouring to obtain a little more information. Therefore he would like to ask one or two questions with regard to the transmitting and receiving instruments. Mr. Marconi had seemed to have abandoned the use of oil. If he remembered rightly, in his first experiments, he had used a Righi transmitter with oil between the poles. He had tried, last summer, a large number of experiments with transmitters of various kinds, and found that oil was practically of no advantage. The real cause of the effect, when a spark was passed between the poles in air, was due to the fact that air possessed a peculiar property of passing, under a given electrical stress, out of a condition in which it was a nearly perfect non-conductor to a perfect conductor, and it did this with extreme suddenness. If they put oil between the poles, although they might be able to raise the two poles to a greater difference of potential before the spark happened, yet, nevertheless, as all oils were carbonaceous substances, after one spark, or perhaps two, had passed, carbon seemed to be deposited between the poles in the form of fine flowing particles, and this prevented the extreme suddenness of the breaking of the dielectric conductor, so that what they gained on one hand they lost on the other. Perhaps Mr. Marconi would tell them whether he had abandoned the use of oil for that reason. Referring to the coherer, he thought he recollected hearing in the early history of the subject, that Mr. Marconi used to exhaust his coherer tube; he did not know whether he did this now. It might be advantageous in making a coherer for long-distance work, but for laboratory and short-distance work there seemed to be no advantage; in fact, it was a greater advantage in many ways to have a coherer which they could easily take to pieces and change the powders, because the sensitiveness of the apparatus appeared to depend very much on getting exactly the right proportion of filings. He quite confirmed Mr. Marconi's remark that the coherer was not the uncertain and treacherous instrument it was generally supposed to be. He found that amalgamating the metal certainly had an advantage that might be due, perhaps, in some way or another to the presence of the mercury vapour. He found that mixing about 5 per cent. of very finely powdered uranium with the nickel filings of the coherer gave a material that was sensitive and certain in its action. By far the most interesting point of Marconi's system was the use of the vertical wire, because he thought they could say with perfect certainty that it was the use of this wire that had enabled him to carry out these long-distance experiments. He had only tried it on a small scale, but he had found the

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advantage of the vertical wire. Last summer he had experimented with horizontal and vertical wires of the same length, and had got effects over distances with vertical wires that he could not get with horizontal wires. He then asked Mr. Marconi if it were necessary that the earth connection should be complete. When he was at Bournemouth last year witnessing some experiments Mr. Marconi had told him that the earth connection was necessary, and that if this was broken in both places you could not get the transmission over the same distance. It was a most interesting question.

Dr. ERSKINE MURRAY, one of Mr. Marconi's assistants, said that four years ago, when he joined the Wireless Telegraph Co., he was as ignorant of the subject, if not more so, than a good many of those present. Everybody who interested themselves could not help following the experiments from an outsider's point of view, from what they got in the newspapers and technical journals. When he had first gone to Bournemouth and seen the apparatus, he had been much struck by the "ordinariness" of the thing. It was worked just like any other telegraph, not quite so fast as in the General Post Office, but still working at a very rational speed and with very considerable certainty. He thought the increase of the vertical wire with distance was a most interesting feature of the system. Some simple illustration might be taken from the ordinary electrical machine. As they all knew, in a frictional electrical machine the electricity was collected by means of a number of fine points, and the tension on the point was very much greater than on a more rounded part of the conductor. In the case of this vertical wire they had the earth as one large conductor, and these wires standing up on the surface to serve as the fine points of an electrical machine. The surface density increased as it went up, as likewise did the force, but the amount of this increase had not yet been calculated. But probably it would be pretty nearly in proportion to the distance from the earth. The action at the top was more or less proportional as the square of the surface density.

Mr. SYDNEY EVERSHED said he had done some work in connection with wireless telegraphy of the electromagnetic kind, but he had never made an experiment with Hertzian telegraphy. He would like to read the Paper first, and then possibly he might be able to discuss it, or at any rate ask some questions. During the time Mr. Marconi had been carrying out his work, several things had occurred to him which he would like to see cleared up, such as the power used, the law of the variation of distance to which they could signal, the connection between the distance it was possible to signal and the length of the vertical wire and other points of that kind. It appeared, however, that Marconi had anticipated every one of these questions. He (Mr. Evershed) noticed that the law relating to the length of the vertical wire and the distance to be signalled was an exceedingly simple one, and drew the attention of the meeting to the analogy between that and the law he had explained in connection with his own system of wireless telegraphy, a few weeks ago. He had then shown that the distance to which they could signal by means of electromagnetic induction depended, among other things, on the product of the areas of two circuits. During that same discussion Dr. Fleming had referred to the analagous case of the vertical or horizontal wire used in Hertzian telegraphy, and suggested that the true function of that wire was to integrate the electric force over a considerable space and thereby get sufficient energy to work a coherer. That explanation also seemed an exceedingly simple one and was, he thought, the best. It followed from this that Mr. Marconi's law must be true, because the effect of the vertical transmitting wire was proportional to its length, and the effect of the receiving vertical wire proportional to *its* length; consequently, if they doubled the length of the two wires they quadrupled the effect, a law which Mr. Marconi appeared to find fairly accurately fulfilled in his experiments. At any rate, he found it fulfilled with a sufficient accuracy to enable him to design new telegraphs for greater distances. In conclusion, he wished to be the first to congratulate Mr. Marconi on having succeeded in effecting signals between lightships and the shore.

Mr. H. W. SULLIVAN said he would like to ask Mr. Marconi whether his system required a perfect earth—*i.e.*, an earth of little or no resistance. In view of the difficulty which had been experienced in establishing and maintaining an earth connection on outlying and practically non-conducting rocks, such as the Fastnet, through the submerged earth plates being frequently thrown up on the rock in stormy weather by the action of the sea, he thought this was a matter of considerable importance. If Mr. Marconi had successfully solved the difficulty, as seemed to be the case, of communicating in all weathers with outlying lighthouses and lightships, he had conferred a great and lasting benefit on the world.

Mr. W. P. GRANVILLE asked if the vertical wire in this system was measured from the sea line, or from the height on which it stood. For instance, the standard on which the wire was erected at Alum Bay was on a hill, perhaps 100ft. or 200ft. in height, and the same at Bournemouth, and he should like to know whether the height of the top of the vertical wire above the sea plane made any material difference. Another question he asked was with regard to neighbourhood of conducting masses at the transmitting or receiving end. In the case with which he had been more immediately interested in, viz., the Fastnet rock, the whole mass of the tower was of thick boiler plate, as were all the buildings on the rock. Had Mr. Marconi, under such conditions as these, found any great difficulties?

Capt. BRETT thought it somewhat difficult to discuss a Paper which was mainly a series of facts that had taken place. However, there seemed to be a good deal of interest in the question of the earth connection, but not wishing to anticipate Mr. Marconi in his reply, he would only say that, during some experiments Marconi had, at his request, suddenly disconnected the earth connection of the receiver but the signals came just as before, the receiver being on shore, so that it would appear that, under these conditions, the earth connection was not a necessity for the working of the apparatus, at any rate up to 12 miles. He was prepared to accept that the earth connection to the transmitter was a necessity, because it afforded an oscillating character to the discharge, but in the matter of the receiver the question of a bad or good earth did not come into the question; no earth at all was sufficient. Personally he would like to ask Mr. Marconi if he had continued these experiments to any great extent over greater distances.

Capt. VIVIAN confirmed everything that had been said about the success of the Marconi system in connection with lightships, and mentioned that experiments had been in progress for over two months on the Kentish coast.

Capt. KENNEDY, R.E., had taken part in many of Marconi's experiments, especially those on Salisbury Plain and in the Isle of Wight, and he had also read a Paper before the Royal United Service Institution dealing chiefly with the military application of wireless telegraphy. As regards the question of fixed stations, such as forts and camps, he thought the difficulties had been solved, but when they came to an army in the field it was another matter. They could not carry 100ft. poles about with them. They had to find some other way of raising the vertical wire, as it was evident they could not do without it. He had tried several experiments with kites and balloons, and one of the advantages of these was that they got rid of all the difficulties of insulation. They were practically unlimited in the length of their wire; it was as easy to have a 1,000ft. wire as it was a 10ft. wire. In one experiment at Bath he had put up two miles of wire on one kite, although it was needless to say that the enormous impedence on this wire was too much. He thought he was right in saying that about a year ago he was the only true believer in Mr Marconi and his system, excepting, of course, Capt. Brett and Capt. Jackson, of the Royal Navy, who both had been staunch supporters.

Prof. J. PERRY (in the chair) asked Mr. Marconi if it was necessary to have any earth connection. It was one of the most difficult things for him to understand why there should be any earth connection necessary.

Thursday, March 9.

Mr. JOHN GAVEY congratulated Mr. Marconi on the advance he had made in perfecting this system during the past 15 months. He had been associated with him in his early experiments, and had taken an active share in those carried out across the Bristol Channel. These experiments were to some extent crude, in the respect that the apparatus was practically untried and uncertain in its action. They had, however, succeeded in obtaining thoroughly good signals from one side of the Channel to the other, and had learned enough then to render it desirable to proceed with further experiments. It was arranged by the Post Office for these further experiments to be made, and the necessary apparatus was immediately put in hand. Some months elapsed before it was ready for use, and a further series of experiments were undertaken by the Post Office in the neighbourhood of Dover. The objects in view were to ascertain the law connecting the height of the conductors with the distance over which transmission was possible, and generally to test the system. They obtained the permission of the War Office to provide a transmitting station at Fort Burgoyne, near Dover, and a number of receiving stations were put up at different distances. The results of these experiments led them to certain conclusions, most of which had been verified by Mr. Marconi since, and many of them repeated in his Paper. These proved the law of the square of the height of the wires, but they went a little further. They found that with single elevated conductors, syntony did not come into the effect at all, so that not only did distances to which it was possible to transmit increase as the square of the height, but within certain limits it increased as the product of two vertical conductors of irregular height. Assuming that it were possible to transmit signals over certain distances with two conductors 50ft. high—the square of which would be 2,500—they could, under favourable conditions, transmit over the same distance with two conductors of different heights, which would give the same product. They found further, that there were marked effects on the syntony if a capacity were placed at the top of the vertical conductor, and, further still, they found that the use of a capacity enabled them to traverse or transmit over a certain distance with a lesser height of conductor. Another curious phenomenon they came across was that they required a greater height of vertical conductor to transmit signals over land below the sea level. Taking the experiments in the Bristol Channel as a guide, and also the subsequent experiments made by Mr. Marconi at Spezzia, they had calculated that it would require a vertical conductor 35ft. in height to transmit signals over a mile of water, but, to their surprise, they found it required a vertical conductor 50ft. high to do this. They naturally made numerous experiments to ascertain the cause of this apparently abnormal result, and ultimately they asked Mr. Marconi to come down with some of his own most recent apparatus, and they found that there *was* a distinct difference in the power required for transmitting over land as compared with that required over water. Subsequently he observed that Prof. Slaby, of Charlottenburg, who had been sent over by the German Emperor to watch the experiments in the Bristol Channel, had obtained the same results in his experiments conducted in Germany. He (Prof. Slaby) had attributed the difference in the results over land and water to the particles of dust floating about in the atmosphere, but with due deference to such a high authority as Prof. Slaby, he was afraid he could not agree with this view, because, in the case of Dover, there would scarcely be such a wide difference in the atmosphere over the grounds immediately adjoining the Straits and over the Straits themselves. He ventured to suggest that it was rather due to the reflection from the surface of the water, for water over such a distance as one mile they could assume to be an almost even plane reflecting mirror. There was no doubt that as these experiments over water were generally conducted from considerable heights, many of the waves, which would otherwise be reflected into space, were reflected back from the water and impinged on the receiving vertical wire, whereas, probably on land, many of these waves would be absorbed or possibly reflected right away into space. With regard to the height of the vertical wire, he noticed that Mr. Marconi had made a very considerable reduction in this, having now brought it down to 20ft.; but he would like to know whether this was a practical

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working height with a fair margin of safety, which would admit of working under all conditions, or whether this was the shortest height which could be obtained with skilled operators at the transmitting and receiving instruments. He had come across another interesting thing in connection with the Post Office experiments. When they discovered the discrepancy that existed between the results over water and over land, they investigated every possible cause which might have led to this difference. Naturally enough they immediately suspected the earth, for, as everyone knew, on the chalky downs in the neighbourhood of Dover, it was very difficult to get a thoroughly good earth at a moderate depth. They therefore disconnected the earth entirely from the coherer, and substituted an ordinary coil of wire, one end of which was insulated; in fact, they substituted a capacity for an earth. They found the signals were equally good when the capacity was substituted for the earth, and they have gradually reduced that capacity from a length of about 200 yards to a simple strip of brass about 2ft. long, and with this very small capacity they could still receive just as well as they did when the coherer was connected to earth. They tried the same effect at the transmitting end, but found they could not get good signals without an earth connection. Probably, if they had used a capacity of sufficient size to dispose of the large amount of energy sent into the transmitting vertical wire, they could have done without an earth at either end. They also found that the oil of the transmitter in the Righi form was quite superfluous. A simple air gap in the coil was all that was necessary. With reference to the question raised as to the amount of energy taken in producing these results, he thought it was rather a question of frequency than power, and this was shown by experiment. They had a very large coil capable of giving a 20in. spark, but as a general rule they adjusted it so that with 5 amperes it would give 6in. sparks. As a matter of fact, when they increased the current to 10 amperes to get a 20in. spark, they had to screw up the contact breaker very tightly, which reduced the periodicity, and they got a worse result with 10 amperes and slow vibration than with 5 amperes and rapid vibration. They also had tried large copper reflectors of the type exhibited by Mr. Marconi, and at first he thought they were going to get some very promising results, for at a distance of half a mile, with the transmitter in the focus of one of the reflectors, they could pick up the signals in the open air; but when they extended the experiment they got very disappointing results, and after a time they abandoned the idea. It appeared that even slight undulations that did not come in the direct line of the reflectors, were quite sufficient to prevent the satisfactory transmission of signals. He gathered from Mr. Marconi's Paper that he had obtained satisfactory signals up to two miles by means of reflectors; it appeared to him that signalling by means of reflectors would be far and away more satisfactory than signalling from vertical conductors. If they signalled from vertical conductors and from a large number of stations within a limited range, whatever was sent on one conductor could be heard on all the others, and it was only possible to transmit one message at a time. The use of reflectors would remedy this evil, and would be a great advantage in the practical application of the system. In a Paper like this he thought it was always a difficult matter to know when to draw the line between popular description and technical results; but, perhaps, in his reply, Mr. Marconi would refer to one or two matters of practical importance. First of all, the question of screening the receiving apparatus from the effect of the violent surgings in the transmitting apparatus was one of very great interest. The difficulty had been solved by Capt. Jackson in one way, Mr. Marconi had solved it in another; but if he (Mr. Marconi) saw his way to giving, in his reply, some explanation, it would be of great interest. Other points would also probably strike the author, such as the protection of installations from the effects of lightning. The vertical wire used was practically a lightning conductor, and to introduce a lightning conductor of this sort into the centre of a building or lightship without adequate protection would be very undesirable.

Mr. MERVYN O'GORMAN thought it possible to explain telegraphy without wires over long distances without assuming Hertz waves at all. A coherer was not only a detector of Hertz waves, it was really a detector of minute constant differences of potential. He suggested that there was a minute difference of potential, which any other instrument would not detect, set up through the *earth* and not through the air space between the two stations.

Mr. E. TREMLETT CARTER said it would be interesting to know how Mr. O'Gorman explained the action of reflectors on his theory.

Mr. O'GORMAN said he did not suggest that the coherer did not work with reflectors, he had merely advanced a hypothesis of an alternative method of wireless telegraphy.

Mr. W. P. GRANVILLE said that 100 Obach cells had been mentioned in the Paper as the power at Alum Bay, but if his memory did not fail him, he thought he had heard that these 100 Obach cells were not used directly connected to the induction coil, but were used to charge an accumulator off which the induction coil was worked. He would like to know if this were correct, because, if it was, it showed that they could not use the system in places where they were not able to have a dynamo. With regard to the screening effect, they had heard from public accounts that even three men-of-war interposed between the receiving ship and the signalling station have not prevented the receipt of messages, while they heard again that the waves are reflected. The two things did not agree. Which was correct?

Mr. L. MILLER asked if it would not be better to use several spark gaps, in series, for the transmitter, as it appeared that when using horizontal wires two gaps were certainly better than one, and more, he thought, would be of still greater advantage. He should also like to know which were the most sensitive metals to use for the coherer, apart from the question of de-cohering. He had had an opportunity of working with an extremely sensitive relay that worked with less than $\frac{1}{15}$th milliampere, but to his surprise he did not get any better results than with a less sensitive one. It seemed to him that a coherer was wanted that would break down if a succession of weak waves reached it. He had heard of carbon coherers acting in that way, and would be glad to know if anyone had made experiments with a carbon coherer.

Mr. A. A. C. SWINTON, replying to Mr. Miller's inquiry as to carbon coherers, said that he made experiments some time ago to see if Röntgen rays would affect the resistance of carbon, and apparently it did so, but he had found out afterwards that it was due to the contact-breaker of the induction coil.

Mr. A. C. BROWN had found that carbon coherers did break down gradually. One wave would slightly reduce its resistance, another would reduce it more, and so on.

Prof. SILVANUS P. THOMPSON (in the chair), speaking on the advantage of having the vertical conductors earthed at the bottom, said it seemed to him that there was one advantage that had never been pointed out yet, viz., that the earth directly below the vertical conductor played the part of a mirror. In a great many problems it was possible with advantage, to introduce optical ideas. Some years ago, in conjunction with Mr. Myles Walker, he had pointed out that many electromagnetic problems might be solved by the application of the idea of masses of iron acting as a magnetic mirror. Suppose they had a solenoid, say 2in. in diameter, and 6in. long with a certain number of coils of wire traversed by a current; the coil would have a certain magnetic moment. If they put against the end of that solenoid a large sheet of iron sufficiently thick and of sufficiently high permeability it would practically act as a mirror, so that the coil with the sheet of iron behind it would have exactly double its previous magnetic moment. In the Marconi transmitter the earth connection caused the earth to act as a mirror, and doubled the virtual length of the vertical rod. On the question of the variation of distance over which they could signal on land or water, he thought here, again, optical ideas could very well be introduced. He thought it possible to account for the greater absorption of the waves over land, as compared with water, by assuming that the conductivity of the earth was greater than that of water. It might seem curious to say so, but it appeared to be something of the sort. With regard to coherers, he said it was no use putting a mirror within a quarter of a wave length of the thing that was giving out light. Hertz had pointed this out. If they referred back to Hertz's researches, they would find that he used mirrors something like 10ft. high, and the oscillator was about 8in. long.

A hearty vote of thanks was accorded Mr. Marconi at the conclusion of the discussion.

DR. WEHNELT'S ELECTROLYTIC CURRENT INTERRUPTER.

At the meeting of the Institution of Electrical Engineers, held on March 9, Mr. A. A. Campbell Swinton exhibited Dr. Wehnelt's new electrolytic current interrupter. It was Dr. Fleming, he said, who, in the discussion on Dr. Lodge's Paper, gave the reason why there was great difficulty in obtaining syntonic results with Hertzian wireless telegraphy as opposed to magnetic wireless telegraphy, with which Dr. Lodge's Paper dealt. The real reason was because there is at present, or had been until recently, no means of obtaining continuous trains of Hertzian waves. Some years ago he made some experiments on this subject, and he showed curves at the meeting of the results obtained then by analysing the spark in the primary of a Tesla coil by means of a revolving mirror; and, as they saw, he got about five oscillations. This number was the maximum obtainable, and the whole series took place in about $\frac{1}{50000}$th of a second. The next lot of oscillations occurred in the opposite direction because he was working with alternate currents of 100 periods per second. Quite recently, a new form of contact breaker had been invented by Prof. Wehnelt, of Charlottenburg, which had an advantage in that it made it possible to get discharges from an induction coil, not as with ordinary contact breakers, say 30 or 40 per second, but 1,000 or more, and under certain conditions still more could be obtained. The apparatus consists of a vessel containing dilute sulphuric acid—about 1 part of acid to 5 of water—in this is dipped a large lead plate and also a glass tube to the end of which is fitted a platinum wire. The inside of the tube may be filled with mercury, or a larger wire could be used. They must not take the platinum wire to the top of the vessel because it would get hot. This formed the whole of the contact breaker. An ordinary induction coil without the contact arrangements was connected straight on to the 100-volt mains through this apparatus, and the only thing to be careful about was to see that the platinum wire electrode was positive. The apparatus would not work if the lead plate was positive. The exact action seemed fairly simple at first sight, but on going into it further it became more complicated. Obviously, oxygen was given off at the platinum pole, and one could imagine that a large amount of oxygen was given off round the pole, thus making an insulating sheet, and thereby the current would be interrupted. The oxygen was then absorbed by the solution, and the current started again. This seemed very simple, and one reason, possibly, why it took place when the platinum wire was positive, and not when it was negative, was that oxygen was more soluble in water than hydrogen. As a matter of fact, this explanation did not cover the facts, and he did not know the true explanation himself. There was a great deal of heat developed; indeed, there was an arc formed at the end of the platinum wire. This contact-breaker, moreover, would

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not work upon a non-inductive circuit; it would not work if, instead of having the primary of an induction coil or magnet, they had a lamp resistance in series with it. In explaining the working of the apparatus he said that, as he removed the core of the magnet, the note changed, the periodicity of the discharge depending on the amount of the magnetic inertia of the circuit. As he reduced the magnetic inertia, or self-induction of the circuit, the note went up. He thought it was, undoubtedly, important from the point of view of wireless telegraphy, and very likely in other ways, because it seemed to be the first real advance made for many years in continuous interruptions at very high frequencies.

Mr. E. TREMLETT CARTER asked if the effect observed with this interrupter would in any way suggest that it acted as a Trevelyan rocker—*i.e.*, whether it was a thermal effect. If the condensation of steam would allow contact to be made again, or, if the alterations between heating and cooling caused by the passage of the current produced this effect, he thought they would get a vibration very much like that of the Trevelyan rocker.

Mr. SWINTON said that, of course, temperature had a good deal to do with it. Steam very likely had very much the same effect in this case as the gas, due to electrolytic decomposition, but neither one or the other could account for the fact that the apparatus would not work upon a non-inductive circuit, and that when it was upon an inductive circuit, the induction in the circuit determined the frequency to some extent.

Prof. SILVANUS P. THOMPSON said there was clearly something in the nature of resonance taking place. It had long been common knowledge that the deposit of gas upon an electrode had the effect of making that electrode act, to a certain extent, as a capacity. In the researches of the late C. Varley they found this fact stated, and again in a Paper published in the *Journal* of the Russian-Physico-Chemical Society, by Prof. Sloughinoff, in 1881, upon the intermittence of the discharge at a small electrode when a sufficiently high E.M.F. is applied. Prof. Sloughinoff had examined it in a rotating mirror, and found that it was intermittent.

THE INDUCTION MOTOR.*

BY ERNEST WILSON.

Introduction.

The advent of the induction motor may be said to have marked an epoch in the use of alternate currents for power distribution, for, up to the time of its introduction, the only alternate current motor for comparatively large sizes was of the synchronising type. This type of motor, as is well known, requires to be run up to such speed that the frequency of the armature corresponds to the frequency of supply before being switched on to the circuit. For small sizes the ordinary direct current motor with laminated magnets can be, and was, employed, but the want was felt of a motor possessing the characteristic features of the direct current type, and capable of dealing with considerable power. The transmission of energy by the aid of electricity for the propulsion of tramcars and electrical locomotives may be cited as an example in which, one may say, until quite recently, the direct current motor has been exclusively used. In this case a motor is required which is capable of exerting an initially great torque for starting purposes, it must be easily controlled by drivers, and must be efficient. Consider the case in which power is transmitted from a distant waterfall to a district in which electrical traction is required. We should probably find that the turbines are coupled to two- or three-phase alternate-current generators, which supply directly or through step-up transformers to the line wires. At the receiving end the energy is delivered to a motor generator directly, or through step-down transformers, such motor generator converting this energy into the form of direct current for transmission to the cars by any of the well-known systems. This motor generator is of the synchronising type, and should be run up to synchronising speed before being switched on to the supply circuit. Now, if alternate currents could be employed on the car itself, it follows that no running machinery would be required in the substation, since the requisite reduction of potential difference could be accomplished by static transformers. At the present time the three-phase induction motor is being used at Lugano on the street cars, and is about to be installed on other lines, so that it is actually employed in practice. Now for two or three-phase currents to be transmitted to the car, it requires three conductors; if the rail be employed as one, then two other insulated conductors are required—these are overhead at Lugano. According to usual construction, the motor, even if single-phase, requires two or three-phase currents to start properly; that is, to give an initial torque of the required magnitude. The subject, therefore, has great practical importance at the present time. The primary object of this Paper is to investigate in an actual motor the conditions upon which the starting torque depends.

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The Motor.

The motor experimented upon was kindly lent by Mr. Alexander Siemens to the Siemens Laboratory, King's College, London. Fig. 1 is a side elevation, and Fig. 2 an end view of the motor which is intended to deliver 15 B.H.P. when running at 1,000 revolutions per minute, and supplied with a single-phase alternate current at 220 volts, the frequency being 50 periods per second.

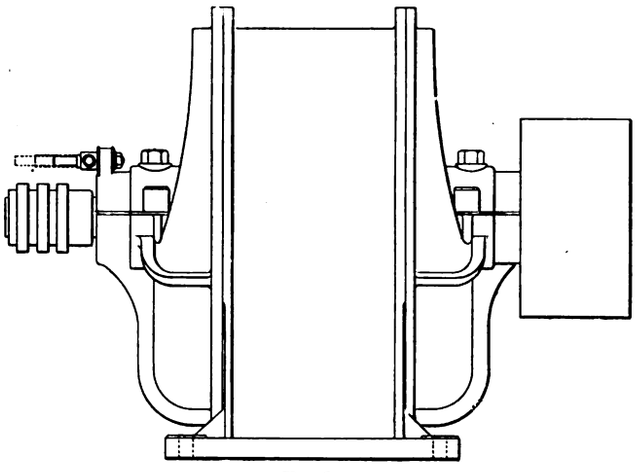

Fig. 1.

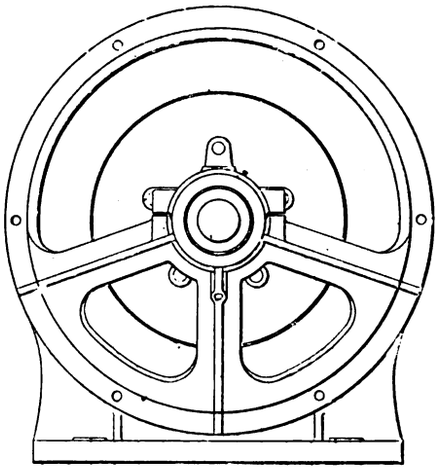

Fig. 2

In order to measure the initial torque, a beam having a radius of 3·5ft. is fixed to the shaft, and the pull in pounds measured at this radius by a spring balance, the armature being brought to its zero position by raising the spring balance by aid of a rope passing over a pulley. The actual observations of pull are, at the best, rough, since the readings, when small, are seriously affected by the friction of brushes and bearings, but they are sufficiently accurate for the purpose of this Paper. Before dealing with the actual experiments it will be well to describe the motor. Its stationary portion, Fig. 6, is wound with two circuits, marked respectively A and B. These circuits are so distributed that two-phase currents are required to give an approximate rotating magnetic field for starting purposes, and, when once started, the motor is intended to work on the single phase. The conductors are placed in slots, the main winding B consisting of 156 bars, and having a resistance of 0·038 ohm. The auxiliary winding A has 144 bars, and resistance 0·045 ohm. The armature (Fig. 6) is wound three-phase with three circuits, which are pooled together at one end, and connected respectively to three rings insulated on the shaft. These rings are connected through brushes to a non-inductive rheostat capable of varying the resist-

* Paper read before the Institution of Electrical Engineers, March 9th.

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ance externally inserted in each circuit by steps, as follows :—Open circuit, 2·37, 1·03, 0·42, 0·13 ohms at about 15°C., and short circuit; the ends of these three external resistances in the rheostat remote from the brushes are pooled together. Each armature circuit has 48 bars, and a resistance of 0·025 ohm, the bars being placed in slots in the armature. There are 150 slots in the stationary portion and 72 slots in the armature, two bars being placed in each slot, and the number of periods per revolution is three. The radius of the armature is 22·2cm., and the length of core parallel to the shaft 17·8cm.

The coils A B were supplied with currents from two Siemens alternators* separately, or, if required together, in any desired

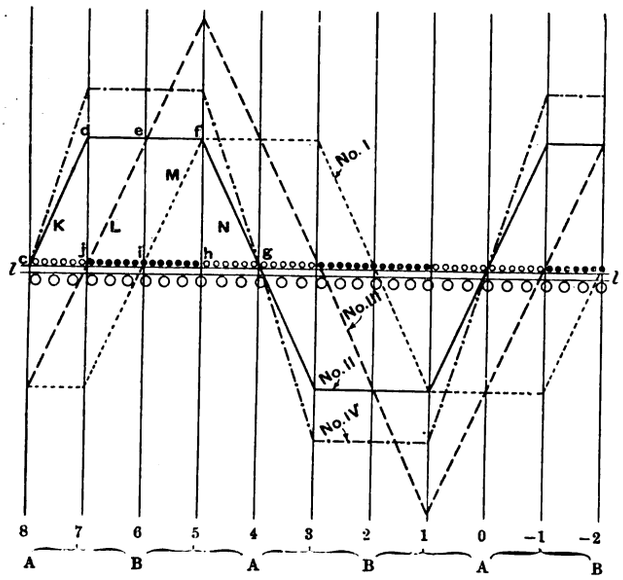

FIG. 3.

phase. By aid of a Kelvin quadrant electrometer and revolving contact maker fixed to the shaft of the alternators, the currents in the respective circuits have been deduced from observations, at different positions of the phase, of the potential difference between the ends of a non-inductive resistance in the circuit. The potential differences across the circuit were reduced when necessary to suit the sensibility of the electrometer by aid of considerable non-inductive resistances forming a shunting ratio.

SYMBOLS.

In the Paper the following symbols are used :—E_1, E_2, are the volts across the circuits A and B respectively; I_1, I_2, are the total inductions per turn in C.G.S. units in the circuits A and B; m_1, m_2, are turns in circuits A and B ($m_1=72$, $m_2=78$); x_1, x_2, currents in amperes in circuits A and B; R_1, R_2, resistances of circuits A and B ($R_1=0{\cdot}045$ ohm, $R_2=0\ 038$ ohm); T periodic time

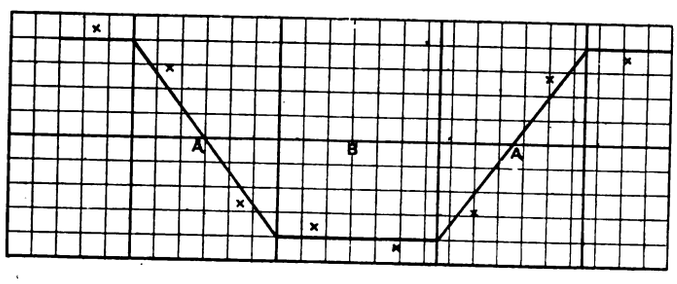

FIG. 4.

in seconds; f frequency of supply in complete periods per second; N number of poles per circuit per revolution = 6; m number of coils per period on stationary portion; θ one period of surface revolution; l length of armature and stationary iron cores measured parallel to axis = 17·8 cm.; r radius of armature = 22·2 cm.; l_1 length of air space measured radially = about 0·175 cm.; A_1 area of air space over one group of windings, B, in square cm.; l_2 length in cm. of teeth on armature and stationary portion of motor; A_2 area of teeth in square cm.; l_3 mean length of induction in iron in cm.; A_3 area of iron in square cm.; I total induction by characteristic curve; ν leakage coefficient; B induction in C.G.S. units per square cm.; $r_1=r_2=r_3$ = resistance of each armature circuit = 0·025 ohm; $\rho_1=\rho_2=\rho_3$ = extra non-inductive resistance in each armature circuit; these can have values ∞, 2·37, 1·03, 0 42, 0·13 and 0 ohms; $n_1=n_2=n_3$ = conductor turns on each armature circuit = 24; $y_1\ y_2\ y_3$ currents in the armature circuits respectively, in amperes; $e_1\ e_2\ e_3$ electromotive forces of the respective armature circuits C, D, E, in Fig. 6—that is, they are the potential differences between the ends of the respective circuits corrected for current into resistance 0 025 ohm.

THE MAGNETIC CIRCUIT.

Let the horizontal lines 11 (Fig. 3) represent the surfaces of the armature and the bored face of the stationary portion straightened out. The ordinates represent induction density, the areas induction. The windings A, B, are diagrammatically represented ° ° ° ° ° and • • • • • respectively. The lower row of large circles represent the armature conductors. Consider the winding A, and suppose that it only is the magnetising coil. One would expect the distribution of induction over the bored face to take the form represented by the full line (Curve No. II.), assuming for the moment that there is no leakage. Let the area $c\,d\,j$ be called K; $j\,d\,e\,i$, L; $i\,e\,f\,h$, M; and $h\,f\,g$, N. Then K + L + M + N is the total induction over

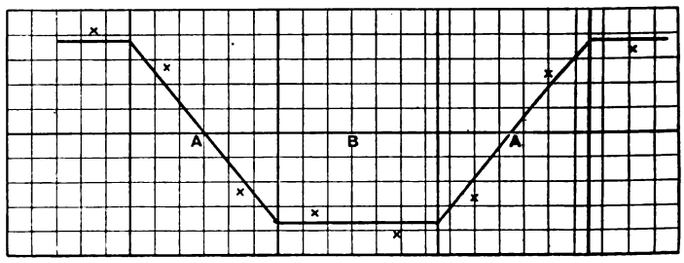

FIG. 5.

the half period ($\theta/2$) between c and g. If the characteristic curve for the surface $j\,h$ be worked out in the ordinary way, the total induction I given by it will be represented by the areas L + M.

For the purpose of finding the distribution of induction near the bored face, a series of insulated copper wires numbered 1, 2, 3, 4, 5, 6, were stretched across the surface parallel with the axis of the machine, and placed relatively to the coils A and B, as shown in Fig. 3; the wires have a diameter of 0·2mm., and touch the surface of the bored face. Electromotive forces have been observed between adjacent wires for different positions of the phase by aid of a quadrant electrometer and revolving contact maker attached to the axle of the alternate current generators; first when

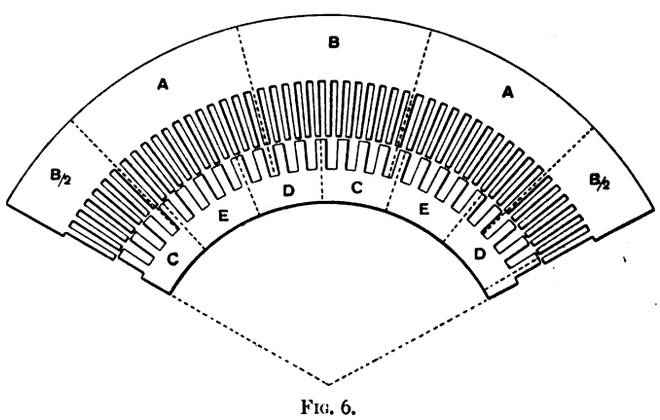

FIG. 6.

the motor was supplied with one-phase, second when supplied with two-phase currents. These E.M.F. curves have been integrated, and give therefore at any epoch the average total induction over the area between the two wires considered. These wires cannot give the distribution of induction *in* the stationary portion itself, but a good deal can be inferred from the curves obtained. Deal with the single phase curves first. The coil A was chosen for the single phase current. Table I. gives particulars of the test in which the frequency was 51·7 and the square root of mean square value of E_1 63 volts. We see that the curves dI_1/dt and (2 - 3), (3 - 4), (4 - 5), (5 - 6) are in phase. Their areas have been taken, and give total maximum inductions of 0·37, 0 1097, 0 0723, 0·0679, 0·0891

* For description of these machines and revolving contact maker, see *Phil. Trans. Roy. Society*, Vol. CLXXXVII. (1896), A. pp. 229-252.

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Table I.

Angle in 60ths of a period.	$\frac{dI_1}{dt}$ Volts.	x_1 Amperes.	Coil 2-3. Volts.	Coil 3-4. Volts.	Coil 4-5. Volts.	Coil 5-6. Volts.
0	+0·774	+10·89	+0·246	+0·168	+0·130	+0·217
3	+0·556	+13·29	+0·159	+0·116	+0·087	+0·159
6	+0·108	+14·43	+0·029	+0·029	+0·0	+0·043
9	+0·326	+12·98	-0·130	-0·072	-0·087	-0·087
12	+0·829	+ 9·765	-0·232	-0·145	-0·159	-0·188
15	-0·864	+ 5·859	-0·290	-0·174	-0·174	-0·232
18	-1·049	+ 1·142	-0·333	-0·217	-0·203	-0·275
21	-1·286	- 1·701	-0·304	-0·203	-0·188	-0·246
24	-1·233	- 4·663	-0·304	-0·217	-0·188	-0·246
27	-0·949	- 8·44	-0·304	-0·203	-0·188	-0·232

Table II.

0	+1·51	+18·78	+0·522	+0·290	+0·246	+0·420
3	+1·05	+23·05	+0·377	+0·203	+0·174	+0·304
6	+0·25	+25·04	+0·087	+0·014	+0·029	+0·072
9	-0·59	+22·75	-0·188	-0·145	-0·145	-0·159
12	-1·28	+17·41	-0·420	-0·304	-0·275	-0·348
15	-1·63	+11·45	-0·536	-0·362	-0·333	-0·448
18	-2·01	+ 5·194	-0·652	-0·420	-0·377	-0·507
21	-2·44	- 1·374	-0·623	-0·406	-0·348	-0·507
24	-2·34	- 7·788	-0·695	-0·449	-0·406	-0·550
27	-1·88	-13·59	-0·608	-0·391	-0·348	-0·478

in 10^6 C.G.S. units. The average inductions given by the exploring coils have been plotted in Fig. 4, in which the abscissæ are as in Fig. 3, the surfaces of the armature and bored face of the stationary portion of the motor straightened out. The full line in Fig. 4 has been drawn, and encloses an area per half period equal to 0·1097 + 0·0723 + 0·0679 + 0·0891, that is, equal to the sum of the inductions given by the exploring coils shown in Fig. 3. Another set of curves at higher maximum induction density (Table II.) give 0·676, 0·211, 0·135, 0·122, 0·168 in 10^6 C.G.S. units. These points have been plotted, and the full line drawn through them as shown in Fig. 5, enclosing the area represented by 0·676 + 0·211 + 0·135 + 0·122. The frequency in this case is 56 and $\sqrt{\text{mean}^2}$ E_1 118 volts. The object of drawing the curves in Figs. 4 and 5 is to show that there is ground for assuming the form given in curves Nos. I. and II., Fig. 3. Assuming, then, in Fig. 3 that L=M=K+N, and that K=N, one would expect the magnetising coil to experience a reaction represented by the rate of change of the average of areas L+M and L+M+K+N; *i e*, 1·25 (L+M). Further, the exploring coils (2-3), (3-4), (4-5), (5-6), if the air space experienced the whole induction, would give over half a period ($\theta/2$), $1\frac{1}{2}$ (L+M). In any case, on the assumption of distribution of induction represented by the full line, the maximum value of $\int\frac{dI_1}{dt}dt = 1·25/1·5 = 0·83$ of actual total induction. If the distribution were represented by a sine curve, this coefficient would be 0·85, and has been obtained graphically. Referring to the figures 0·37/0·83 = 0·446, and 0·676/0·83 = 0·814 in 10^6 C.G.S. units. Of these it appears that 0·339 and 0·635, in 10^6 C.G.S. units, gets into the air space—that is, the leakage is 24 and 22 per cent. respectively. The fact is, there is serious leakage across the teeth in this machine; but the coils 1, 2, 3, &c., have a thickness of 0·2mm., and are covered with one layer of silk, so that they account for a portion of the air space. Coming now to the characteristic curve. In Fig. 6 the length of the air space (l_1) measured radially lies between 0·15cm. and 0·2cm.; the area of the air space A_1 is taken to be 210 sq. cm.; l_2 is taken to be 15·2cm., and is the length of the teeth on armature and stationary portion; A_2, the area of the teeth, is taken to be 105 sq. cm.; l_3 is taken to be 48cm., and is the mean length in the iron; A_3, the area of the iron, is taken to be 415 sq. cm. Then the equation to the characteristic curve is

$$\frac{4\pi m_1 x_1}{10\times 3} = 2\left\{\frac{l_1 I}{A_1} + l_2\frac{I}{\mu_2 A_2} + l_3\frac{Iv}{\mu_3 A_3}\right\}$$

where $m_1=72$ and is the number of conductor turns; x_1 is the current in amperes; I is the total induction over area A_1, that is area *jh* (Fig. 3) of the armature, *v* is the leakage co-efficient which is taken to be 1·5. No great refinement can possibly be attempted in the results of characteristic curve calculations, since the air space length l_1 is not known very accurately and is of such importance. Taking an ordinary induction curve for transformer plate, and $l_1=0·175$cm., the characteristic curve for $x_1=14·4$ would give I the value $0·215\times 10^6$; for $x_1=25$, I would have the value $0·390\times 10^6$. We note that the maximum inductions given by coils (2-3)+(5-6) are 0·200 and 0·380 in 10^6 C.G.S. units respectively. This is sufficient to show that if the air space length were known accurately, the result might be predicted with sufficient accuracy for practical purposes.

(To be continued.)

CORRESPONDENCE.

THE WEHNELT INTERRUPTER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In working in the laboratory of the Technical College, Finsbury, upon the phenomena of the liquid interrupter recently applied by Wehnelt to the induction coil, several facts have been observed which throw light on the causes of this interesting matter. The actual experiments have been entirely in the hands of my assistant, Mr. J. Dennis Coales, and of Mr. W. Royal Dawson, senior student in the department.

The phenomenon is essentially one of resonance, and depends upon (1) the presence of self-induction in the circuit, (2) the operation of the small platinum anode in the acid as a capacity. The flow of current from this anode when a continous voltage is applied is unstable, since the evolution of gas on its limited surface checks the flow until the accumulating gas is bodily removed from the surface. Given this initial instability, given the well-known fact that a polarisable platinum anode has a capacity, and given that self-induction is present, there at once follows by electric resonance an oscillatory current superposed upon the continuous current; the period of the oscillations depending, as is well known, on the product of the self-induction and the capacity.

As was observed so far back as 1881 by Slouginoff (*vide* the *Journal* of the Russian Physical and Chemical Society, Vol. 12, p. 192; or *Beiblätter*, Vol. 5, p. 901) the discharge is intermittent. This may be seen by examining, in a revolving mirror, the luminous point which appears at the anode. This experiment was shown by Mr. Coales in the library of the Royal Institution last Friday. The frequency of the discharge can be varied, both by varying the size of the anode, and by altering the self-induction by introducing into the circuit a choking-coil with a movable core. We have also observed several curious results by inserting two or more liquid interrupters in series or in parallel. Two in series act in general as a single one of about half the capacity. We have found that the regularity of the intermittences is improved by the device of causing a jet of acid to flow rapidly past the anode so as to aid in the regular removal of the bubbles of oxygen.

If the pressure on the surface of the liquid is raised, the current passing through the break increases: as an instance when the pressure was raised from 1 atmosphere to 3 atmospheres the current changed from about 5 amperes to about 6 amperes, the frequency of the break on the other hand decreasing.

By use of incandescent lamps and of voltmeters we have further verified the resonant effects. The following experiment is quite easy, and at once suggests many variants, by its exact analogy with similar experiments made with alternating currents. A choking-coil was joined in series with a liquid interrupter—a platinum wire tip projecting into a beaker of acid with a sheet of lead as kathode—and the two were together placed across the mains of our electric lighting circuit, which is a continuous current supply at about 100 volts. Under these circumstances, though the voltage at the terminals was only 100 volts, a 150-volt lamp in parallel with the choking-coil was well illuminated. In another experiment, with varying self-induction, the voltage across the terminals of the choking-coil was 91 volts when a 3-ampere current passed; but, on increasing the self-induction, the current dropped to 2·6 apparent amperes, and the voltage rose to 159 volts, though the terminals of the circuit were only at 100 volts. If, with a suitable voltmeter, the voltages across the liquid interrupter and across the choking-coil are separately measured, their values added together always exceed that of the voltage of the mains which supply them; and, with a suitable adjustment of the parts, they may each separately be greater than the original voltage.—Yours, &c.,

SILVANUS P. THOMPSON

Technical College, Finsbury, E.C., March 8.

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TO THE EDITOR OF THE ELECTRICIAN.

SIR: Dr. Wehnelt's high-speed electrolytic break, which was exhibited in action at the last meeting of the Institution of Electrical Engineers by Mr. Swinton, is undoubtedly an addition to the resources of the physical laboratory. After hearing Mr. Swinton's explanations, I tried the break with an 8in. Apps induction coil, and obtained the flaring arc-like discharge between the terminals of the coil. This discharge, as Sir William Crookes pointed out some time ago, is really the flame of burning nitrogen. If an adjustable non-inductive resistance is placed in series with the electrolytic break and with the necessary inductive resistance or choking coil, it is possible to vary the number of discharges of the coil per second from one or two per second up to a thousand or more. It is best to use a choking coil of high inductance and very low resistance, and add the required resistance to the circuit by non-inductive resistances in series with the choking coil. If a couple of large Leyden jars are connected in the usual way across the secondary terminals of the coil, the discharge is quite startling when the coil is worked with the high-speed break.

If, in addition to the Leyden jars, a Tesla coil is employed as usual to take up the oscillatory discharge of the jars, the secondary high-frequency discharge is much increased. The electromotive force in the secondary circuit of the Tesla coil is also greatly exalted. It is well to proceed cautiously in trying this experiment. I have broken down the insulation of my Tesla coil in a dozen places this afternoon in trying the effect. If the electrolytic high-speed break is used with a Tesla coil it is necessary to have a secondary circuit very well insulated with a dielectric of considerable strength. The break will be especially useful in spectroscopic work, as the discharge with a Leyden jar in circuit with the coil secondary is exceedingly brilliant and continuous. The positive electrode of the break is best made by passing a stout copper wire down a narrow porcelain tube, the copper wire having a platinum tip welded to it. The platinum tip should just protrude through an ebonite plug which stops up the bottom of the porcelain tube. If the platinum wire is sealed into a glass tube it gives endless trouble by continually cracking out.—Yours, &c., J. A. FLEMING.

London, March 15.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: At a time when Wehnelt's interrupter is attracting a good deal of attention it may be of some little interest to point out a use to which it may be put, apart from that of working induction coils.

There can be little doubt, I think, that electrical resonance effects play an important part in the working of the interrupter which seems to act largely as a sustainer of electrical oscillations in its own circuit, for which it performs the same kind of function as the reed does for the organ-pipe. As evidence in support of this view may be mentioned the very noticeable influence which the presence of self-induction exercises on the intensity and pitch of the note given by the interrupter as well as on the light effects produced at the anode. Keeping the current constant, the introduction of a large self-induction lowers enormously the pitch of the note, making it, at the same time, much louder, while the withdrawal of self-induction raises the pitch. With only a very small self-induction the interrupter works less satisfactorily, and, indeed, the existence of a certain amount of self-induction seems to be, in a great measure, essential to its proper action. The capacity of the anode acting like a condenser supplies, of course, the other element necessary for the production of resonance. One result of the existence of oscillatory currents would be the production, by electrolysis, of a mixture of oxygen and hydrogen at the anode, giving rise, in turn, to a succession of minute explosions and correspondingly sudden interruptions of the current. A close inspection of the anode, while the interrupter is at work, lends colour to this view of the nature of the actions which take place there.

That the interrupter is capable of exciting and maintaining oscillations in a circuit containing capacity and self-induction can be shown very easily by connecting a condenser across the terminals of the interrupter. A considerable current, easily measurable on an ordinary electro-dynamometer, will then flow into the condenser, and from the magnitude of this current and the value of the electromotive force between the condenser terminals, we can, assuming the condenser current as simple periodic, deduce the frequency of the alternations. Now, my experiments show that the frequency so determined is, within very wide limits, altogether independent of the pitch of the note which the interrupter happens to be emitting, but depends solely on the capacity of the condenser and the self-induction of any coils which are included in the circuit. With the condensers I have been using, having capacities varying from 0·33 to 1·33 microfarads, I have obtained frequencies ranging from one to three or four thousand alternations per second; and, no doubt, still higher frequencies could be obtained with smaller capacities. The condenser current is steady enough to measure with accuracy. By placing a coil in series with the condenser and dynamometer, and measuring the electromotive force between its ends and also between the condenser terminals, it is possible from the dynamometer and voltmeter readings to get a fairly approximate value of the self-induction of the coil. As an instance the self-induction of a coil having a calculated value of 0·0018 henry worked out as 0·0023 henry, different determinations agreeing amongst themselves to within a few per cent. A Wehnelt's interrupter used in conjunction with a condenser is thus a very convenient device for producing from a continuous current a steady alternating current of moderately high frequency, by means of which all the ordinary phenomena of such currents can be readily studied. For example, it is a difficult matter *not* to get the Ferranti effect at the terminals of a condenser.—Yours, &c., ROBERT BEATTIE.

Owens College, Manchester, March 15.

NEUGSCHWENDER'S WAVE DETECTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of March 3 Mr. Fournier d'Albe abstracts from *Wiedemann's Annalen* an account of a remarkable kind of anti-coherer discovered by Neugschwender, depending on a film of moisture on glass whose resistance increases with the impact of electric waves.

But I conjecture that the action is really of the orthodox coherer kind, the continuous or semi-continuous film instantly aggregating into globules under electric influence, and so breaking the continuity.—Yours, &c., OLIVER J. LODGE.

GOVERNMENT TELEPHONES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of the 10th there is an article on the Telephone Question, in which, referring to a statement I made in the House a few days ago, you say:—

"There may be some villages in America where a telephone service can be had for $15 a year, but in the aggregate the rates are, we believe, considerably higher than in this country. The average tariff in New York is far above that in London."

It is not a question of "villages" in the United States only having cheap telephone service. The following is a quotation from a letter which I recently received from a well-informed correspondent in reference to the telephone business in the States:—

"There are between 1,500 and 2,000 new telephone exchanges in operation in the United States, whose rates are from $1.50 to $3.00 per month, according to the size of the city or town in which the exchange is located. These are in opposition to the Bell."

The rates in New York are higher than in London, but the service is also much better. If you are unaware of why it is so dear there, your intimacy with telephony in the United States cannot be extensive. The high rates for service are maintained by bribery and corruption, and the facts have been exposed in the State Legislature again and again. It is this which afflicts telephone users in New York just as our standing affliction has been the Telephone Department of the Post Office. Where there is monopoly in America the rates are high; where there is competition, actual or possible, service is cheap and usually good.—Yours, &c.,

London, S.W., March 15. A. D. PROVAND.

[Reference is made to this letter in our editorial columns.—ED. *E.*]

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CANDLE POWER EFFICIENCY OF INCANDESCENT BODIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: From experiments made with filaments composed of mixtures of various alkaline earths, I find that such filaments will burn in a vacuum. This is contrary to the statements made by Mr. Swinburne and others about the "Nernst" lamp. In fact, I find the same filament, when giving the same candle-power, requires less energy than it does when burning in the open air, and, moreover, that the difficulties of the mounts when such filaments are in a vacuum almost vanish.

I think the above facts are important, as I cannot imagine how it can now be said that the light of such filaments depends upon extra oxygen. This fact also, apart from other considerations, tends to show that such bodies are not electrolytes, for it appears that, with the same filament, they require the same voltage, whether they be run with alternating or continuous current, when either in a vacuum or in the open air.

A point of some interest is that such filaments, when run at the efficiencies given for the "Nernst" lamp, change so that the initial warming up temperature has to be gradually raised higher and higher, and I shall be glad to hear whether this point has been discovered and remedied in the "Nernst" lamp. There are many other points which, with the few tests I have already made, show that the production of such lamps is surrounded with many practical difficulties—chiefly in obtaining uniformity of voltage, candle-power and efficiency, and in obtaining good mounts; their increasing resistance and loss of candle-power when burning, &c.

Whilst dealing with the above subject I may remark that I cannot understand how it comes that there are so many theories advanced for the efficiency, light, &c., of incandescent bodies generally. It seems to be quite a simple matter. It is purely a question of temperature, with the "Nernst" lamp, as with carbon or any other body raised to incandescence. With a filament formed of alkaline earths one possesses a body which is a bad heat radiator; consequently, it does not require such a supply of watts or calories per second to maintain it at any given temperature. Again, with the alkaline earths we have bodies whose fusing point is extremely high (much higher than carbon); consequently, the temperature to be given to them can be much higher than to bodies whose fusing points are lower—in other words, a given quantity of such a body can be made to give a greater light, but at greater temperature, the said temperature requiring less watts or calories for its maintenance, owing to the body's bad radiating power. In the face of this I do not see the necessity for speaking about the exchange of oxygen, electrolytic effects, &c.—Yours, &c.,

Hammersmith, W., March 10. C. J. ROBERTSON.

PARLIAMENTARY INTELLIGENCE.

THE NEW LONDON ELECTRICAL BILLS.

The Select Committee of the House of Commons appointed to consider the scheme of the St. James's and Pall Mall Electric Light Co. for the extension of their works, commenced their inquiry yesterday (Thursday), Sir W. Coddington presiding. The other members of the Committee were Mr. Price, Mr. Clough and Mr. Cubitt.

Mr. Balfour Brown, Q.C., and Lord Robert Cecil appeared for the promoters; Mr. Freeman, Q.C., and Mr. Barclay, for the St. James's Vestry, Westminster, who were petitioning against the Bill; and private petitioners were represented by Mr. E. Boyle, Q.C., and Mr. C. A. Russell, Q.C.

Mr. BALFOUR BROWN, Q.C., said the object of the Bill was to enable the promoters to acquire lands and electric generating stations, and for other purposes. It was an almost exactly similar Bill to one which passed through both Houses of Parliament last year at the instance of the Chelsea Electricity Supply Co. (see *The Electrician*, July 29, 1898, p. 467). The promoting Company came into existence in 1888. For the first seven years they worked under a licence. In 1890 they got a provisional order by which their length of life was extended to 42 years from 1889. Of the £100,000 capital asked for at the start only 5,000 £5 shares were subscribed for, and the business had to be carried on by means of a loan of £35,000, afterwards increased to £50,000, on terms which gave the Debenture holders the option to change their Debentures for Ordinary shares. The present capital of the Company was £160,000 Ordinary shares and £100,000 Preference shares. The Company had begun their business at a place called Mason's-yard, but they had been obliged to go to Carnaby-street. The vibration, &c., at the former place had been complained of and the Court of Chancery had required them to abate the nuisance according to the requirements of the Board of Trade. There was no vibration at Carnaby-street. The demand upon the Company was so great that they could not meet it without acquiring land for the extension of their undertaking. It was found impossible to do this by agreement; therefore, they were compelled to come to Parliament for compulsory powers. Last year the Chelsea Company and the Metropolitan Supply Co. (Limited) secured somewat similar powers. There was an absolute necessity for the passing of the Bill. In 1890, when they began their business, they had 177 consumers, and in 1898, 1,400. There were now on their system 142,853 lamps, and whereas in 1891 they supplied 1,000,000 units of currrnt, in 1898 they supplied 3,448,000. The Company's plant only gave a surplus of 13 per cent., so that should there be a fog or breakdown the surplus might be easily exhausted. According to experts prudent working for safety should give them 25 per cent. surplus. The average price per unit obtained was 4·35 pence per unit, the authorised charge to which they could go if they chose being 8d. For public lighting they charged 2½d. per unit, which was a less amount than adjoining local authorities, who made their own electricity, could manufacture it for. The horse-power of the Company's engines now was 4,500. It was proposed to add 2,500 H.P. And, beyond this, it was proposed to put up transformers which would be constructed in connection with the generating station they were seeking to put up in conjunction with the Westminster Company on the banks of the Regent's Canal. He pointed out that on the previous day, when the fog was very bad, the Company used as much as 60 tons of coal, and were brought to the end of their tether so far as manufacture was concerned. Under the circumstances it was necessary to have a place where they could store coal, and that they should have the necessary generating capacity for making electricity. It was necessary to bring electricity to Carnaby-street. Referring to the opposition, he said the St. James's Vestry, Westminster, complained of the inconvenience of putting up such large works as those proposed in the West-end within 150 yards of Regent-street. In reply to that he pointed out that the promoters were anxious to avoid the construction of too large a generating station, and, therefore, they proposed entering into partnership with the Westminster company and constructing works on the Regent's Canal. It was complained that no provision was made for compensating the petitioners for damage which would be done to their roads and other property. This he did not understand, for the reason that all the mains in the streets were to be made not under the proposed Bill, but under a provisional order already in existence. The petition was a weak one. The Craven trustees and others, who were petitioners against the Bill, did not wish to sell their property, and therefore alleged that it was not necessary for the petitioners to extend their works at Carnaby-street. These petitioners would be dealt with satisfactorily under the Lands Clauses Act.

Mr. EUSTACE BALFOUR, Chairman of the St. James's and Pall Mall Company, gave evidence in support of the Bill. He said that the proposed works at Carnaby-street would only enable them to meet their requirements to 1901. If the whole of the new site were covered with works there would not be a sufficient supply to last ten years. The price charged for private lighting was 4·35d., and for public lighting 2½d. per unit. They hoped to decrease the power price to 2d.

Mr. SYDNEY DOBSON, Engineer to the company, said that at present they had 6,000 H.P. at work. In 10 years they expected to supply half a million lamps with electricity, and then they would require 15,000 H.P. This extension was necessary in order to avoid a breakdown of the existing supply. The supply of the Company had increased 15 per cent. per annum during the past two years. They anticipated a large increase in the motor business as soon as they could reduce the cost of current for power.

Sir FREDERICK BRAMWELL, C.E., said he had known the works of the promoting company for some time. They were admirably conducted, but of insufficient capacity, and the powers now sought were quite necessary.

Prof. A. B. W. KENNEDY also gave evidence in support of the Bill.

Mr. FREEMAN, Q.C. (for the St. James' Vestry), declared that the Vestry and owners of property would tell the Committee that there was at the present time inconvenience and nuisance both from smoke and vibration, and the fear entertained was that if Parliament allowed the Carnaby-street generating station to be enlarged, as proposed, the nuisance must inevitably be increased. The Company could make arrangements under their other Bill for generating all their electricity elsewhere.

The Committee adjourned until to-day (Friday).

LEGAL INTELLIGENCE.

Short and Others v. Viola.

An appeal was heard in the High Court before Lords Justices A. L. Smith, Collins and Romer, in which the plaintiffs appealed for judgment or a new trial in the action tried in November before Mr. Justice Wills and a special jury. The original action was brought to recover damages from the defendant, Mr. Otto F. Viola, for non-performance of an agreement. Verdict was given for the plaintiffs upon what counsel for the appeal said were the material issues, but for the defendant upon one issue. The plaintiffs were the Eureka Tempered Copper Co., of Pennsylvania, U.S.A., of which the plaintiff Short was chairman. The company in 1894 possessed secret processes for casting copper without alloys or blowholes, and for treating copper after it had been cast both for hardening or making it malleable. They employed a hundred hands and had agents in London. It was proposed to establish a branch in London, and defendant was approached, and became a party to an agreement by which he undertook

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to form a company with £20,000 capital to take over the European rights and all European orders, the company receiving certain shares. On the agreement, the action went for trial, and plaintiff said there had been misdirection and a verdict against the weight of evidence. Plaintiffs alleged that they had been taken by surprise by defendant's evidence, and that the learned judge who tried the case had wrongfully refused to allow them to call rebutting evidence. The surprise evidence brought forward by defendant was that the plaintiffs had no secret process, and the plaintiffs declined in open court, "with reporters and representatives of electrical firms and analytical chemists present," to divulge their secrets; but they offered to hand up particulars of the secret process to the judge or the jury, and they desired to recall their chief witness, Mr. Short. This was, however, refused, and the verdict of the jury had to be taken as the case then stood. The English company was not formed.

Lord Justice SMITH (to Mr. Harris, Q.C., for the appellants): You refused to tell what your process is, and I think the jury might very well take the inference that you have no secret process at all.

Mr. HARRIS: It was offered to the judge and jury.

Lord Justice SMITH: I have never allowed that in a court of justice. The other side call evidence that you have no secret process, and you after that want to recall your witnesses. You ought to have had that evidence before.

Mr. HARRIS said plaintiffs refused, and he said rightly, to disclose their secret process in open court.

Lord Justice SMITH: You need not have gone into court.

Without calling upon the respondent's counsel, their lordships delivered judgment, dismissing the appeal with costs.

Lord Justice SMITH said the point taken by the defence was that there was no secret process at all, and consequently the agreement entirely failed to provide any consideration. Mr. Short, in the witness box, did not say what the secret processes were. He was within his rights, but he had no reason to be surprised at the effect of this upon the jury. The specific evidence before them was that there was no secret process at all, and upon all the circumstances as put before them the jury acted. In his judgment Mr. Justice Wills was right, and the verdict of the jury must stand.

The other Lords Justices concurred.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The "Big Blue Book" for 1899 is NOW READY. The Directory Division has been corrected up to Feb. 8, 1899, and all the latest new names, changes of address, &c., will be found included. The Handbook Division has been much extended, many valuable tables having been added. The volume contains, also, the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways, finally corrected to Feb. 9, 1899. The price of the Directory and Handbook remains the same—10s., post free 10s. 9d.; abroad, post free, 12s. (United States 13s. 6d.).

TENDERS INVITED.

As announced in an advertisement, the *Barking* District Council invite tenders for the supply and erection of one 80-kilowatt steam dynamo, with necessary pipe-work and accessories. Plans, &c, may be obtained from the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C., after 11th inst., and tenders, addressed to the chairman of the Council, must be lodged at the Council Offices before noon of the 27th inst.

The *Sunderland* Corporation invite tenders for (*a*) india-rubber covered cables, (*b*) cast and wrought iron pipes and street service boxes, (*c*) stoneware casings and bearers, and (*d*) house fuse boxes. An advertisement contains further particulars, and specifications, &c., can be obtained on application to the borough electrical engineer (Mr. J. F. C. Snell), Dunning-street. Tenders, addressed to the Chairman of the Lighting committee, must be delivered at the office of the town clerk (Mr. Fras. M. Bowey), Town Hall, Sunderland, by noon of Thursday, 30th inst.

The *Plymouth* Corporation invite tenders for twelve months' supply, from April 1 next, of transformers and arc lamp carbons. Specifications may be obtained from the borough electrical engineer (Mr. John H. Rider), to whom tenders must be sent by 23rd inst. Further particulars are given in an advertisement.

The *Doncaster* Corporation invite tenders for the supply and erection of (*b*) three mild steel Lancashire double-flued boilers; (*c*) three sets of steam dynamos, two sets of larger steam dynamos, condensing plant, &c., and a 6-ton overhead traveller; (*d*) storage battery of 136 cells, having a capacity of 750 ampere-hours; (*e*) electrical instruments and other apparatus; (*f*) underground armoured cables, street boxes, &c. Further particulars are given in an advertisement, and specifications can be obtained from the consulting engineer (Mr. James N. Shoolbred), 47, Victoria-street, London, S.W., or at the office of the Borough Surveyor, Doncaster, after 14th inst. Tenders must be sent to the town clerk (Mr. Thos. B. Sugden) by noon of 28th inst.

The *Poplar* (London) District Board of Works invite tenders for the execution of the following contracts:—(*a*) Engine and pump room equipment and all electrical plant except battery; (*b*) boiler house equipment; (*c*) battery and battery stands; (*d*) public street lighting. Specifications, &c., may be obtained from the clerk to the Board (Mr. Leonard Potts), 117, High-street, Poplar, London, E., on and after 23rd inst. Further particulars of the Board's requirements are given in an advertisement, and tenders must be sent to Mr. Potts by 10 a.m. of Tuesday, 25th April.

The *Tynemouth* Corporation invite tenders for the supply and erection of the following plant:—(2) boilers, &c., (3) economisers and fittings, (4) ejector-condenser, circulating pumps, tanks and pipework, and water cooler, (5) pumps, feed pipes, &c., (6) travelling crane, (7) traction switchboard, (8) lighting switchboard, (9) accumulators, (10) cables, and (11) traction steam dynamo. An advertisement contains additional information. Specifications, &c., may be obtained on and after 20th inst., at the offices of the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's Gate, Westminster, S.W., and tenders must be sent in to the town clerk (Mr. Horatio A. Adamson), by noon of Saturday, 15th April.

The Corporation of *Peterborough* invite tenders for the supply and erection of the following electric lighting plant:—(1) Lancashire boilers and economiser; (2) Steam dynamos, balancers and boosters; (3) Secondary battery and accessories; (4) Switchboard and instruments; (5) piping, tank, condensers and pumps; (6) insulated cables. Specifications may be obtained on application to Mr. John C. Gill, Municipal Offices, Peterborough, and tenders must be lodged with the town clerk (Mr. W. Mellows) not later than Thursday, 20th April. Further particulars are given in an advertisement.

The *Edinburgh* Corporation invite tenders for the supply and erection of water tube boilers at Dewar-place station. Specifications may be obtained from the resident engineer (Mr. F. A. Newington), and specifications, &c., may also be seen at (but not obtained from) the offices of Prof. Alex. B. W. Kennedy, 17, Victoria-street, London, S.W. Tenders must be delivered to the offices of the town clerk (Mr. Thomas Hunter, W.S.), City-chambers, Edinburgh, by Monday, April 3rd. An advertisement contains further particulars.

The *Aberdeen* Corporation invite tenders for the supply of:—(1) two Babcock-Wilcox boilers, (2) one 180-kilowatt steam dynamo (Belliss or Willans and Robinson engine), with steam and exhaust pipes, and one 75-kilowatt balancing set. An advertisement contains further particulars, and specifications, &c., may be obtained from the city electrical engineer (Mr. J. Alex. Bell). Tenders must be sent in to the town clerk (Mr. W. Gordon), Town House, Aberdeen, by April 5.

The *Paddington* (London) Guardians invite tenders for the wiring of the workhouse in Harrow-road. Tenders must be delivered before 5 p.m. of 28th inst.

The Electric Lighting committee of the *Rothesay* Town Council invite tenders for the supply and erection of two 20 H P. coupled engines and dynamos, switchboard, cables, arc lamps and posts, feed pump, steam and exhaust pipes, &c. Tenders to town clerk (Mr. John T. Wilson) before noon of Monday, 27th inst.

The Guardians of the *Poplar* (London) Union invite tenders for the supply and erection of (*a*) steam turbines and dynamos (direct coupled), (*b*) electric motors, (*c*) accumulators, (*d*) electric cables, wiring, &c., and (*e*) main switchboard and distribution boards. Tenders to Mr. G. H. Lough, before 6 p.m. of 22nd inst.

The committee of the *Stockport* Sunday School require tenders for the electric lighting of their premises. Applications for permission to view premises to secretary by March 24.

The *Southend* Corporation invite tenders for the temporary transfer of their provisional order. Tenders to town clerk by April 6.

The *Lewes* Corporation invite offers for the erection of electricity supply works. Tenders by March 24.

The *Bury* (Lancs.) Electric Lighting committee invite tenders for a Lancashire boiler with steam and other pipes. Tenders to Town Clerk by 20th inst.

The *Stockport* Corporation invite tenders for the supply, erection and maintenance for 12 months, of 36 continuous current arc lamps. Tenders to chairman of Gas and Electricity committee, by 23rd inst.

The *Beckenham* District Council invite tenders for construction of a dust destructor. Tenders to the clerk, by 27th inst.

The *Bristol* Corporation invite tenders for installing the electric light at the petty sessions courts and offices. Tenders to clerk by March 30.

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The *Gillingham* (Kent) District Council invite tenders for wiring their Technical Institute. Tenders to clerk, Gardiner-street, New Brompton, by 23rd inst.

The *Plymouth* Corporation invite tenders for the supply of steam coal and lubricating oils (for 12 months). Tenders to borough electrical engineer (Mr. J. H. Rider) by 24th inst.

The *Halifax* Corporation require tenders for supplying 100 creosoted telegraph poles. Tenders to Clerk by 20th inst.

The *Aberdeen* Corporation invite tenders for the supply and erection of the following materials for the equipment of their George-street and Woodside tramway route :—(*a*) permanent way and roadwork, (*b*) overhead line construction, (*c*) feeder and test cables, (*d*) tramway cars and all accessories, and (*e*) switchboard, instruments, &c. Tenders to town clerk (Mr. W. Gordon) by 10 a.m. of 29th inst.

The Corporation of *Port Louis* (Mauritius) invite tenders for the exclusive privilege to establish and maintain electricity supply works in the town. Further particulars are set out in an advertisement, and tenders must be addressed to the Agent-General (Mr. M. Ulcoq), 9, Idol Lane, London, E.C., by noon of 23rd April. Conditions (in French) may be obtained from Mr. Ulcoq.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been received by the Leyton School Board for the electric lighting of the Kirkdale-road and Harrow-green schools :—

	Kirkdale-road.	Harrow-green.
— Digby	£464 11 6	£459 18 0
Westminster Engineering Co.	451 6 0	430 2 0
J. E. Spagnoletti and Crookes	449 15 0	418 0 0
Strode and Co.	427 0 0	417 0 0
Edmondson's Electricity Corporation	414 8 0	385 0 0
Moody Bros.	412 5 3	359 17 0
Allingham and Fennell	344 12 0	335 14 0
H. D. Barlow and Co.	341 3 0	333 3 0
Vaughan and Brown	327 0 0	306 0 0
W. R. Woodward	237 5 0	225 5 9
Vulcan Electric Co.	208 6 0	208 19 8
Architect's Estimate	385 0 0	360 0 0

The Aberdeen Town Council have accepted the tender of Messrs. T. Bolton and Sons for the supply of copper strip, 1in. by 25in. and 1in. by 2in.

The Inverness District Lunacy Board, who recently decided to introduce the electric light into the Inverness Asylum, at a cost not to exceed £5,000, have accepted the tender of Tangyes (Limited), for the supply of steam engines, that of Siemens Bros. and Co. for dynamos, and of Messrs. James White for the main switchboard. The lighting is to be carried out under the supervision of Dr. J. T. Bottomley, F.R.S.

The Birmingham Corporation have accepted the tender of the Birmingham Electric Supply Co., for substituting electric for gas lighting in the Council chamber at £1,774.

The Burnley Corporation have accepted the tender of Messrs. Williamson and Joseph for the supply of a switchboard.

The Exeter Town Council have accepted the tender of Babcock and Wilcox (Limited) for the supply of a 500 H.P. boiler at £1,120, and that of S. Z. de Ferranti (Limited) for supplying a 250-kilowatt steam alternator at £3,460.

The Electric committee of the Belfast Corporation have accepted the tender of Babcock and Wilcox (Limited) for the supply of water-tube boilers.

Messrs. Handley and Shanks have obtained the contract from the Dublin Board of Control for the electric lighting of the Richmond (Dublin) Lunatic Asylum. The plant will comprise two steam engines, dynamos and a battery of accumulators. The work will be carried out to the specification of Mr. Walter Leake.

The tender of Messrs. Laurence, Scott and Co. has been accepted by the Lincoln Corporation for the supply of engines, dynamos, &c., at £4,423.

The Aberdeen Town Council have accepted the tender of Messrs. P. C. Middleton and Co. for wiring the Art Gallery at £75.

APPOINTMENTS VACANT AND FILLED.

A thoroughly competent manager is required for large india rubber works to be established on the continent. Some further particulars are given in an advertisement.

The Folkestone Electricity Supply Co. require an electrician-in-charge. Applications to the engineer and manager (Mr. Thomas Hesketh). See advertisement.

The Corporation of Devonport require an electrical engineer competent to devise an electric lighting and tramway scheme for the borough. Salary £300 per annum. Further particulars are set out in an advertisement. Applications must be lodged with the town clerk (Mr. A. B. Pilling), by Wednesday, 29th inst.

The Bolton Electricity committee require two junior assistant engineers. Further particulars are set out in an advertisement, and applications must be sent to the borough electrical engineer (Mr. Arthur Ellis) by noon of 30th inst.

As advertised elsewhere, the Edinburgh Corporation invite applications for the position of assistant to the superintendent of mains. Applications to the resident electrical engineer (Mr. F. A. Newington), 5, Dewar-place, Edinburgh, on or before Monday, April 3.

We are pleased to announce that Mr. F. Harman Lewis, late borough electrical engineer to the Corporation of Wolverhampton, has been appointed to succeed Mr. H. Collings Bishop at Leyton, on the occasion of Mr. Bishop's transferring his services to Wigan. Mr. Lewis commenced the study of electrical engineering in 1883, when he entered as a student at Finsbury. In 1886 he entered the works of the Electrical Power Storage Co., where he remained for about two years. In 1889 he was for a time upon the staff of the Westminster Corporation, then for about two years an assistant engineer to the St. James' and Pall Mall Co., and in 1891 he was appointed electrical engineer to the Corporation of Hull, for whom he designed and carried out electricity works on the three-wire system, at the cost of about £35,000. He was appointed in 1893 electrical engineer to the the Borough of Wolverhampton, and designed and laid down an electricity works on the 2,000 volt direct current system, for private and public lighting, at a cost of about £40,000. He resigned from Wolverhampton in 1898.

BUSINESS NOTICES.

Official intimation will be made this week of the partnership entered into between Mr. W. H. Preece, C.B., F.R.S. (late engineer-in-chief to the Post Office), Major Cardew, R.E., ret. (for the past 10 years' electrical adviser to the Board of Trade), Mr. A. H. Preece and Mr. Llewellyn Preece, who will together form the firm of Preece and Cardew, consulting electrical engineers, 13, Queen Anne's-gate, Westminster, London, S.W.

Messrs. Gillies and Hornidge have taken City offices at 49, Queen Victoria-street, E.C., where future communications should be addressed.

Messrs. E. J. Everett and W. J. Cole (trading as Everett and Co.), engineers and electricians, 22, Charterhouse-square, London, E.C., have dissolved partnership. Debts by Mr. Everett.

The London offices of Messrs. Lacey, Clirehugh and Sillar, consulting engineers, have been removed to 2, Queen Anne's-gate, Westminster, S.W., where all future communications should be addressed.

Messrs. Handley and Shanks have opened a branch at 46 and 47, Corn Exchange-buildings, Fennell-street, Manchester. Mr. C. E. Hunter will act as representative.

Messrs. Woodward and Craig, electrical engineers, 69, Waterloo-street, Glasgow, have dissolved partnership. Debts by Mr. Craig.

Owing to increased demand for their goods the Electrical Co. has established, in addition to their Brighton branch, a branch establishment at 21, Corn Exchange-buildings, Fennel-street, Manchester, with Mr. A. V. Ward as manager. The Company state that at present they have on order machines aggregating nearly 2,000 H.P. The open and enclosed arc lamp department continues busy.

BANKRUPTCIES, LIQUIDATIONS, &c.

A receiving order has been made against F. Marson (trading as F. Marson and Co.), electrician, 1, Poplar-avenue, Leicester. The first meeting of creditors will take place on 21st inst. at the Official Receiver's, 1, Berridge-street, Leicester, and the public examination on April 7th at the Castle, Leicester.

A meeting of the Globe Electrical Advertising Syndicate (Limited) will be held at 1, St. Peter's Church Walk, Nottingham, on April 13 to receive an account of the winding up.

The application for the discharge in bankruptcy of P. C. Pope, electrical engineer, 6, Castle-street, Hapton, near Burnley, will be heard on May 20th at the Court House, Burnley.

The deed of assignment previously referred to in the matter of John Alfred Edmondson, electrical engineer, Leeds, has, we are informed, been assented to by creditors representing a large proportion of the liabilities. The solicitors who have the matter in hand anticipate that creditors will eventually be paid 20s. in the pound.

In the liquidation proceedings of New and Mayne, Limited, Mr. D. F. Basden, liquidator, 33, St. Swithin's-lane, London, E.C., notifies that deferred debentures of the International Engines Patents Development Co., Limited, are about to be issued to the creditors for the amount of their respective claims.

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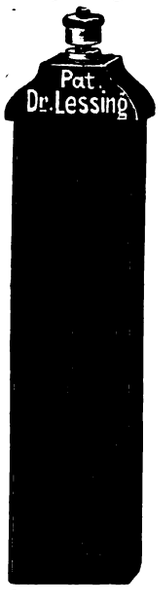
Salvage Sale.—Messrs. Wheatley Kirk, Price and Goulty have been instructed by the General Electric Co. to sell by auction on Wednesday next, March 22, a quantity of slightly damaged electrical stock, upon the premises, 203, Upper Thames-street, London, E.C., consisting chiefly of an extensive collection of electrical fittings and appliances damaged at the recent fire. Some further particulars are given in an advertisement. Catalogues of between 300 and 400 lots can now be obtained.

Sale by Tender.—Messrs. Fuller, Horsey, Sons and Cassell will offer for sale by tender, in one lot, a valuable leasehold engineering works situate at Barnsbury-street, Islington, London, N. The plant and machinery is practically new, and a portion of the contents will be found set out in an advertisement on another page. Tenders have to be sent in by noon of Thursday, March 23, to the Registrar of Companies (Winding-up), Bankruptcy Buildings, Carey-street, London, W.C.

Personal.—The personal friends of Mr. Ch. Gerhardi, manager of the Direct Spanish Telegraph Co., will entertain him at dinner at the Freemasons' Tavern, Great Queen-street, London, W.C., to-morrow (Saturday), the opportunity being taken to congratulate him upon receiving from the Queen Regent of Spain the appointment of Comendador of the Royal Order of Isabel la Católica.

Mr. George Gray Ward, vice-president and general manager of the Commercial Cable Co., has been elected president of the St. George's Society of New York, an important body of representative Englishmen in America. The position of president of this Society is regarded as a high honour.



A New Capped Carbon Plate.—The illustration below shows a new capped carbon plate, manufactured by Dr. Lessing at Nurnberg, whose agents here are Messrs. Krupka and Jacoby, of Watling-street, London, E.C. The introduction of a new carbon plate, which is claimed to be equal to any good capped carbon plate on the market, will be of interest to our readers.

Davy Improved Arc Lamp.—A demonstration was given a few days ago of the special features of the Davy improved arc lamp. The features are claimed to include perfect sealing, simple method of sealing, and ease of renewing the carbons and cleaning the enclosing bell, steadiness of running, whiteness of light, silence while running, long life, non-breakage of enclosing glass, and freedom from blackening, buckling and ash deposit. The lamp is said to be regulated for any current, and will run on direct or alternating current as desired, and in the latter case on any frequency without alteration. It will also run on series circuits. The lamp is 2ft. in length, and weighs only 14lb. complete with case and globe.

Resistance Materials.—We are asked to state that the "Beacon" high resistance material referred to on p. 694 of our last issue is not a new material.

Roller Bearings.—Owing to the large and increasing number of orders received by the Roller Bearings Co. (Limited), and owing to the difficulty in obtaining prompt delivery of material, which retards the completion of the bearings, the directors have made arrangements for enlarging the works and equipping them with improved machinery. The company report that their bearings, both large and small, are in very extensive use, and are giving excellent results, with the natural result that repeat orders are the invariable rule.

Electric Advertising Signs.—An advertising sign of new design, patented by Mr. W. T. Bell, of Nottingham, is exhibited in Oxford-street, London, at the corner of Tottenham Court-road. The sign has been erected by the Universal Electric Advertising Syndicate (Limited), who have acquired the Bell patents for this country, France and the United States, and we understand that arrangements are in progress for erecting similar machines in many large towns. We are informed that the sign consists of two sections, one below the other, each containing 504 lamps, so that the total number of lamps employed exceeds 1,000, although the total number in use for any one display rarely exceeds 300. It is possible to exhibit almost any number of advertisements successively, each being timed to appear for about 10sec., followed by 3sec. of darkness. An arrangement is introduced by which the lamps in each row light successively from the bottom upwards, producing the effect of a blind being drawn rapidly up, and exhibiting the particular wording desired. The construction of the electrical machinery, the controlling mechanism and the outside sign has been carried out by Messrs. Laing, Wharton and Down. The chief advantage claimed for the invention is that almost any advertisement or announcement may be made to appear at will without any alteration in the structure of the sign. The interior apparatus is compact, is entirely automatic, and is worked by an electric motor.

"Cost of Municipal Trading."—Price 2s. Messrs. P. S. King and Son, of Great Smith-street, Westminster, have issued in book form the Paper read before the Society of Arts by Mr. D. H. Davies, and the complete discussion thereupon, with interesting diagrams showing (1) the National Debt and local debt of the country, (2) the proportionate increase of rates and debt compared with population and valuation for 1878 and 1897, (3) the National Debt per head of population compared with the local debt, (4) the amount of local debt per £100 of rateable value, and (5) the proportion of local debt attributed to remunerative expenditure. An abstract of Mr. Davies' Paper has been recorded in *The Electrician*, and many of our readers may wish to possess the complete Paper and discussion on a subject which will in the near future require to be discussed and dealt with on the broadest lines. Much depends upon the manner in which this matter is handled, and a useful aid to a complete understanding of the development of municipal trading enterprise can be obtained from the publication under review. With Mr. Davies' deductions we are in general agreement, and, as many of those who joined in the discussion on the Paper are acknowledged leaders of men, the views then expressed upon this important question will prove of service to those studying the subject.

Alleged Infringement.—Mr. J. Slater Lewis, author of the well-known work, "The Commercial Organisation of Factories," recently brought an action against the *Mechanical Engineer* and John Heywood, publisher, Manchester, for infringement, and it is, in our view, to be regretted that Mr. Slater Lewis was not successful in his action. Without the lesson of this particular case, the time has certainly come when the property of authors and publishers should be better protected. It is a crying evil that no sooner is a book published which can fairly claim to be a standard work on the particular subject treated, than a pack of harpies set about clipping and carving the contents, and re-hashing them for publication either in cheap periodical or book form, just keeping clear of the all too lenient copyright laws. We write feelingly upon this subject, as we have been great sufferers; in fact, we have a case on hand at the present time where complete sets of articles, illustrations, and editorial remarks have been taken word for word, *en bloc*, without even the courtesy of acknowledgment. It is doubtful whether we can obtain any redress, and it is certain that if we obtained a verdict that is all we should obtain. From the remarks of Mr. Justice Cozens-Hardy in Mr. Slater Lewis's case, and from the statement we make above, it is manifestly time that some amendment of the law were brought about to protect technical experts from this wholesale piracy of their brain work. In the action brought by Mr. Slater Lewis, it was stated by the judge that use had admittedly been made of the plaintiff's book, and, in giving judgment for the defendants, the question was asked whether they demanded costs, and this question having been answered in the affirmative, Mr. Slater Lewis has the satisfaction of knowing that use has been made of his book without his permission, and that he has to pay handsomely for proving it.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from March 8 to March 14, with the ports of destination:—

Argentina—Buenos Ayres, £6. *Australasia*—Melbourne, £210 (telegraph material); Perth, £56; Port Chalmers, £28; Sydney, £158; Wellington, £26. *Austria*—Trieste, £178 (including £28 telegraph material). *Belgium*—Antwerp, £261; Ostend, £70. *Brazil*—Rio Janeiro, £490 (telegraph material). *Canada*—Montreal, £10. *Ceylon*—Colombo, £102. *Egypt*—Alexandria, £200. *France*—Boulogne, £112; Dunkirk, £250. *Germany*—Hamburg, £590. *Holland*—Amsterdam, £133; Flushing, £41; Rotterdam, £116 (telegraph material). *Hong Kong*, £14. *India*—Bombay, £432 (including £152 telegraph material); Calcutta, £1,920. *Italy*—Genoa, £500. *Japan*—Nagasaki, £2,151; Yokohama, £73. *Malta*, £450 (telegraph material). *South Africa*—Cape Town, £137; Durban, £98; East London, £26; Port Elizabeth, £1,517 *Straits Settlements*—Singapore, £25. *Sweden*—Stockholm, £44 (telegraph material). Total £10,424, against £19,555 in the corresponding week last year (March 9 to March 15).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Acton.—Messrs. Lacey, Clirehugh and Sillar have been appointed consulting electrical engineers to the Council, which has offers from three companies to supply electric current in the district—the British Insulated Wire Co., the London United Tramways and the Metropolitan Electric Supply Co. The latter offers current at 4d. per unit, provided the whole of the supply for the district be taken for a period of not less than five years, or at 3d. per unit for a term of not less than ten years.

Alleged Fraud.—At the Guildhall on Wednesday, Claude Vautin was again remanded, without bail, on the charge of obtaining valuable securities by means of false pretences.

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Arbroath.—The Council have been informed that the Board of Trade have resolved not to expunge the clause from their Provisional Order giving to the Corporation power to hand over the electric lighting to a company. The Council, in conjunction with other local authorities and companies, intend to make a fight for the retention of the clause.

Bangor-Donaghadee Electric Tramways.—The County Down Grand Jury have approved the scheme of the Drake and Gorham Electric Power and Traction Co. for the construction of an electric tramway between these two towns at an estimated cost of £100,000.

Barnsley.—A tramways committee is to be formed to consider the advisability of constructing a system of electric tramways in the district.

The foundation stone of the new electricity supply works was laid on Thursday last by Councillor W. Brady.

Batley.—Messrs. Lacey, Clirehugh and Sillar have been appointed consulting engineers to the Town Council to prepare a report as to establishing electricity supply works and constructing electric tramways in the district.

Blackburn.—The Board of Trade have approved the new electric tramways of the Corporation. As soon as the lines are opened for traffic a reduction in the fares will be made.

Bradford.—The total income of the electricity department for the past half-year amounted to £13,011. 3s. 8d., an increase of £2,169. 3s. 1d. over the corresponding period of last year. The total expenditure, including interest and sinking fund, was £10,519. 10s. 3½d., an increase of £2,577, and the profit £2,491, a decrease of £407. The number of consumers was 850, an increase of 31 per cent., and the total units consumed, exclusive of current for trams, &c., has been 723,000, an increase of 31 per cent. The total profit since the opening of the works, after paying interest and sinking fund, was £20,882, while £10,556. 12s. 3d. had been set aside for depreciation, leaving £10,326 to be appropriated by the Council for distribution as it thought best.

Brighton.—In the accounts of the electricity department which were presented to the Town Council yesterday (Thursday), the income for the past year was given at £42,194. 11s. and the expenditure £22,846. 14s. 7d., leaving a gross profit of £19,347. 16s. 3d. Of this sum £147. 16s. 5d. has been appropriated to make provision for bad debts and £19,200 carried to net revenue account. Payment of interest on redeemable stock, loans, &c., absorbs £5,844. 2s. 9d. and sinking fund £6,553. 16s. 8d. leaving a balance of £6,802. 0s. 7d., which the Lighting Committee have, on the recommendation of the manager (Mr. Arthur Wright) allocated as follows:—

Relief of general district rate	£2,135
Depreciation of batteries	2,000
Depreciation of meters	1,000
Engineer's commission account	1,497

The balance (£170. 2s. 10d.) has been added to the reserve fund, which now amounts to £7,107. 14s. 3d. The income from the sale of current was made up as follows:—

820,985 units, at 7d.	£23,945	7	11
1,277,811 units, at 1½d.	7,986	6	3
56,475 at 7d. (public lamps)	1,647	3	9
493,430, at 1½d. do	3,083	18	9
Total	£36,662	16	8

The difference between this amount and £42,194. 11s. was made up by £3,437. 7s. 9d. for attending to public lamps, £366. 9s. 10d. for street lighting installation work, £947. 14s. 1d. for meter rentals, &c., £700. 7s. 8d. for work executed for customers, £58. 17s. 4d. brought forward, and a few minor items. There are now 257 public arc and 941 incandescent lamps. The quantity of electricity generated was 3,242,017 units, the total sold 2,648,701 units. During the year expenditure on capital account amounted to £25,652. 12s. 8d., bringing the total to £237,987. 3s. The total borrowing powers are for £290,881, and £67,726 is still unspent. The Committee have resolved, as from 1st Jan. last, to reduce the charge for current, after the first hour's consumption, from 1½d. to 1d. per unit.

The electricity accounts and the recommendations of the Lighting committee were duly approved by the Corporation.

Bristol.—The Council propose to purchase property adjoining the electricity works at Temple Back for £2,500 for carrying out extensions of the station building.

Cape to Cairo Telegraph.—It is announced that an understanding has been arrived at between the German Government and Mr. Cecil Rhodes as to the continuation of the Cape to Cairo telegraph through German East African territory.

Cardiff.—At Monday's Council meeting, Councillor Fox moved that "Proceedings be taken against Messrs. S. Z. de Ferranti (Limited) for the recovery of £2,112, penalties for the non-fulfilment of their contract for the supply and delivery of a new alternator on Sept. 15, 1896, at the electricity works, and which was not so delivered and has not been finally taken over by the electrical engineer up to the present time." After discussion an amendment was carried "That it be an instruction to the town clerk to take counsel's opinion as to whether it is advisable, and if so advised to take proceedings to recover damages from Messrs. Ferranti."

Chelmsford.—Mr. Robert Hammond has been called in by the Council to prepare a report upon the advisability of purchasing the undertaking of the local supply company.

Coatbridge.—As the British Electric Traction Co.'s Bill for the construction of electric tramways in Coatbridge and Airdree has been rejected, the Coatbridge Council have appointed a committee to co-operate with the Airdree Council in the preparation of a scheme to be carried out jointly by the two authorities.

Coventry.—The City Council have decided to modify their scale of charges for electric current to 6d. per unit for the first hour's maximum demand, and 3d. after.

Darfield.—Major Cardew has held an inquiry here into the application of the Council for a provisional order. It was stated that, with the exception of oil lamps, there was no illuminant in the district, and the desire for some sort of light in the streets was great. In 1897 the inhabitants held a meeting with a view to commemorating the Diamond Jubilee, and one of the things which was determined upon was the introduction of a system of electric lighting. Mr. William Johnson, engineer and manager of the Sheffield Corporation electricity department, said he estimated the capital expenditure necessary for the establishment of electricity works at from £8,000 to £10,000. The annual cost of maintenance and sinking fund would amount to about £1,175. The street lighting would require 121 16 c.p. incandescents. They would be able to supply nearly 73,400 units per annum for private lighting, which at 4d. per unit would produce £1,223. After evidence had been given in favour of the application, the Mitchell Main Colliery Co. and one or two other property owners opposed on the ground of expense.

Dundee.—The harbour engineer, who recently presented a report on the cost of lighting the harbour electrically, has been instructed to prepare a supplementary report as to the cost of lighting if the Board takes current from the Council's mains.

Exeter.—Acting upon the advice of their borough electrical engineer (Mr. H. D. Munro), the Council have decided to provide additional plant in order to be in a position to meet the anticipated increased demand next winter. The new plant consists of a 500 H.P. water-tube boiler and a Ferranti alternator of 250 kw. capacity. The entire cost of the extensions will amount to £5,350.

Exhibition.—An international motor car exhibition will be held at Berlin in September. Particulars from secretary, 1, Universitätsstrasse, Berlin, N.W.

Fire Tests.—A report has just been issued by the British Fire Prevention Committee upon a floor built by the Expanded Metal Co. (Limited). The object of these tests is to obtain reliable data as to the exact fire resistance of the various materials, systems of construction or appliances used in building practice.

Glasgow.—A conditional agreement has been entered into between the Corporation and the Kelvinside Electricity Co. for the purchase of the undertaking of the latter for £37,000.

In reference to the question of the generation of current for the tramways department, the Electricity committee have issued their report. Bearing in mind the gigantic proportions of the scheme of the tramways department, and the large amount of generating plant which will be required, it is evident (says the report) that no greater economy in the works cost of production is to be hoped for by combining the generating plants of the Electricity and Tramways departments, although there might be some saving in the cost of distribution; and, in view of the whole circumstances of the case, it is desirable, as a matter of expediency, that the tramways department should be entirely responsible for the whole tramways undertaking, including the generating and distributing plant and mains, if a system such as that recommended by their expert (Mr. Parshall) is to be carried out. The Electricity committee recommend that if the tramways department is entrusted with the supply and distribution of electricity for their own purposes only, they should be required to run all their mains, feeders, returns, and conductors, or leads of any and every kind, which may require to be laid underground in the space between and under the tramway rails.

Hampton Wick.—A committee has been formed to ascertain the terms of the Kingston Corporation for giving a supply of electric current to this district.

Harwich.—The Council propose to transfer their provisional order to the English Industrials (Limited), in consideration of the payment of £300 down. The Council also reserve the right to repurchase.

Huddersfield.—The Council have adopted recommendations to introduce electric traction on such sections of the tramways as the Tramways committee may decide, and to apply for sanction to borrow £100,000 for carrying out the work.

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A resolution has been passed by the Council "that trading powers should be granted to corporations to administer the undertakings now possessed by them, and such other undertakings or concerns dealing with commodities required for the domestic or commercial convenience, and for the benefit of all classes of ratepayers, and that all trading should be subject to the proviso that local authorities should retain the absolute control of their streets."

Kendal.—Councillor Wakefield, at the last Council meeting, moved that the Council apply for a provisional order. He thought the matter had been under consideration long enough, and it was time some decided step should be taken. Eventually an amendment by Councillor Braithwaite, that the matter be left in the hands of the present sub committee, was carried. The committee had been making investigations, and they had obtained expert advice, which would enable them to make a report and present a scheme to meet the requirements of the town.

Leeds.—At the meeting of the Council on Friday it was decided to borrow a further £150,000 for extension of the electric lighting undertaking. Ald. Wigram said the Council wished to complete the existing station on the lines originally laid down, and that necessitated an expenditure of £33,500 on the present station, £46,000 on the increased mains, sub-stations and distribution, and £12,500 to provide for capital expenditure to Feb. 25, making £92,000. The increase of the output for this outlay was in the proportion of 7 to 4. This increase, judging by the past rate of demand, was estimated to last to Dec., 1900. When they had extended the lighting station, they would be able to supply an increasing demand, and give a continuous increase at the present rate. They would provide for that purpose, £25,000 for buildings and £33,000 for mains and machinery.

The Tramway committee propose to appoint a traffic manager to control the outside work of the tramways department.

Light Railways.—The Board of Trade have sanctioned the order for the construction of the Llandudno-Colwyn Bay light (electric) railway.

The United Service Tramways Co. propose to apply for power to construct a light (electric) railway between Roker (Sunderland) and Houghton-le-Spring.

The Light Railway Commissioners held an inquiry at the Guildhall, Westminster, on Wednesday, into the application of the Metropolitan Tramways Co. for power to construct light (electric) railways between Highgate, Finchley and Wood Green, and Finchley, Hendon and district. Mr. Pember, Q.C., who (with Mr. E. F. V. Knox) represented the promoters of the Finchley and Hendon railway, said a similar application was rejected in 1897, but the scheme had been somewhat modified. The line would start from Brondesbury, and, with a branch through Cricklewood, would run through Hendon, Finchley, Hornsey and Islington, to a terminus in the Archway-road near the terminus of the County Council's tramways. The line would be a little over 10 miles in length, and the cars would be driven by electric power on the overhead trolley system, and they would start with a ten minutes' service. The Islington Vestry are supporting the scheme. He stated that the scheme would cost £200,000.

Limited Liability Undertakings.—Notice is given that at the expiration of three months the names of the following electrical joint stock companies will be struck off the register :—

Akester Electro-motor and Accumulator Co.
Anders Telephone Co.
British Light Railways.
Denison Auto-telegraph Machine Syndicate.
Economic Electric Specialty Co.
"Electrical Plant."
Globe Electric Co.
Hermite British Electro Bleaching Co.
Lineff Electric Traction and Lighting Syndicate.
Mexican Gas and Electric Lighting Co.
New Electricity Supply Co., of Croydon.
Omnibus and Tramcar Electric Lighting Co.
Phœbus Electric Battery Syndicate.
Rogers Arc Lamp Co.
Self-generating Electric Vehicle Light Syndicate.
Tayler-Smith Electric Co.

London County Council—At Tuesday's meeting a resolution was approved :—"That it is expedient that the provisions of the Light Railways Act, 1896, for the construction of light railways, be put in operation in the suburban districts by the Council, either by itself or in conjunction with the other county authorities around London ; and that, with this view, the Highways committee be empowered to prepare and submit to the Council schemes for this purpose, and to negotiate with the other authorities with a view to joint action being taken."

Manchester.—The Council have decided to apply for sanction to borrow a further £500,000 for extensions to the electricity undertaking. Ald. Higginbottom said it was absolutely impossible to say how much money they would require in the future. Their business was increasing by leaps and bounds, and they were obliged to cater for an urgent public want. They had to wait several months for their last loan.

Metric System.—The metric system is to be introduced into the Russian Empire by the year 1900, the necessary arrangements being at the present time under the consideration of the various governmental departments.

Middlesbrough.—An inquiry has been held here into the application of the Corporation to borrow £36,000 for electric lighting purposes. The consulting engineer (Mr. Robert Hammond) submitted plans and gave technical details of the Corporation's electric lighting scheme. There was slight opposition as to the proposed site of the works.

Partick.—Owing to the Glasgow Corporation having provisionally acquired the undertaking of the Kelvinside Electricity Co., the public inquiry fixed for yesterday (Thursday) into the application of the company for a Provisional Order has been postponed.

Private Bill Legislation.—The London County Council propose to introduce a Bill for power to reconstruct and alter any tramways which have been acquired by the Council so as to adapt the lines for electric traction, to work the tramways electrically, to acquire land for a generating station, &c.

Provisional Orders Not in Operation.—In the House of Commons, on Friday, Mr. Ritchie stated, in reply to Mr. Thomas Bayley, that there were 30 local authorities who had obtained provisional orders for electric lighting who had taken no steps to give effect to the orders within the prescribed time. Besides these there were 63 authorities who obtained orders in 1897-98, and who had apparently done no work ; but the time prescribed had not yet expired. The Board of Trade had called the attention of local authorities to the matter, and had informed them that the Board proposed to consider the question of revoking the orders. In nearly all these cases the local authorities had replied that they were now taking steps to put the orders into execution.

Radcliffe.—A conference of representatives of the Radcliffe, Little Lever, Prestwich and Whitefield District Councils will be held to consider the question of joint action in order to provide electricity supply works for, and to construct electric tramways in the districts named.

Plymouth.—An inquiry was held here on Friday into the application of the Corporation to borrow £9,000 for the erection of a refuse destructor at Prince's Rock. The destructor is to be worked in conjunction with the electricity supply works. The borough electrical engineer (Mr. J. H. Rider) stated that the electricity department were prepared to take steam power to the extent of 150 H.P. from the destructor immediately, for which they would pay £830 per year. It would cost them more than that to generate the power themselves. By the time the destructor was completed, he hoped they would be in a position to take the full amount of steam from the destructor to the value of about £1,500 a year.

Swansea.—Modifications of the electricity supply scheme were approved by the Electric Lighting committee on Wednesday. The capital expenditure involved by the modified scheme is estimated at £24,648.

Telephone Trunk Extension.—Telephone trunk communication has now been established with Huntingdon, Peterborough and Stamford.

The Telephone Abroad.—An interesting series of reports respecting the telephone service in various foreign countries has been issued. The reports were prepared by the British Consuls in response to a circular from the Foreign Office setting out a series of 23 points upon which information was requested in answer to an inquiry in Parliament by Mr. A. D. Provand. A large amount of valuable information concerning the telephone, its inception, installation and working, is included in these reports, which mark a distinct advance in this class of publication. Whatever views may be held regarding the action of Parliament in dealing with the telephone question in this country, the publication of these consular reports is both opportune and useful. The consolation or satisfaction to be derived from these documents by advocates of municipal control and competition in telephone enterprise by the experience of other countries is doubtful, but we commend their careful perusal by all interested in the subject, prior to the second reading of the Government Bill in Parliament. If by their aid Members of Parliament are brought to carefully consider the intricacies of this telephone business, the publication of these reports will have served a very useful purpose.

Wakefield.—The revenue of the electricity department for the past year amounted to £2,318, and the expenditure to £1,135. After allowing for interest and sinking fund (£1,054) there was a net profit of £129 on the first year's working, a highly satisfactory result, upon which the engineer (Mr. J. K. Brydges) and Electric Lighting committee are to be heartily congratulated.

Workhouse Lighting.—Electric lighting is to be adopted at the Halifax Workhouse at an estimated cost of £1,000.

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Worcester.—The accounts of the electricity department, an abstract of which was given in our last issue, were presented and approved at the meeting of the City Council last week. Contrary to custom, the discussion was of a harmonious character, and, instead of indulging in personal recriminations, members took to congratulating one another on the pleasing prospect of a profit on this year's working.

Wormit (Dundee).—This village is now lighted electrically. Incandescent lamps are employed. Current was switched on for the first time on 8th inst.

Electro-Harmonic Society.—A smoking concert will be held at the St. James's Hall Restaurant, Regent-street, London, W., on Friday, March 24, at 8 o'clock.

COMPANIES' MEETINGS AND REPORTS.

Metropolitan Electric Supply Co. (Limited).

The twelfth ordinary general meeting of this Company was held on Tuesday at Winchester House, Old Broad-street, under the presidency of Sir JAMES PENDER, Bart., M.P.

The SECRETARY (Mr. E. Cunliffe Owen) having read the notice convening the meeting.

The CHAIRMAN said: Gentlemen, I presume you will, as usual, take the report as read. I desire to express my regret that, owing to the serious illness through which our chairman, Sir Eyre Shaw, has passed, he is not present to-day, and it has, therefore, devolved upon me to preside on this occasion. I feel sure our chairman will receive the sympathy of all the shareholders, and that you will give me every support. Since we last met we have to deplore the loss of Dr. John Hopkinson, who, as one of our consulting engineers from the inception of the Company, rendered us the greatest help in all the many technical questions upon which he was called upon to advise. The report and accounts fully show the Company's position during the period with which we are dealing. Turning to the capital account, our capital has been increased by the issue of 22,500 shares. Many shareholders have written to us in reference to this issue, but I think you will readily call to mind that these shares were subscribed for at par by the holders of Founders' shares in consideration of the rights of those shares having been cancelled, in accordance with the arrangement come to in June last. The shares, Nos. 1 to 100, which were formerly Founders' shares of the nominal value of £10 each, now rank as Ordinary shares of like value but without any special privileges attaching thereto. The additional capital thus issued and upon which up to the end of the year £118,530 had been paid, has been almost entirely expended on mains and on our new Willesden works. With regard to these works an Act was obtained during last session, authorising us to erect these works, and this Act also gave us power to lay our mains along the towpath of the Grand Junction Canal Co., we having previously entered into an agreement with that body for that purpose. At one time we hoped that it might have been possible to have had the assistance of these works to relieve the strain of the past winter's supply. This, however, is not practicable, and we have no doubt in the long run that it will be found advantageous not to have been tempted to unduly press forward the works, and ample time will now be available for perfecting this important undertaking, as we are now aiming for the completion of the first portion in the early part of the summer in order that the plant may be in thorough working order to cope with next winter's demand. With regard to our expenditure on mains, this, in addition to our normal extensions, has been largely caused by the change we are gradually making in our system of supply. The unfortunate fire which occurred at Manchester-square last summer considerably delayed us in this work, the necessity for which, from the point of view of economical working and distribution, has already been explained to you, and is becoming increasingly urgent. The only other item in capital expenditure to which I think it is necessary to allude is the heavy item of parliamentary expenses. A portion of this expenditure was entailed in connection with our Willesden Act, and the remainder through our having been forced to defend—and, I am glad to say, successfully defend—our property in Marylebone. To this I shall refer again.

The revenue account shows that we have had a very considerable increase of business—an increase not altogether shown by the growth of revenue receipts. This is accounted for by the large reductions we found it necessary, as a matter of policy, to make in our rates of charge to customers. In addition to the desirability of conciliating local authorities, we had to meet actual competition in some districts, and to provide for a contingency of possible competition in others, before the alteration in our system of distribution and the completion of our new generating works had placed us in a position to make this reduction profitably. This, gentlemen, is the principal reason of the reduction in the dividend. This is also the principal explanation of the increased proportion of revenue expenditure to gross income, although the fire at Manchester-square, and the serious trouble of the Welsh coal strike, have also had an important share in the increase of expenditure. The coal strike was a serious matter, as it not only entailed the use of unsuitable and expensive fuel, but has left behind it a legacy of increased prices, which, we fear, will be maintained for some time to come. I ought to express our thanks for the assistance rendered to us by other supply companies, by which we were enabled to supplement our own supply during the exceptional period under review. With regard to this coal expenditure, I assure you the Board are fully alive to the absolute importance of effecting every possible economy in this direction. It is wholly in view of this necessity that our original system of distribution, admirably adapted as it was for pioneering work over a very large district like ours, but unsuitable after the business has developed and demand has become general, is being changed. These changes, coupled with the decreased works cost which we may hope to attain at Willesden, will, the board are confident, ultimately place the Company in a position to cope profitably with any requirements which may arise. The changes I have indicated, and the completion of our works, all point to the necessity of further capital issues. It will be seen from the accounts that we have funds in hand sufficient for immediate requirements, but it will probably be found necessary to make some further issue of capital during the year, and the board, happily now unhampered by the special interests of different classes of shareholders, will be able to take such measures as will best serve the interests of the Company as a whole.

The number of lamps connected during last year is a larger one than in any previous year. This is mainly accounted for by the reductions we have made in our charges; but, quite apart from this, there is no doubt that the use of electric energy is becoming yearly more general, and more a necessity. It is now my pleasing duty to refer, in a few words, to the work of our staff during a time of exceptional strain and difficulty; for, with this very large increase of lamp connection, and without the hoped-for assistance from Willesden, some of our stations were severely taxed, and we ought to acknowledge the skill, care and vigilance of our officers in successfully coping with this exceptional state of affairs. Gentlemen, we should have preferred to have been in a position to recommend at least a similar dividend to that of last year; but as, in addition to the reasons which I have given, the board are in agreement with your auditors, that it is necessary to build up the nucleus of a strong depreciation and reserve fund, they have not felt justified in exceeding their present recommendation. They are, however, fully confident in the soundness of the Company's position, and look forward to the time when the rate of dividend paid last year will not only be again reached, but exceeded. In conclusion, I should like to say a few words respecting the stiff fight which we had in Parliament last session to protect our property against the application made by the Marylebone Vestry to obtain competitive powers of supply against us. I scarcely like, from this position, to criticise too closely the unfortunate and mistaken policy which that Vestry has adopted towards this Company. While freely admitting that their action was dictated by a desire to serve the interests of the ratepayers (of which, however, I may mention that we are numbered among the largest), we rejoice that Parliament has decided to protect the interests of investors against what we consider to have been a most dangerous attack upon the security of capital. I trust that this policy will in future be respected as a precedent, and I shall certainly do my best to uphold it. I now move that the report and accounts be adopted and that the dividends be declared as set out in the report.

Admiral of the Fleet Lord JOHN HAY, G.C.B., seconded the motion.

Mr. CONWAY BISHOP said he thought the Company's accounts compared rather unfavourably with those of, say, the Westminster Company. He had been a shareholder in both for some years. The cost of generation of electricity last year was 47½ per cent. in the Metropolitan Company against 24 per cent. in the Westminster Company, while the Metropolitan Company's lamps connected numbered 430,000 against 339,000 in the Westminster, the cost of coal in the Metropolitan Company was £45,000 against £14,000 in the Westminster Company, and this seemed to him a large difference.

Mr. YOUNG said he was a large shareholder in the Company, and in most of the London companies which were paying dividends. He also thought that the Metropolitan Co.'s accounts compared unfavourably with those of the other companies. He thought 5 per cent. a miserable dividend as the life of their Company was limited, and they had a comparatively short lease, at the expiration of which they would be taken over without any allowance for goodwill, and at only the then value of plant. They would, in fact, be treated exactly as the Telephone Company was being treated now. Unless great care was exercised, the shareholders would be in a serious position at the end of their term.

Mr. JEFFREYS said he was somewhat in agreement with the criticisms passed, but he did not think either of the previous speakers had done justice to the difficulties with which the Board had had to contend. They would shortly be having the Willesden station to assist them, and he understood that that would enable them to cope with their difficulties. He thought the Directors had done great things in the past year, and had been very successful in defeating the action of the Marylebone Vestry.

Mr. JOHN NEWTON could not at all agree that the Company was in anything like a serious position, as had been argued by some of the speakers. A few years ago he bought some shares in the Company at 7½, he might have sold them since at 22, and they were even now at 17 or 18, and he, therefore, thought investors at any rate should be satisfied. He desired to support the Board in what they had been doing. He regarded the prospects of the Company as excellent. They had debited revenue with a large outlay for maintenance of all their works, and he did not see why they should continue to put a large sum aside for depreciation.

Mr. BALDWIN asked for some particulars of an item on the credit side of the revenue account relating to the rental of meters, which had decreased from £9,575 in 1897 to £4,478 in the present accounts.

The CHAIRMAN, in reply, assured the several speakers that the Directors had listened with great attention to what had been said, and were as anxious as the shareholders that the working of the Company should be successful. They were constantly endeavouring to obtain new business. With regard to the distinctions drawn between the Metropolitan and Westminster companies, he would ask Mr. Frank Bailey to reply, and that gentleman, who had been longer connected with the Company than he had, would explain the reasons why they could not work as economically as the Westminster and some other companies. Owing to severe competition in the Strand district they had been

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obliged to reduce their charges in many ways, entailing a serious loss to them in respect to the payment of dividend; in fact, the loss on the sale of current and meter rentals came to a dividend of about 2½ per cent., and they had lost by the extra expenditure of coal a dividend of ½ per cent. If these changes and charges had not had to have been made the Directors would have been able to pay this year a dividend of 8 per cent. The Directors did not regard 5 per cent. as a splendid dividend, and hoped to present next year as good a record as in previous years. They looked forward with hope to the assistance of the Willesden station. The amount of bad debts actually written off last year amounted to £2,100, a very large sum, which they were taking every step to reduce.

Mr. FRANK BAILEY said the Company originally started with very ambitious aims. They had a district of 4½ square miles, whereas the Westminster Company started with only 2 square miles. At that time, too, the Directors were very anxious to adopt not only the best system for ultimate use, but that which would cost the least capital outlay. Of course, theirs was not quite a commercial undertaking in the ordinary sense. They were a company with Parliamentary obligations, and they had to supply any customer with current who required it in any portion of their area of supply. As the shareholders were aware, they started with the alternating high-pressure system which was adopted in order to secure the possibility and feasibility of pioneering such a large district, and they had succeeded he thought satisfactorily in this. They could supply any customer who applied for current, but they did this at high working cost. The criticisms of the shareholders were based on percentages, a very useful but a rather misleading procedure, unless great care was used. The percentages referred to at the meeting were naturally based on revenue—unfortunately he meant bearing in mind the percentage—but fortunately in view of the future of the Company. The Chairman had pointed out how they had been affected to the extent of 3 per cent. in the dividend. When, therefore, they debited works costs with such a large decrease of revenue, they were doing an injustice to the staff. With regard to the question of coal, they, of course, did not use more than they could help, but he must again draw their attention to the fact of the system which was adopted in connection with this matter. They had had to use the system, as it cost the least capital outlay in the first instance, and, therefore, they could not derive the same economical results from a small as from a large capital. Had they started with the most economical system their capital instead of being £1,000,000, would now have been £2,000,000 or £3,000,000. They would in that way have got the same economical results, but their returns would have been the same. They had now got the Willesden station, and he was perfectly satisfied that they would be quite contented in future.

Sir Eyre M. Shaw, Sir James Pender, Bart., M.P., and Mr. J. Verity were re-elected Directors, and the auditors, Messrs. Deloitte, Dever, Griffiths and Co., reappointed.

A vote of thanks to the Chairman, Directors and staff was carried unanimously, and, having been acknowledged by the Chairman, the proceedings terminated.

Bournemouth and Poole Electricity Supply Co. (Limited).

The second ordinary general meeting of this Company was held on Monday, March 13, 1899, Mr. AYMOR H. SANDERSON (Chairman) presiding.

The SECRETARY (Mr. H. B. Renwick) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, this is the first annual meeting of the Company, and your Directors have great pleasure in submitting to you the report and statement of accounts for the year ended December 31st last. This pleasure is much enhanced by the fact that they are able to show results even better than those anticipated by the prospectus which was issued by this Company in December of 1897. Before proceeding to refer to some of the items in the account, it is my duty to mention the retirement of Lord Rathmore, our late Chairman, and to express to you the great regret that the Directors and I myself feel, that his lordship has found it necessary, in consequence of the many calls upon his attention, to retire from this board. From the balance-sheet you will see that our assets are represented by investments of £4,000 in 2¾ per cent. consolidated Government stock, by £51,108 in shares of the Bournemouth and District Electric Supply Company, and loans on security to that company amounting to £63,891. In all, the amount invested by this Company is £119,000. The premiums on the first issue of shares have been applied towards writing off the preliminary expenses, and the remaining balance of £18 has been written off out of the revenue of the past year. The only expenditure made by the Company on capital account during the year has been the expense of applying to the Board of Trade for a provisional order for the districts of Christchurch, Pokesdown, and neighbourhood. These include a rapidly-increasing area which will, if we are successful in our application, form a most valuable asset of the Company. The only other item I have to refer to on this side of the account is sundry debtors £4,431, which consists mainly of interest, &c, due on December 31st to this Company from the Bournemouth and District Electric Supply Co., but that has since been considerably reduced. On the other side of the account you will see what are the liabilities of the Company. I should mention that our authorised capital is £150,000. That consists of 6,000 Four and a-Half per Cent. Preference shares of £10 each, and 6,000 Ordinary shares of £10 each, making together £120,000, and we have a balance of shares still unissued, amounting to £30,000. I will turn to the revenue account, by which you will see that the total receipts for the year have been £6,103, and that, after deducting our expenses of about £91, we have carried the balance amounting to £6,013 to the net revenue account. We have paid an interim dividend on the Preference shares at the rate of 4½ per cent. per annum up to June 30, 1898, amounting to £1,240; and we have also paid a final dividend on those shares to December 31st last, which leaves a balance of £3,469 available for distribution now. Out of this amount your Directors recommend that a dividend at the rate of 4 per cent. on the Ordinary shares, less income tax, be now declared, which will absorb £2,262, and leave £1,206 to be carried forward to the next account. Well, now, gentlemen, I have very little to add except to point out to you that, in the opinion of your Directors, we possess a very valuable property indeed in holding, as we do at the present time, the whole of the capital of the Bournemouth and District Electric Supply Co. The progress of that Company is evidenced in the fact that during the past year there has been connected the equivalent of 8,752 8 c.p. lamps, as compared with the equivalent of 3,482 during 1897. You will observe that these are record figures in the history of the Company, and although it is perhaps too much to hope that we shall continue to make the same rate of progress every year—still, we have very great faith that we have a most valuable and increasing property in the Bournemouth and district undertaking. I must just call attention to the fact that there is an application before the Board of Trade for the transfer of the undertaking now held by the Bournemouth and District Company to this Company, and as we now hold, as I have previously said, the whole of the shares in that Company, there would appear to be no reason whatever why any opposition should be offered to that transfer. We have, therefore, every reason to think that the Board of Trade will grant our application, and that when this transfer has been effected it will considerably decrease the amount of our administrative expenses. I do not think, gentlemen, that I have anything to add to what I have told you, but I shall be very pleased to answer any questions which may be asked on the subject of the report and accounts. I now move the adoption of the report and accounts.

Mr. J. ATKINSON HOSKER, in seconding the motion, congratulated the shareholders upon the progress made during the past year and upon the rosy prospects of the Company. He wished to say that the shareholders were to be congratulated upon the valuable officers that they had. They had a secretary, Mr. H. B. Renwick, and a staff, whose hearts and souls were most thoroughly in their work, and he felt certain that, much as they could congratulate themselves upon the past year's working, they would, as years rolled by, have to congratulate themselves still more in the future.

Mr. ORDISH mentioned that a certain amount of publicity had been given to the action of the Bournemouth Corporation in seeking to obtain a Provisional Order, and he should like to know whether this Company would be affected, in any way, by what that public body proposed to do.

The CHAIRMAN: We have given this subject full consideration, and I may say that we have not the slightest fear with regard to the result of that application to the Board of Trade.

The resolution was then carried unanimously.

The payment of the interim dividend on the Preference shares, at the rate of 4½ per cent., was confirmed, and a dividend on the Ordinary shares at the rate of 4 per cent. for the year was declared.

The retiring Directors, Mr. J. A. Hosker and Mr. F. W. Reynolds, were re-elected, and the auditor, Mr. R. H. Marsh, was re-appointed. The Directors' remuneration for the 12 months ended December 31 last was fixed at £300, with a similar amount for the year 1899, but in the event of the Company taking over, during the year, the undertaking of the Bournemouth and District Co. the amonnt is to be increased to £500.

A vote of thanks to the Chairman, Directors, secretary and staff was unanimously accorded, and the proceedings terminated.

Dover Electricity Supply Co. (Limited).

The fifth ordinary general meeting of this Company was held at Dover on Wednesday. In moving the adoption of the report and accounts, the Chairman (Sir William H. Crundall), said that they showed a material improvement in the Company's position. He reminded the shareholders that five or six years ago it was mooted that the municipal authorities should take up the supply of electric current in the town, he then holding the office of Mayor. He could not persuade some of his colleagues to do this, but was determined that the town should have the benefit of electricity supply. It therefore became his duty to cast about for the means of finding capital for the new enterprise. Through the Brush Company and the County of London and Brush Provincial Co. capital had been found, and the handsome and substantial building in which they were at present had been erected and equipped with all the necessary plant, mains, &c. At Eastbourne the Corporation had just agreed to take over the electric undertaking at something like 160 per cent. above the capital outlay, and knowing Eastbourne, he thought he might say that the Dover station was a better one, and that they had got a very valuable property, capable of enormous development. No doubt they would have heard that there had lately been a movement in Dover to take over their concern, but it seemed to him that the Company could have no desire for negotiations—at any rate, on the present basis of its earning power. For 1898 a 2½ per cent. dividend would have been able to have been paid on the whole capital employed, but for the fact that a considerable amount had had to be paid for interest on advances. These advances would now be paid off, the whole of the share capital having been issued, and a premium as high as £1 per share had been obtained on some shares dealt in. He hoped that they would earn and distribute a considerably larger percentage in respect of the present year. There was practically no limit to the amount which they could pay in dividends, and he hoped that it would not be long before they were paying, say, 12½ per cent., which they could do without reducing their present rate for current. He might remind the shareholders that any sale on the part of the Company for the next 12 years would be entirely a matter of negotiation, and even then, though compulsory, the undertaking would have to be bought as a going concern. The progress of the Company had been exceptionally good; a loss of £950 on the first nine months' working in 1895 was reduced in 1896 to a loss of £450; in 1897 the profit was

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£1,100, and in 1898, as they would see, the profit had risen to £2,200. The Corporation, if they desired to take over the concern, would have to pay a very heavy premium. The further capital expenditure in 1898 had been for the purpose of meeting the increased demand, and he hoped that still further calls for expenditure of capital would be necessitated for the same reason. The lamp connections at the end of the year had been approximately 12,500. The plant capacity had been raised in 1898, so that it would deal with about 26,000 lamps connected. A contract had been entered into for the supply of light, and probably a certain amount of power to the contractors for the National Harbour. In addition to this the applications for ordinary lights had been 50 per cent. more than those received in the corresponding period of last year. He desired to thank the staff for their services. The report was then adopted, and the retiring Directors were re-elected.

British Electric Traction Co. (Limited).

The report of the directors of this company for the year to Dec. 31 last, just issued, is as follows:—

Capital Account.—During the year the directors have issued 10,000 Six per Cent. Cumulative Preference shares of £10 each at £12. 10s. per share, and £100,000 debenture stock at £116 per cent. The whole of the premiums (after deducting expenses), amounting to £29,135. 15s. 8d., have been placed to reserve, invested in Consols. Since the closing of the books further issues have been made of 20,000 Preference shares and £100,000 debenture stock. The proceeds of these issues will be brought into the next account. The subscribed share and debenture capital is now £300,000 in Ordinary shares of £10 each, £300,000 in Six per Cent. Cumulative Preference shares of £10 each, and £200,000 Five per Cent. Perpetual Debenture stock—total, £800,000. The whole of the present authorised share capital having been subscribed, the directors recommend that powers be taken to increase the nominal capital by the creation of 60,000 shares of £10 each; and notice is given of an extraordinary meeting to consider and pass the necessary resolutions.

Profit and Loss Account.—The gross profits, including £9,804. 9s. 6d. brought forward (but without taking into account the premiums of £29,135. 15s. 8d.), amount to £77,999. 14s. 7d., and, after deducting the expenses chargeable to revenue, the expenses incurred in connection with schemes not proceeded with and written off, and interest on debenture stock, there remains a net profit of £67,778. 13s., which the directors propose should be applied in writing off the remaining portion of preliminary expenses (£5,879. 1s. 8d.), reduction of goodwill account by £5,000, interim dividend at the rate of 6 per cent. per annum on Preference shares to Aug. 15, 1898 (£1,195. 16s. 8d.), dividend at the rate of 6 per cent. per annum on Preference shares, due Feb. 15, 1899, accrued to Dec. 31, 1898 (£2,252. 1s.), dividend at the rate of 6 per cent. on the Ordinary shares for the year (£18,000), and to carry forward £35,451. 13s. 8d.

Contracts and Undertakings.—Arrangements have been made for the adoption of electric traction in various localities. In some cases agreements have been entered into for the purchase or leasing of existing tramway undertakings, while in others parliamentary powers or orders under the Light Railways Act have been secured or applied for. Some of these arrangements have been made in co-operation with other parties. The total amount expended on works, and in negotiations and promotions (after deducting costs of undertakings which have been sold or transferred, and after writing off expenses incurred in respect of schemes or contracts not proceeded with) is £157,730. 17s. 7d.

Investments.—The company holds shares and debentures (which cost £420,731. 2s. 11d.) in a large number of existing tramway and analagous companies, and in some instances the majority of shares, with a view to the further development of the company's business and the adoption of electric traction. (Particulars of most of these associated companies are given in an appendix to the report.) An income of £11,853. 15s. 10d. has been derived from investments, but a large proportion of the amount appearing under this head was not so employed until the latter part of the year.

Annual Meetings and Accounts.—In order to include the results of the working and the accounts of the associated companies, which are generally made up to Dec. 31, in the annual report and accounts of the company, the directors propose that in future the accounts of the company should be made up to March 31 in each year.

Direct Spanish Telegraph Co. (Limited).

The report of the directors of this Company for the year ended Dec. 31 last states that the accounts show, after providing for interest on, and redemption of, Debentures, a balance to credit of revenue of £11,843. 18s. 9d. After adding the usual £5,000 to reserve, the directors recommend the declaration of dividends for 1898 of 10 per cent. on the Preference and 4 per cent. (free of tax) on the Ordinary shares, absorbing £5,486. 4s. Half this amount was distributed on Oct. 1 last, as an interim dividend in respect of the half-year to June 30. The balance of £1,357. 14s. 9d. is transferred to contingencies account.

The traffic receipts show an increase of £3,812. 15s. 5d., compared with 1897. The ordinary working expenses were £349. 3s. 8d. in excess of those for 1897.

On May 21 a fault was discovered in the Bilbao cable at about 13 knots from Bilbao. Although this fault did not interfere with the communication it was thought prudent to remove it, and this was effectually done on June 23. On July 8, the Bilbao cable broke at a distance of 199 knots from Falmouth, and was repaired on July 14. In both cases the repairs were promptly executed by cable ships of the Eastern Telegraph Co. The cost of these repairs, viz., £2,117. 11s. 3d., is charged to revenue. The cost of fitting extended premises in Gracechurch-street, London, for the Company's purposes (£961. 5s. 3d) is also charged to revenue.

South London Electric Supply Corporation (Limited).

In the second annual report of the directors of this Company it is announced that good progress has been made in developing the Coporation's undertaking. The buildings, including dust destructor, are nearly completed. The boilers are in position, and steam pipes, electrical plant, storage batteries, engines and steam alternators should be delivered in a few weeks. Permanent offices have been erected at the works, and the temporary offices will be vacated on 25th inst.

After thoroughly investigating the probabilities of finding water, the directors decided upon sinking an artesian well at the Corporation's site. The result has proved most satisfactory, the engineers reporting a test showing that at least 5,000 gallons of excellent water per hour can be depended upon. The total cost of boring and equipping the well will amount to less than £1,000. A considerable annual expenditure for water will be saved, The length of roadway in which mains have been laid now reaches 22 miles, making about 68 miles of ways, into which upwards of 37 miles of cable have been drawn.

The Corporation has been able to supply electricity to a large number of lamps, pending the construction of the generating station, by connecting the mains to those of the County of London and Brush Provincial Co.'s. This policy was adopted with the view of forming the nucleus of a business, and not in the expectation of earning immediate profit. When the works are opened the lamps of the numerous consumers already connected will at once provide a load for the machines, there being at this date on circuit the equivalent of upwards of 15,000 8 c.p. lamps, with applications in hand for a further 2,500.

The undertaking being in its constructional stage, the accounts are not yet drawn up in Board of Trade form, but a revenue account accompanies the report, the balance of which has been carried into the general balance-sheet.

Richmond (Surrey) Electric Light and Power Co. (Limited).

The report of the directors for the year to Dec. 31 last states that the capital expenditure during the year was £6,452. 12s. 3d., chiefly upon machinery and mains, making a total of £51,246. 4s. The balance to credit of net revenue, including amount brought forward, and after payment of interest charges, &c., is £1,340. 12s. 4d. The directors recommend a dividend on the Ordinary shares at the rate of 4 per cent. (less tax), leaving £129. 3s. 10d. to be carried forward.

The equivalent of 12,352 8 c.p. lamps were connected to the mains at Dec. 31st, an increase equivalent to 2,840 8 c.p. lamps connected for the year. In order to meet the increasing demand for current additional plant has been installed, and further additions will be made during the present year. Considerable extensions have been made to the mains, and further extensions are in contemplation.

BRITISH ELECTRIC TRACTION CO. (LIMITED).—The directors' report for the year ended Dec. 31 states that they have issued 10,000 £10 Six per Cent. Cumulative Preference shares at £12. 10s. per share and £100,000 debenture stock at 116 per cent. The whole of the premiums (amounting to £29,135) have been placed to reserve. Since the closing of the books further issues have been made of 20,000 Preference shares and £100,000 debenture stock, and the proceeds of these issues will be brought into the next account. The subscribed capital is now £300,000, in Ordinary shares of £10 each, £300,000 in Six per Cent. Cumulative Preference shares of £10 each, £200,000 Five per Cent. Perpetual Debenture stock—total, £800,000. The whole of the present authorised share capital of the company having been subscribed, the directors recommend that powers be taken to increase the nominal capital by the creation of 60,000 £10 shares. The gross profits (including £9,804 brought forward), but without taking into account the premiums, amount to £77,999, and, after deducting debenture charges, &c., there remains a net profit of £67,778. It is proposed to write off the remaining preliminary expenses £5,879, reduction of goodwill account £5,000, dividend on Preference shares and a dividend at the rate of 6 per cent. on the Ordinary shares for the year, carrying forward £35,451. Arrangements have been made for the adoption of electric traction in various localities. In some cases agreements have been entered into for the purchase or leasing of existing tramway undertakings, while in others parliamentary powers or orders under the Light Railways Act have been secured or applied for. The total amount expended on works and in negotiations and promotions (after deducting the costs of undertakings which have been sold or transferred, and after writing off expenses incurred in respect of schemes or contracts not proceeded with) is £157,730. The company holds shares and debentures, which cost £420,731, in a large number of existing tramway and similar companies, and in some instances the majority of shares, with a view to the further development of the company's business and the adoption of electric traction. An income of £11,853 has been derived from investments.

BRITISH INSULATED WIRE CO. (LIMITED).—The third ordinary general meeting of the shareholders of this company was held at the works, Prescot, on Wednesday, Mr. W. Marriner Brigg (chairman of the company) presiding. Mr. E. Tracey, the secretary, having read the notice convening the meeting, the Chairman moved the adoption of the report and accounts, and congratulated the shareholders on the substantial progress which the company had made. Orders continued to come in very satisfactorily, and they were now in the position that in the middle of the third month of the year they had sufficient orders in hand to occupy their works for the whole year provided their total output did not exceed that of the past year, though that was not at all likely. They had every reason to look forward to a still more successful future. They

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had found it desirable to go in for a still further extension of their works and that extension was already commenced. They had also arranged for a quotation of the company's shares on the London and Manchester Stock Exchanges. They had from time to time written off considerable amounts (aggregating some £70,000) against depreciation, and in every way the company was in an excellent position. The motion was unanimously carried, and a further dividend of 10 per cent. on the Ordinary shares (making 15 per cent. for the year) was declared. The retiring directors (Messrs, J. E. Pearson and Thos. Snape) were re-elected and the usual vote of thanks to the chairman terminated the proceedings.

BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS CO. (LIMITED).—The directors' report to Dec. 31 states that the total receipts in Buenos Ayres and London amounted to £57,337, and the expenses to £41,391, showing profit on working for 10 months of £15,945. After payment of debenture interest (£9,920), &c., there will remain a sum of £5,927 available, out of which the payment is recommended of a dividend at the rate of 6 per cent. per annum upon the amounts paid on the "A" Preference shares. £2,843 will be carried forward. The transfer of the new concession was made on June 22, 1898, at which time and up to the end of the year a short section, about two miles and a quarter in length, had been worked electrically. This section showed a loss on working to Dec. 31, but this was owing to purely exceptional causes, which have since all been removed. Amongst them, under the agreement with the original concessionaire, the company had to take over a contract for the supply of electric current on onerous conditions. The directors have now entered into a new contract for the supply of current for five years from Jan. 1, 1899, on favourable terms. In December last the company obtained permission from the Buenos Ayres municipality to lay down at once its own double independent track over the whole of the length of the new Belgrano electric lines, an important section of which, connecting Government House (Plaza Mayo) with Palermo Park, has recently been opened with satisfactory results. The company has obtained a concession for a new line, about 1½ miles in length, along Calle Cañitas, forming an alternative and more direct route to Belgrano.

ISLE OF MAN TRAMWAYS AND ELECTRIC POWER CO. (LIMITED).—The directors report that the amount available for dividend is £11,506, and the payment is recommended of a dividend of 6 per cent. on the Preference and Ordinary shares, which will absorb £9,900. £1,000 goes to reserve. The company has acquired valuable water rights, which will be used for generating electricity and other purposes. An expert has reported that 500 H.P. can be constantly obtained for eight months of the year, and the directors were further advised that by utilising this power they would be able to generate and accumulate sufficient electricity to work electric and cable systems and do whatever lighting may be required. This would effect a considerable saving, as the steam plant would be shut down for eight months in the year. On the Laxey and Ramsey section there was a profit of £72.

LIVERPOOL DISTRICT LIGHTING CO. LIMITED.—The directors' report for 1898 states that the plant at the Waterloo generating station has been working up to its full output, and it will be necessary to increase the capacity of this station before next winter. The number of lights supplied at the beginning of the year was about 450 ; at Dec. 31 last the equivalent of 2,059 16 c.p. lamps were connected, and orders have been received for over 600 more. The permanent plant at the Gateacre station was connected up at the beginning of the year. The number of lights at the beginning of the year was about 200 which was increased at Dec. 31 to about 1,050. Several orders are in hand and promised for the Gateacre district. In order to meet the necessary expenditure for these additions a further call of £1 per share, which will be due on April 12, has been found necessary. During the year the company has carried out a fairly successful contracting business. A proportion of the general office expenses has been charged against this work, leaving a net profit of £132 from their manufacturing and contracting business. In October last the directors decided to reduce the price for current, in Waterloo, from 8d. to 6d. per unit, and to institute a system of "free" wiring. The number of consumers has increased during the year from 15 to 59, and the company have in hand orders for arc lamps for Great George's-road, Waterloo. This will be a material source of revenue, and generally the directors have no doubt that the balance-sheet for the year 1899 will be a very satisfactory one. As the company have only been working 12 months, and most of that time under very light load, no provision has been made for depreciation.

NORTH STAFFORDSHIRE TRAMWAYS CO.—At a meeting held last week it was announced that the profits, on the half-year's working to Dec. 31 last (after paying debenture interest and the dividend on the Six per Cent. Preference shares), admitted of the payment of a dividend at the rate of 3 per cent. per annum on the Ordinary shares, an appropriation of £1,000 to reserve, and £1,924. 8s. 8d. carried forward. As a result of the agreement for the sale of the undertaking of the North Staffordshire Company the Potteries Electric Traction Co. have purchased the majority of the shares. Mr. Emile Garcke was elected a director of the company, vice Mr. W. J. Carruthers Wain resigned.

OXFORD ELECTRIC CO. (LIMITED).—The ordinary general meeting was held last week. The report stated that the revenue account for 1898 showed a profit (including £18. 17s. 5d. from last year) of £4,692. 9s. 1d After providing £1,613. 13s. 8d. for debenture and other interest and writing off the balance of the capital issue suspense account (£218. 3s. 10d.) and £25. 8s 2d. on account of hire purchase installations, the available balance (£2,835. 3s. 5d.) the directors proposed to appropriate as follows: —£2,500 in payment of a dividend at the rate of 5 per cent. per annum on the share capital, and £250 to be added to the reserve and renewal of plant account, leaving £35. 3s. 5d. to be carried forward. The capital expenditure during the year had been provided for by the issue of Debenture stock. Since the last report the equivalent of 4,564 8 c.p. lamps had been connected to the mains. The increase compared favourably with the progress in 1897, and was partly due to the introduction of the hire purchase system of installing the light. An additional boiler of 200 H.P. capacity had been installed at the works, and the distributing mains extended in various thoroughfares. The capacity of the high-tension mains connecting the generating and sub-stations had been practically doubled during the year, and the efficiency of the system thereby considerably increased. The control of the distribution of current had been transferred from Broad-street to the generating station at Osney with satisfactory results. The report and accounts were adopted.

SMITHFIELD MARKETS ELECTRIC SUPPLY CO. (LIMITED).—An extraordinary meeting was held on Friday, Mr. J. Browne Martin presiding, to pass resolutions for making alterations in the articles of association, so as to bring them into conformity with the requirements of the Committee of the Stock Exchange. The resolutions were duly approved. The Chairman said that the business of the company was progressing in a satisfactory manner. The first issue of shares was nearly doubly subscribed for. There was no intention of issuing the second part of the capital immediately. Mr. Ernest Schenk said he had been furnished with a statement which showed that their cost of production was actually lower than a great many other companies whose production of current was greater. All that was said at the last meeting as to their business being on the increase had been verified. Since Sept. 30 they had—connected and on order—increased their business by about 1,000 8 c.p. lamps. Several of their old customers had come back. The board had applied for powers to extend their operations in the city, and they had secured 8,000 signatures to a petition in support of their application.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 2, 1899). Price of silver 27½d. per oz. (March 16). Consols (2¾ per cent.) 110¼—110½ for money, 110½—110¾ for account ; 2½ per cent. 103⅜—103⅝ (March 16), Stock Exchange Settling Days : Consols, April 6 ; Stocks and Shares Continuation Days, March 27 and April 11 ; Ticket Days, March 28 and April 12 ; Pay Days, March 29 and April 13 ; Mining Share Carry over Days, March 25 and April 10.

ARON ELECTRICITY METER (LIMITED).—The transfer books of the 6 per cent. Cumulative Preference shares of this company will be closed from March 23 to April 1 inclusive, preparatory to the issue of interim dividend warrants.

BUDAPESTE ALLGEMEINE ELECTRIZITATS-ACTIENGESELLSCHAFT.—The report of this company for the year 1898 states that the undertaking has made considerable progress, there being at the end of the year an equivalent of 84,793 16 c.p. lamps connected against 73,682 in 1897. Various extensions of the mains were made and the profits amounted to 191,714.07 kroner. After carrying various sums to reserve and renewal accounts, payment of debenture interest, &c., a dividend of 5 per cent. has been declared, against 4 per cent. for the previous year. Much of the credit for this satisfactory state of affairs is due to the commercial and technical director (Mr. E. de Fodor), who was, after having been technical director only for some time, appointed to the former post early in the year.

CITY AND SOUTH LONDON RAILWAY CO.—Letters of allotment for the recent issue of £375,000 Ordinary share capital of this company were posted on Wednesday.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING CO. (LIMITED).—The transfer books and register of members will be closed from the 14th to the 27th inst. inclusive, preparatory to the payment of the Preference share dividend. The directors recommend the payment of the dividend on the Six per Cent. Preference shares for the six months to Dec. 31, carrying forward £5,774.

EASTERN TELEGRAPH CO. (LIMITED).—Payment will be made on April 14 of dividends, at the rate of 3½ per cent. per annum (less tax), on the Preference stock of this company for the quarter ending March 31, 1899, and an interim dividend of 1¼ per cent. on the Ordinary stock (free of tax), in respect of profits for the quarter ended Dec. 31, 1898. The transfer books will be closed from April 7 to 14, inclusive.

F. H. ROYCE AND CO. (LIMITED).—During the week this company, which has an authorised share capital of £60,500, invited applications for 6,000 Six per Cent. Cumulative Preference shares of £5 each.

GERMAN-ATLANTIC TELEGRAPH CO. (LIMITED), COLOGNE-ON-RHINE.—As various inaccurate statements concerning the projected German-Atlantic cable have been published, we have been asked to insert the following particulars :—"The firm of Felten and Guilleaume, of Mulheim-on-Rhine, some time ago obtained from the German Postal Administration a concession for establishing direct cable communication from the North German coast *viâ* the Azores to the United States of North America. This concession secures to the undertaking a certain amount of traffic revenue from Germany, and also arrangements have been made with American telegraph companies whereby American traffic to Germany will be transmitted over the new German cable. For the purpose of floating a joint stock company with the above mentioned title, with a capital of 20,000,000 marks, to carry out this concession and to enter into certain contracts made in connection with same, a syndicate, under the leadership of the A. Schaafdhausen'schen

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Bankverein, of Cologne, has been formed by the following firms: Felten and Guilleaume, Mulheim-on-Rhine, Disconto-Gesellschaft, Dresdner Bank, Darmstadter Bank, S. Bleichroder, Born and Busse, of Berlin, Sal. Oppenheim, jr., & Co., and Levy, of Cologne. Within this group arrangements have been made to carry out, conjointly by the German-Atlantic Telegraph Co. and the firm of Felten and Guilleaume, the erection at Nordenham, on the North German seacoast, of a submarine cable factory, for which the requisite territory has been taken over (from another German firm who had destined it for the same purpose). The new company will be formed under the style of 'Deutsche See-Kabelwerke Actiengeselschaft,' with the domicile at Cologne, and a capital of 2,000,000 to 3,000,000 marks. This company is also said to undertake the laying and repairing of cables and will procure a cable ship for this purpose. Although the floating of the above company is assured there are still some formalities to go through which, no doubt, will be shortly completed. The whole of the capital for the company which has obtained the concession has been subscribed.

GESELLSCHAFT FÜR ELEKTRISCHE UNTERNEHMUNGEN (BERLIN).—A dividend of 10 per cent. for 1898, compared with 8½ per cent. for 1897, has been declared.

WILLIAM JAMES GLOVER AND CO. (established 1818) (LIMITED).—On another page will be found the abridged prospectus of this company, which is formed with a share capital of £100,000 in 5 per cent. Cumulative Preference shares and Ordinary shares of £1 each. Applications are now invited for 40,000 Preference shares and 10,000 Ordinary shares at par, payable 2s. 6d. on application, and 7s. 6d. on allotment, the balance by instalments of 5s. each at intervals. It will be seen that the company has been established over 80 years in connection with wire rope manufacture, and the prospectus states that the company will combine three manufactures: wire drawing, rubber and insulating material, and electric cables. The old-established works at St. Helens have been secured, and particulars regarding these and other properties taken over will be found set out. The services of Mr. Heyl-Dia have been secured, and he joins the board as managing director. Certificates are set out from Messrs. Banner, Spencer and Co., chartered accountants, who have examined the books of the old company for some years past, and the works have been valued by Messrs. Rushton, Son and Kenyon, of Manchester. The lists open to-morrow (Saturday) and close on Wednesday.

"MOTOR" AKTIENGESELLSCHAFT FUR ANGEWANDTE ELEKTRICITAT (BADEN).—A dividend of 6 per cent. has been declared for the past year, against 5 per cent. in 1897.

ROCKHAMPTON (QUEENSLAND) GAS AND COKE CO. (LIMITED).—The directors report that for the year 1898 the electrical operations show a profit of £236. 2s. The directors are considering the advisability of an extension of plant in both sections (gas and electric lighting) rendered necessary by increase of business. An Order in Council under the Electric Light and Power Act, 1896, has at length received the sanction of the Governor in Council for the full term of 42 years. The company's position in connection with the supply of electricity for Rockhampton and its suburbs being thus assured, the directors have decided upon issuing debentures on the London market.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has been asked to appoint a special settling day in 5,530 £5 (fully paid) vendors' Six per Cent. Cumulative Preference shares (Nos. 1 to 5,530), and a further issue of 7,500 £5 (fully paid) Six per Cent. Cumulative Preference shares (Nos. 20,001 to 27,500) of the *British Insulated Wire Co. (Limited)*, and to allow 24,000 £5 (fully paid) Ordinary shares (Nos. 10,001 to 34,000) of the *New General Traction Co.* to be quoted in official list.

TELEGRAPH MANUFACTURING CO. (LIMITED.)—The Preference share transfer books of this company will be closed from the 16th to the 30th inst., inclusive.

WILLANS AND ROBINSON (LIMITED.)—The transfer registers will be closed, prior to the ordinary general meeting, from 15th to 29th inst. inclusive.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Mar. 11	3,775	+ 496	9	37,544	+ 2,913
Blackpool Corporation...	...	...	...	...	...	...
Blackpool and Fleetwood	„ 11	212	...	10	1,676	...
Bradford Corporation ...	...	...	...	...	...	...
*Bristol Trams & Carriage	„ 10	2,460	+ 200	10	24,800	+ 1,401
City & South London Ry.	„ 12	1,072	- 5	11	12,179	+ 383
Dover Corporation	„ 11	147	+ 47	49	8,628	...
Dublin United (Southern)	„ 10	626	+ 247	10	6,071	+ 2,141
*Glasgow Corporation ...	„ 4	8,217	+1,262	...	...	...
Liverpool Corporation						
Dingle Route	„ 4	460	...	16	8,442	...
Prince's Park Route...	„ 4	317	...	7	2,081	...
Liverpool Overhead Rly.	„ 12	1,364	+ 34	11	14,273	- 551
*Sheffield Tramways.....	„ 12	1,234	+ 350	10	12,032	+ 2,551
*South Staffs. Trams.....	„ 10	588	+ 55	10	5,934	+ 145

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price March 9.		Price Wednesday, March 15.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Week Ending March 15. Highest	Lowest
			TELEGRAPHS.					£ s. d.			
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	103	104	103	104	3 16 11	January and July	..	..
25,000	10	..	Amazon Telegraph	3	4	3	4	..	..	..	..
£125,000	100	5%	Do. 5 per Cent. Debentures	87	93	87	92	5 6 5	..	..	..
£205,500	Stock	24 0	Anglo-American	65	68	65	68	5 2 0	Feb., May, Aug., Nov.	68	65½
3,047,200	Stock	30/0	Do. Preferred	117½	118½	116½	117½	5 2 7	„ „	118½	116½
3,047,200	Stock	18/0	Do. Deferred	14½	14¾	13¾	14½	6 6 4	..	14¾	13 15/16
2,500,000	10	3/0	Brazilian Submarine	16	16½	16	16¼	4 4 10	Mar., June, Oct., Dec.	16⅝	16
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	110	114	110	114	4 7 9	June and December	..	..
10,000,000	$100	$2½	Commercial Cable Capital Stock	190	200	190	200	4 0 0	Jan., Apr., July, Oct.	..	..
£1,332,523	Stock	4%	* Do. 4 per Cent. Debenture Stock	105	107	105	107	3 15 2	„ „	105½	105⅝
16,000	10	8/0	Cuba Submarine Ordinary (Deferred)	9¼	10¼	9½	10½	6 13 4	February and August	..	..
6,000	10	10/0	Do. Preference 10 per Cent.	17½	18½	17½	18½	5 8 1	„ „	..	..
12,951	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October ..	..	..
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	„ „	10⅜	10½
£30,000	50	4½%	Do. 4½ per Cent. Debentures	104⅞	107⅞	104⅞	107⅞	4 4 1	January and July ..	..	..
60,710	20	3/0	Direct United States Cable	12¼	13¾	12⅞	12¾	5 2 0	Jan., Apr., July, Oct.	12½	..
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	103	106	103	106	4 5 6	..	..	..
£4,000,000	Stock	8%	Eastern Ordinary	180	185	180	185	3 16 1	Jan., Apr., July, Oct.	183	181
£1,795,000	Stock	3½%	Do. 3½ per Cent. Pref. Stock	104	107	104	107	3 5 7	„ „	..	..
£1,432,248	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	126	130	125	129	3 2 9	May and November	127	125½
£89,900	100	5%	* Do. 5 per Cent. Debentures, 1899	99	102	99	102	4 18 0	February & August	..	..
250,000	10	2/6	Eastern Extension	18	18½	18	18½	3 15 8	Jan., Apr., July, Oct.	18½	18½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	129	125	129	3 2 3	February & August	..	..
£16,200	100	5%	* Do. 5 p. c.(Austin.Gov.Sub.)Deb.1901(reg.)	99	103	99	103	4 17 1	January and July ..	..	..
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	..	..
£35,100	100	5%	*Eastern and S.African 5 p.c.Mor.Deb.,1900(reg.)	99	103	99	103	4 17 1	„ „	..	..
£46,500	100	5%	Do, (Bearer)	100	103	100	103	4 17 1	„ „	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures,1909	102	105	102	105	3 17 8	February & August	..	..
£200,000	25	4%	Do. 4% Mauritius Sub. Debs. (red.)	104⅞	107⅞	104⅞	107⅞	3 15 2	May and November	..	..
180,227	10	1·9	Globe Telegraph and Trust	12⅝	13⅛	12⅝	13⅛	3 17 4	Jan., Apr., July, Oct.	13⅛	12⅞
180,042	10	6%	Do. 6 per Cent. Preference	17	17½	16⅞	17⅛	3 9 7	„ „	17⅛	16 15/16
150,000	10	5/0	Great Northern of Copenhagen	30	31	30	31	3 4 6	January, April, July	30⅞	..
£97,800	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb.(red)	100	103	100	103	4 8 0	June and December	..	..
17,000	25	12/6	Indo-European	57	60	57	60	4 3 4	May and November	..	..
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 1904	108	111	108	111	5 8 1	March & September	..	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs.(red)	100	108	105	108	3 14 5	June and December	..	..
11,889	8	4/0	Reuter's	6½	7½	6½	7½	5 6 8	April and October ..	..	..
3,381	£100 Cert.	6%	Submarine Cables Trust	139	144	140	145	4 4 3	„ „	..	..
15,609	10	..	West African Telegraph	2½	3½	2½	3½	..	..	..	..
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	98	101	99	102	4 18 0	March & September	102½	..
80,008	2½	..	West Coast of America	½	1	½	1	..	..	..	..
£150,000	100	4%	* Do. 4 per Cent. Debentures	103	106	103	106	3 15 9	June and December	..	..
88,321	10	1/6	West India and Panama	1⅞	2⅛	1⅞	2⅛	..	May and November	..	..
34,565	10	6.0	Do. 6 per Cent. 1st Preference	10½	11	10½	11	5 9 1	„ „	10⅞	..
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	„ „	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures	105	108	105	108	4 13 3	January and July ..	..	..
64,269	15	5.0	Western and Brazilian Ordinary	12⅞	13	12½	13	4 11 3	May and November	..	..
88,129	7½	3.9	Do. 5 per Cent. Preferred Ordinary	8½	8¾	8½	8¾	4 5 8	„ „	..	..
88,129	7½	1/3	Do. Deferred Ordinary	4	4½	4	4½	..	„ „	..	..
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	107	110	107	110	3 13 2	June and December	..	..
£168,100	100	6%	Western Union 6 per Cent. Sterling Bonds (red.)	98	103	100	105	5 14 3	March & September	..	..

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share	Last Dividend	Name	Previous Week's Price March 8		Price Wednesday, March 15		Rate per Cent. Yielded £ s. d.	Dividend Due	Business Done During Week Ending March 15 Highest	Lowest
			TELEPHONES.								
44,000	£5	4/0	Chili Telephone (fully paid)	2¾	3¼	2¾	3¼	6 8 1	August	–	–
324,850	£1 's.	1½d.	Consolidated Telephone Const. & Manufacturing	⅛	3/16	⅛	3/16	6 7 0	July	–	–
98,000	5	4/0	Monte Video Telephone 5 per Cent. Preference	7/8	1	⅞	1	5 0 0	October	–	–
490,000	5	3/0	National	4⅞	5	4⅞	5⅛	5 11 3	February & August	5	4⅞
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	13	15	12	14	4 5 9	" "	13½	13
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	13	15	12	14	4 5 9	" "	13 1/16	13
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	4½	5	4⅞	5⅛	4 15 2	" "	5 1/16	4⅞
1,129,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	99	101	99	101	3 9 9	June and December	100½	99
71,504	1	0/4	Oriental	⅝	⅞	11/16	13/16	6 8 1	April and October	⅞	–
58,000	5	6/0	United River Plate	4⅞	5⅛	4⅞	5⅛	5 11 3	July	–	–
£151,733	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	107	107	104	107	4 13 11	June and December	–	–
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	–	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (10s pd.)	⅛	⅜	⅛	⅜	–	–	–	–
6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	13	13½	13½	14	–	–	13¾	..
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10¾	11½	10¾	11½	4 4 0	–	–	–
90,000	5	5/0	Charing Cross & Strand Electricity Supply Corp xd	11½	12½	11½	12½	3 4 0	February & August	–	..
30,000	5	2/3	Do. 4½ per Cent. Preference xd	6	6½	6	6½	3 9 3	" "	6½	–
£34,000	5	3 6	Chelsea Electricity Supply Ordinary xd	8½	9½	8	9	3 6 8	March	–	–
£60,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	114	116	114	116	3 18 1	June and December	..	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red) xd	103	106	101	105	4 17 7	April and October	–	..
50,000	10	7/0	City of London Elec. Lighting Ord. 40,001 to 90,000 xd	19½	21½	18	19	3 3 2	February & August	19½	18½
10,000	10	6/4	Do. Ordinary 90,001 to 100,000 xd	19	20	18	19	..	–	–	–
40,000	10	6%	Do. 6% Cumulative Pref. xd	15	16	16	16	3 15 0	January and July	15 11/16	15½
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	124	129	124	129	3 17 10	June and December	123½	..
80,000	10	–	County of London & Brush Prov. Ord. (1 to 80,000)	12	13	11½	12½	–	–	11½	11½
10,000	10	..	Do. (80,001 to 40,000)	12	13	11½	12½	..	–	..	..
20,000	10	6/0	Do. 6% Cumulative Preference	14½	15½	14½	15½	4 0 0	March & September	14½	..
19,661	5	3/6	House-to-House Electric Lighting Supply Ord. xd	9	10	8½	9½	3 13 8	–	..	–
12,000	5	3/6	Do. 7 per Cent. Preference xd	9½	10½	9	10	3 10 0	March & September	–	..
15,000	5	10%	Kensington and Knightsbridge Ord.	13	14	13	14	3 18 7	–	–	–
10,000	5	6%	Do. 6% 1st Pref.	7¾	8¼	7¾	8¼	3 12 9	January and July	–	–
110,000	3	..	London Electric Supply Ordinary	3½	4	3½	4	..	–	–	–
48,050	5	3/0	Do. Preference xd	6½	7	6½	7	4 5 9	–	..	..
£100,000	Stock	..	Do. 4% 1st Mort. Deb.	104	106	105	107	3 14 9	Mch., June, Sept., Dec	107	105½
62,500	10	5/0	Metropolitan Electric Supply Ordinary	16½	17½	16	17	3 10 9	April and October	16 13/16	16½
22,500	10	–	Do. (£7 paid)	12½	13½	12	13	..	–	–	..
£230,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	118	121	117	120	3 15 3	June and December	117	–
6,452	10	6/0	Notting Hill Electric Ordinary xd	16½	17½	16½	17½	3 8 7	March	–	–
10,000	5	–	Oxford Electric Ordinary	6¾	7¼	6¾	7¼	–	–	–	..
275,000	1	–	Rand Electric	⅞	1⅛	⅞	1⅛	–	..	–	–
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb	83	93	83	93	5 8 1	–	–	–
150,000	$100	$2	Royal Electric Company of Montreal Shares	160	180	170	190	4 5 1	–	–	–
130,900	100	4½%	* Do. 4½% 1st Mort. Debs.	107	109	107	109	4 3 9	April and October	–	..
31,980	5	9 6	St. James and Pall Mall Electric Ordinary	16½	17½	16½	17½	4 2 9	February & August	17 7/16	16⅞
30,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	" "	9⅜	..
65,000	5	..	South London Electric Supply Ordinary (£3 paid)	3½	3¾	3½	3¾	..	–	3½	3½
79,900	5	7/0	Westminster Electric Supply Ordinary	15½	16½	15½	16	3 15 0	March & September	16½	15¾
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	2	1/2½	Brush Electrical Engineering	1⅞	2⅛	2	2¼	2 13 4	–	2 1/16	2
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2½	2⅝	2½	2⅝	5 1 1	–	–	2½
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	110	114	110	114	3 19 2	February & August		–
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101	104	101	104	4 6 7	June and December	108	..
£20,000	5	5/0	Callender's Cable Construction	13¼	13¾	13¼	13¾	5 0 0	" "	13	12 15/16
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	114	117	114	117	3 17 5	November and May	..	–
300,000	1	9¾	Castner-Kellner Alkali Co. (fully paid)	1⅝	1⅞	1⅝	1⅞	5 16 5	–	..	..
50,000	1	–	Chadburn's Ship Telegraph Ordinary	1⅛	1⅜	1⅛	1⅜	–	–	–	–
50,000	1	7½d	Do. 6 per Cent. Cumulative Pref.	1	1¼	1⅛	1⅜	4 7 3	–	1⅛	–
32,098	3	1/6	Crompton and Co. (Nos. 1 to 32,098)	3½	3⅞	3½	3¾	4 0 0	–	–	..
£100,000	100	5%	* Do. 5% First Mort. Deb. (red.)	98	101	98	101	4 19 8	January and July	–	..
99,261	5	1 9¾	Edison and Swan United ("A" Shares) (£3 paid)	2½	2¾	2½	2¾	7 1 8	February & August	2 7/16	2 5/16
17,139	5	2/5½	Do. (£5 paid)	4	6	4	6	6 10 0	" "	–	–
£344,028	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	98	101	97	99	4 1 8	June and December	99½	–
17,400	5	5%	Edmundson's Electric Corporation Ord (fully pd)	5½	6⅛	5½	6⅛	4 6 11	Half-yearly	5 7/16	–
112,100	2	1/2½	Electric Construction Co. (Limited)	2½	2¾	2½	2¾	4 12 0	January & July	2 7/16	2⅜
25,000	2	2/9½	Do. 7 per Cent. Cumulative Pref.	3	3½	3	3¼	4 0 0	July	3⅜	–
£140,300	Stock	4%	Do. 4% First Mortgage Deb. (red.)	103	105	103	106	3 15 10	January and July	104½	..
91,196	1	–	Elmore's Patent Copper Depositing	⅛	⅜	⅛	⅜	..	–	–	–
12,500	10	20/0	Henley's Telegraph Works Ordinary	27	28	25	27	5 3 8	February & August	27¾	25
8,000	10	7/0	Do. 7 per Cent. Preference xd	18½	19½	18½	19½	3 11 10	" "	19½	–
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.) xd	113	116	112	115	3 19 10	" "	115	..
50,000	10	15/0	India Rubber, Gutta Percha, &c., Works	22	23	22	23	4 6 11	" "	22½	22
300,000	100	4%	Do. 4% First Mortgage Debentures (red.)	102	106	102	106	3 15 6	March & September	..	..
37,350	12	24/0	Telegraph Construction and Maintenance xd	40	41	38	42	4 5 9	March and July	39½	38½
£150,000	100	..	Do. 4 per Cent. Deb. Bonds	104	107	104	107	3 15 4	..	..	..
£18,400	5	–	Do. Manufacturing Ordinary	9½	9¾	10	10½	–	–	10⅜	10¼
13,400	5	..	Do. 5% Cum. Pref.	5¾	6¼	5¾	6¼	4 0 0	–	–	–
£30,000	5	4/0	Willans and Robinson Ordinary	8½	9	8½	9	4 8 11	April and October	9	8½
£30,000	5	3/0	Do. 6% Cumulative Preference	7¼	7¾	7¼	7¾	3 17 5	" "	–	–
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	106	108	106	108	3 18 8	May and November	–	–
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	8/0	Blackpool and Fleetwood Tramways	23½	24½	24½	25	3 2 9	–	–	–
60,000	10	7/6	Bristol Tramways and Carriage	23½	24½	23¾	24½	2 14 1	–	–	–
£90,410	Stock	4%	Do. 4% Debenture	120	121	120	121	3 6 2	–	..	..
80,000	10	..	British Electric Traction Ordinary	17½	18½	21	22	..	–	21⅞	19 13/16
10,000	10	6/0	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm. pd.)	13½	14½	13¾	14½	4 4 11	–	14	13½
£100,000	Stock	6/2·8	Do. 5% Perp. Deb.	125	127	125	129	3 17 6	–	125	[illegible]
40,000	5	..	Buenos Ayres & Belgrano 6% Cum. Pref. (£3 paid)	3⅜	3⅞	3⅜	3⅞	..	..	3⅞	3 11/16
27,500	5	..	Do. do. do. (fully paid	4½	5	4½	5	..	..	4½	4 7/16
£260,000	..	5%	Do. do. 5% Deb.	108	111	108	111	4 1 11	..	111	108
£85,250	10	3/0	Central London Ordinary	9½	10½	9½	10½	4 18 6	June and December	10¼	10
178,303	10	1/9½	Do. (£8 paid)	7½	8½	7½	8½	4 13 2	" "	7 13/16	7½
£630,000	Stock	2%	City and South London Railway Con. Ordy.	70	72	68	70	3 0 9	January and July	..	–
22,500	10	..	Do. Ordinary (£5 paid)	4½	5½	4½	5½	..	..	..	..
9,251	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	3 5 7	January and July	–	–
£187,701	Stock	4%	Do. 4% Perpetual Debenture	133	135	133	135	2 19 7	May and November	..	.
20,000	10	6%	Imperial Tramways Ordinary xd	24½	25½	24½	25½	2 8 0	March & September	..	..
10,000	10	6%	Do. 6% Preference xd	16	16½	16	16½	3 13 11	" "	–	–
£70,000	Stock	4½%	Do. 4½% Debenture	119	121	119	120	3 15 0	..	–	..
87,100	10	4%	Liverpool Overhead Railway Ordinary	10	10½	10	10½	3 9 2	February & August	–	–
11,000	10	5%	Do. 5% Preference	14½	15	14½	14⅞	3 7 3	" "	–	–
125,000	Stock	4%	Do. 4% Debenture	116	118	106	118	3 14 1	January and July		
80,000	5	8/8½	New General Traction 6% Cumulative Pref	4⅞	5⅛	5	5⅛	5 9 1	–	5⅛	5⅛
£547,000	Stock	3%	Waterloo and City Ordinary	109	112	109	112	2 13 7	June and December	112	–

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

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CONTENTS OF THE CURRENT NUMBER.

NOTES	745	Reviews	763
Meetings of Scientific Societies	747	Electric Traction and its Application to Suburban and Metropolitan Railways. By Philip Dawson	764
The Telephone Service in Foreign Countries	748	Correspondence	766
A Telegraphic Relic found at Omdurman. Illustrated	751	Parliamentary Intelligence	767
Blackburn Corporation Electric Tramways. Illustrated	752	Legal Intelligence	770
Wireless Telegraphy	758	Trade Notes and Notices	771
Dinner to Mr. Charles Gerhardi	759	Companies' Meetings & Reports	776
Electricity Works Accounts	760	New Companies, &c.	779
MUNICIPAL ELECTRIC SUPPLY BUSINESS	762	City Notes	780
		Companies' Share List	782

NOTES.

THE report relating to telephone service in foreign countries, which have just been laid before Parliament, and a summary of which will be found in our columns this week, may be studied with profit by everybody interested in the welfare and future control of the telephone in this country. One thing made clear by a very casual study of the figures now available is, that the statistics hitherto quoted have been studiously selected for the special purpose of attacking the English system. Taking all things into consideration, that system comes out very well by comparison with the systems of which we now have trustworthy information. The tariffs, varying as they do in various countries, and even in the same country, point to the conclusion that they are determined by local circumstances, such as the size of area, the character of the place, whether commercial or residential; and especially the rate of wages and the general cost of installations.

NOWHERE do high profits appear to be made; and Amsterdam and Rotterdam, the sole instances of municipal management, are not encouraging for similar experiments here, if the payment of interest on capital outlay and reserves for depreciation are—as they always ought to be—taken into account. Nor when the facts are carefully studied is the much talked of superiority of Sweden and Norway so real as it seems to be. There are at least three systems in Stockholm alone; but it is pretty plain that the Government are awakening to the desirability of unification; and we can hardly suppose that the public is not of the same mind. The toll system, pure and simple, seems to find an exponent in Switzerland only—a country so different in every respect from our own that we entertain some misgivings as to adopting a system certain to prove an unmitigated nuisance to the business man

A HOWL of indignant protest has been raised against the Bill in Parliament of the Baker-street and Waterloo Railway Co., renamed the Waterloo, Euston and Paddington Railway Co. The Bill provides for the construction of a power station and terminal yard in what the opponents admiringly describe as "the most picturesque part of Paddington." True, the description may puzzle the minds of some as to the exact locality referred to; yet, nevertheless, we can appreciate to some extent the desire of the residents not to be thus singled out, while there are less "picturesque" parts that might be so favoured. In the early days of railroading many a short-sighted borough voted railways a nuisance, and had the stations erected as far away as possible. To-day those boroughs are in the rear of commerce, in consequence. As to the proximity of a steam-driven power station to any "picturesque part," we have always deprecated following this course wherever it is practicable to erect the works in a locality less liable to be injured by tall chimneys, smoke and machinery. Polyphase transmission renders this easy in the case of electrical undertakings of the class to which the railway in question belongs; and our advice to the company is to stick out for its terminal yard, but to erect its power station in a less "picturesque part of Paddington," or even still further away.

PADDINGTON may interest but little the majority of our readers, but the application of polyphase currents to railway working appeals to a much wider circle. It is a subject which was brought prominently forward on Wednesday evening last, at the Society of Arts, during the discussion on Mr. PHILIP DAWSON'S paper on electric traction, a reprint of which we commence this week. One or two speakers expressed the view that the success of the Jungfrau and Gorner Grat railways pointed to the advisability of adopting polyphase working throughout on electric railways. If that argument be advanced, what does the success of the Chicago and the Liverpool electric railways point to, since these are much older and much larger systems of railways? Considering that the Gorner Grat line was only opened in December, 1897, and the Jungfrau line late last summer, there is considerable force in Mr. DAWSON'S reply that he adheres to continuous current motors because he knows what they can be relied upon to do, and can get guarantees, whereas there appears to be great difficulty in getting equally good guarantees for polyphase motors.

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Mr. Mordey directed attention to a very practical and common sense way out of the difficulty viz., that in large traction schemes polyphase generators should be adopted for the power station, the power being transformed at sub-stations to continuous current. This would pave the way for the ultimate adoption of polyphase traction, should such be sufficiently perfected, and it would minimise the cost of converting from one system to the other. Although this has not been the principal object in view, the practice recommended by Mr. Mordey has been adopted already on several lines, as, for example, at Dublin, and has proved quite successful.

Conduit systems came in for some commendation from Mr. Kilburn Scott, who, unintentionally as it subsequently appeared, gave some colour to the idea which has been circulated by a misinformed newspaper press, that the trolley system is extensively and rapidly being superseded by the conduit system on American tramways. A greater error never gained currency; but inasmuch as a false rumour once started is difficult to overtake, we have found it a troublesome task to disabuse the minds of local authorities of the idea that they ought to oppose the trolley system because it is already being supplanted by something better. Much injustice to the claims of the trolley system has arisen from the circulation of this preposterous notion. Thousands of miles of trolley line are working in America with complete success, financially as well as from an engineering point of view; and the proprietors of these lines would be the first to ridicule the suggestion that a conduit system would be in any sense an improvement.

Undoubtedly the conduit system, as perfected by long experience in Washington, and recently adopted in New York, possesses characteristics which, in certain special circumstances, make it preferable to the overhead trolley system. We are of the opinion, however, that the traction system, whether conduit or surface contact or otherwise, has yet to be developed which will be found superior to the trolley system for the general purpose of town tramways or interurban light railways. This being so, it is obviously prudent to adopt the trolley system for the present, rather than to spend large sums of money in laying down an expensive conduit system that may be rendered obsolete in a few years.

However much biology and electrical science may have advanced independently during the present decade, a satisfactory explanation of the peculiar properties possessed by the queer electric fish is still wanting. The *malapterurus* of the Nile, which was the subject of a lecture by Prof. Gotch at the Royal Institution last Friday evening, is a most superior sort of electrical fish, for, unlike the *gymnotus* and the *torpedo*, its electric organ does not impede its motion, and even appears, according to the lecturer, to whet its intelligence. A comparison of the *malapterurus* with other fish of a like nature has induced Prof. Gotch to discredit the older theories of the method by which these animals generate electricity, and to incline to the view that the seat of the electromotive force is the nerve centre itself and not the collection of "plates" hitherto considered to be the electric organ; he does not, however, indicate the precise function of these "plates." These latter are formed of a modified muscular substance and number about two millions. They are separated by an albuminous composition and each is connected by a single nerve fibre to the nerve centre. The E.M.F. of each of these cells, measured, with the help of Mr. G. J. Burch, by means of a capillary electrometer, is about 0·04 or 0·05 volt, *i.e.*, of the same order as the E.M.F. generated by the contraction of a muscle. The time lag between the excitation of the nerve and the maximum E.M.F., proved to be about $\frac{1}{1000}$th of a second, and a single momentary excitation of the nerve suffices to generate an oscillatory E.M.F. Prof. Gotch's hypothesis might possibly be completed and rendered more probable by assuming that the collection of "plates" is nothing more or less than a condenser, or rather a series of condensers, charged at will by the fish; and this would account both for the time-lag and the oscillatory discharge.

The capillary electrometer experiments could not, of course, be repeated at the lecture, but two live *malapteruri*, kindly lent by the Liverpool Corporation, were on view, and currents generated by them were demonstrated audibly and optically by means of a telephone and a prepared frog-nerve respectively, although part of the current was necessarily shunted through the hand of the intrepid lecturer. After the discourse, the audience were invited to test for themselves the "shocking" propensities of the animals. In this the fish again showed evidence of their intelligence, for when teased by the sterner sex fatigue very soon set in, but in response to the more delicate touch of the ladies, they were almost invariably more accommodating.

The Willans engine has been so closely identified with the development of electric supply stations in this country that more than ordinary interest attaches to the tenth half-yearly report of the directors of Messrs. Willans and Robinson (Limited), which has just been issued. Particulars of the report will be found in another column, from which it will be seen that the Company is in a very flourishing condition. Among many other indications of prosperity we may note that the sums reserved out of profits in the five years since the Company was formed aggregate £38,852, a figure which exceeds the amount paid for the goodwill of the business. New works are about to be erected near Chester for the boiler-making departments: and, at the Rugby works, the largest stock size of Willans engine will probably very shortly be increased, the present largest stock size—1,500 h.p.—having proved very popular.

We have received a copy of the first number of *Electrical World and Electrical Engineer*, our new American contemporary, which has been evolved out of a coalescence of the two leading electrical journals in the United States. The new publication appears to combine the good qualities of its progenitors, and to have eliminated what in them may have been of inferior merit. We repeat our good wishes for its success.

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Cable Interruptions and Repairs.—

	Date of Interruption.	Date of Repair.
Dakar—Bathurst	Feb. 9, 1899 ...	Mar. 15, 1899
Paramaribo—Cayenne	Feb. 10, 1899 ...	—
Cayenne—Pinheiro	Mar. 10, 1899 ...	—

New International Telephone Trunk Line.—Telephonic communication can now be held between Berlin and Arnheim, in Holland. The cost of a three minutes' conversation is three marks.

The Wireless Telegraph to France.—We hear that the French station for the cross-channel wireless telegraph trials will not be at Boulogne itself, but at Wimereux, a village two miles to the west of Boulogne, the English station being at South Foreland. The distance between the two stations will thus be 30 miles.

Electrocution.—The electrocution of a female criminal at New York on Monday last, has once more directed attention forcibly to the unnecessary cruelties attendant upon this barbarous method of carrying out the death sentence. Apart from the mental torture, due to the elaborate preparations, while adjusting the criminal to the electrical chair, the fact that it was considered necessary to maintain the fatal shock for 60 seconds should be sufficient to condemn the practice. In the latest case, it appears, 8 amperes at 1,760 volts were maintained for 4 seconds, followed by 2 amperes at 200 volts; in other words, no less than 18 H.P. was expended upon the body of the wretched criminal.

Obituary.—We regret to announce the death, in Schenectady, of Mr. John Kruesi, the chief mechanical engineer of the General Electric Co. of America. Mr. Kruesi was born in Sperchер, Switzerland, in 1843, and remained in his own country until 1867, when he proceeded to Paris. On the outbreak of the Franco-Prussian war he came over to London and went thence to the United States. Shortly after his arrival in the latter country he was engaged by Mr. T. A. Edison. He was associated with the great inventor in evolving the tinfoil phonograph, and in the early electric lighting work in New York City. When the Edison Machine Works were formed Mr. Kruesi was appointed assistant general manager, and when they were moved to Schenectady he was mainly responsible for the design and erection of the works there. Mr. Kruesi died from an attack of influenza after only three or four days' illness.

Telephone Rates in New York.—A bill for the regulation of telephone charges in the State of New York, drawn up by the committee appointed for that purpose by the New York Board of Trade and Transportation, was recently introduced simultaneously in the Senate and the Assembly. The bill provides that the telephone rates in cities of 1,000,000 inhabitants and over shall not exceed $125 a year; in cities of 500,000 to 1,000,000 not to exceed $85; in those of 100,000 to 500,000 not to exceed $48; those of 20,000 to 100,000 not to exceed $36; from 8,000 to 20,000 not over $30, and in all places having less than 8,000 inhabitants not to exceed $27 a year. The charge for local messages at public or pay stations is fixed not to exceed 10c. for the first five minutes, and 5c. for each additional five minutes. The provision is made, however, that the annual rates named in the bill may be raised if it shall be made to appear to the satisfaction of the State officers in charge of the matter that the telephone company is not making, in addition to the amount paid for interest on bonded indebtedness, a net profit of 10 per cent. upon all cash capital. The rate may, however, be lowered if it appear that the company is making a profit of more than 10 per cent.

Cape to Cairo Telegraph Scheme.—Her von Bülow, the German Foreign Secretary, made the following statement in the Reichstag, on Tuesday last, concerning Mr. Cecil Rhodes's scheme for a trans-African Cape to Cairo telegraph:—

With regard to the negotiations which have been conducted here during the last few days between those German departments of State which are concerned and Mr. Cecil Rhodes, I cannot yet give all the details, and I must also take into account the fact that these negotiations are still pending; but I should like to give such information as I can without prejudicing the interests involved. An agreement has been effected between the Trans-African Telegraph Co. and the German Government concerning the construction of a line of telegraph from South to North through German East African territory in connection with the existing South African line. When this agreement will be published, and when it will come into force, depends upon the future progress of other negotiations. I can already say, however, that by the terms of this agreement our rights and our interests are safeguarded in every respect. The Trans-African Telegraph Co. receives permission to construct the line in question across German territory at its own cost. The work must be completed within five years at the outside, and all officials and workmen of the Company will be subject during their stay in our territory to German law, and must obey the orders of the German Governor. The Company is under an obligation to erect at its own expense a further line joining the two stations, in Rhodesia on the one side and in British East Africa on the other, which are nearest to the German frontiers. This line will be destined for the telegraphic service of German East Africa, and will be the property of the German Government. The cost of maintaining this line will be borne by the German Government, which has the right to construct additional lines at its own cost. These telegraph lines belonging to the German Government will be maintained at the Company's expense. The Government reserves to itself the exclusive right of establishing and working telegraph stations in its territory, and at the end of 40 years it may take possession of the lines without payment.

Annual Dinner of the Northern Society of Electrical Engineers.—At the sixth annual dinner of this Society which was held in Manchester, Mr. Ferranti, the new President, responding to the toast of the evening, which was proposed by Mr. Henry Edmunds, referred to the progress of the electrical industry in this country within recent years. The fact that towns are well supplied with gas had, he said, been against the general introduction of public electric lighting in the past; but we could now congratulate ourselves that we were in a satisfactory condition of forwardness instead of being behind other nations. In electric traction, however, it was not because we had been too well served that we had not gone ahead, but because legislation had deterred people from investing in such undertakings. One of the most serious things that affected the industry was the great disadvantage that sprang from the evils of socialism, and municipalities were more and more supplying ratepayers with everything they desired. In electric lighting work they claimed to be successful, but how was it possible to fail with such an excellent business when it was a monopoly? Municipal trading in its worst form was the next step, for the municipalities were now proposing to sell, not merely gas, water and electricity, but to manufacture the articles essential to such undertakings. He was glad there was a strong feeling against that most pernicious form of socialism. Another very objectionable feature of municipal action was the practice of inserting special labour clauses in contracts to regulate the hours of labour, the rate of charges, and the methods in which masters should deal with their men and conduct their business generally. By heeding the demands of the trades unions the municipal representatives were simply buying votes by the use of public money. How were English manufacturers to compete with foreign countries if they were subject to such conditions? We were free traders, but we ought to have free trade in our own country, and engineers should not be fettered and forced to raise artificially the price of the work they performed. Mr. Ferranti's speech was received with great enthusiasm.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, March 24th.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Papers to be read: (1) "On the Criterion for the Oscillatory Discharge of a Condenser," by Dr. Barton and Prof. Morton; (2) "The Minor Variations of the Clark Cell," by A. P. Trotter.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Transparency and Opacity," by the Right Hon. Lord Rayleigh, F.R.S.

SATURDAY, March 25th.

INSTITUTION OF JUNIOR ENGINEERS.

3 p.m. Visit to the Testing Station of the British Fire Prevention Committee at Hanover Gate, Regent's Park, London.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7 p.m. General Meeting of the Graduate Section in the Institution Lecture Hall, 4, St. Nicholas-buildings West, Newcastle-on-Tyne. Paper to be read: "The Application of Electricity to Coal Mining," by T. Duckitt.

TUESDAY, March 28th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be submitted for discussion: "Alloys of Iron and Nickel," by R. A. Hadfield.

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THE TELEPHONE SERVICE IN FOREIGN COUNTRIES.

A parliamentary paper* just issued, containing "Reports respecting the Telephone Service in various Foreign Countries," is most interesting and opportune at the present juncture when the Government are contemplating important changes in the Telephone organisation of this country. These reports originated with a request made to the Foreign Office by Mr. A. D. Provand, M.P. for Blackfriars, Glasgow, that information should be obtained by British Consuls in the various cities of Europe and the United States under headings categorically enumerated in a memorandum dated December 20, 1897. The questions, 23 in number, may be summarised as follows: Those relating to population and size of area; nature of concession whether private, State or municipal; its powers and rights of wayleaves; numbers of subscribers; tariffs and hours of service; wages of workmen and operators, with their hours of attendance. To these were added questions as to the composition of the wires, the character of the circuits; and where the plant, including apparatus, was manufactured, It was also desired that copies of accounts should be obtained with details of capital expended, and profits or dividends earned; but we may state at once that the answers on these points are either not forthcoming, or in the majority of cases, too ambiguous to be of any value. The same may be said of answers to question (18)—"Quality of service, and whether the subscribers are generally satisfied"?—which when answered at all, being with one exception in the affirmative, is suggestive of diplomacy rather than judicial accuracy. The exception confirms this impression, the Consul at Ghent reporting that the public are satisfied with the working, "but complain that 200fr. per subscription is too high." As to what we should call the general efficiency of the service the reports are silent—a fact the more remarkable seeing that a large proportion of the circuits are single wired, and some of them worked entirely by private companies on business principles. As regards the wires the uniform answer is silicum or phospher bronze; single as a rule for overhead, double and of copper for underground. The plant and appliances appear to have been obtained mostly from Stockholm and Germany; England which had a good share in the manufacture at one time being now, we are told, shut out of the market. Answers to the other and more important questions will appear as we examine the reports in detail.

The ground covered by these consular Papers embraces all the industrial countries of the Continent, and furnishes detailed information as to the chief cities of Austria-Hungary, Bavaria, Germany, Italy, the Netherlands, Belgium, Sweden and Norway, and of Switzerland. Of the French telephone service no useful particulars were obtainable; and from Russia only one example is furnished, that of Helsingfors. From the United States also only one report has been received, which, however, is a very striking document in several respects, emanating as it does from the Telephone Company of New York, and disclosing a condition of affairs in marked contrast with what is reported from the cities of Europe. This being so it will be convenient to speak of it at the outset, although the report comes last in the series, and is very brief.

The New York Telephone Co. is the lineal successor of the Bell Telephone Co., which commenced operations in 1878, and was absorbed by the Metropolitan Co. in 1880, being in turn absorbed by the present Company about three years ago. The area covered is about 62½ square miles, with a population of 1,500,000. The Company is organised under the State law, enjoying many privileges as regards wayleaves, &c., and possesses a practical monopoly, but without exclusive rights. Consul-General Sanderson, in his memorandum accompanying the inclosure, speaks of the "satisfactory nature" of the existing service, but also of the efforts made to compel the Company to reduce its charges. He says nothing, however, of municipal corruption defeating these efforts, as suggested by Mr. Provand in our columns last week; nor do we see how the municipalities of this country would escape similar insinuations, with just as much foundation, if the local authorities ever have the same motive for protecting themselves against outside competition. The published tariff of the Company is given as follows:—

90 dollars for	600 messages, say	.....	.....	£18
120 „	1,000 „	„	... .	24
145 „	1,500 „	„	....	29

In the report itself the charges are said "to vary from £15. 10s. to £49 10s. per annum, regulated by the amount of service rendered." "The company, up to July 1, 1896, paid no dividend, the profits being devoted to extending and improving, their property; since that time they have paid dividends at the rate of 6 per cent. per annum." It is not stated how long these charges have prevailed, or whether they have changed for better or worse; but it is a notable fact that since 1895 the subscribers have increased at the rate of three to four thousand each year, whereas for the preceding five or six years the numbers increased very slowly. The figures from 1890 are given below:—

July 1, 1890	8,224	July 1, 1895	10,396
„ 1891	8,527	„ 1896	13,337
„ 1892	8,736	„ 1897	16,786
„ 1893	9,013	Dec. 1, 1897	20,937
„ 1894	9,914		

We give also in full the statement of the Company as to the wages paid to their workmen and operators. It will be seen further on that these rates are double and even treble those paid in many European countries to the same class of employés:—

"The wages paid to workmen range from $9 (about 37s.) to $28 (about £5. 15s.) per week. As a rule they are not required to work on holidays or Sundays, but they must report for duty, and if their services are required they are paid overtime, generally at the rate of about one and a-half. When ill they receive their wages for what is considered a reasonable time depending on the nature of the case, and the Company maintain a policy of insurance to cover the employer's liability in cases of accident or death. In cases where the employer cannot properly be held liable it is the rule, rather than the exception, to grant some compensation. The wages paid to workwomen range from $3 (about 12s. 4d.) to $17 (about £3. 10s.) a week."

Turning now to the Continent of Europe, Italy is the principal country at all resembling New York, if we may judge from the reports on the service in the cities of Rome and Florence. Both places are served by private companies, which are the survivors of other companies now defunct or amalgamated, and which hold concessions from the Italian Government for 25 years, commencing on January 1, 1898. These concessions are, however, subject to cancellation after 12 years on payment, as compensation, of a sum equal to the average net profit of the three preceding years, multiplied by the number of years which each concession has still to run. If undisturbed for the full 25 years, the plant, lines and offices become the property of the State. A tax of 10 per cent. is imposed on the gross profits of each concession, free communication with postal and telegraph offices, and a reduction of 50 per cent. in favour of all Government, provincial or municipal offices. On the other hand, the companies possess almost arbitrary powers in respect of wayleaves. In Rome and vicinity the concession covers an area including a population of about 500,000. The subscription is 168 lire (£6. 14s.) annually, with an extra charge for distances exceeding three kilometres. The service is continuous, night and day. Subscribers number 2,102. About 50 women are employed at the Central Bureau working seven to eight hours a day with wages of 25s. to 40s. per month. Workmen's wages are set down at 1s. 8d. to 3s. 4d. a day, working ten hours. The dividends of the Company which were formerly 3 per cent. are now, under the more secure conditions, 6 per cent. In Florence the same rate of wages prevails, and there is the same continuous service all night and all Sundays. A fortnight's leave of absence is granted annually to the operators, and a holiday on each alternate Sunday. The subscription ranges from £6. 10s. within 1 kilo. to £9. 3s. 4d. within 3 kilos. There are about 900 subscribers in a population of 250,000. Although the law requires double wires, it has not yet been generally enforced, and single wires are the rule. As regards dividends the concluding words of the Florence report are worth quoting; they apply no doubt as well to Rome and other Italian cities:—

"The old local Company distributed yearly a dividend varying from 2 to 3 per cent.; the new Company which has absorbed the others has not

* Commercial, No. 1 (1899).

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yet published a balance-sheet, and it is expected that the dividend, if any, will not be in excess to the above-mentioned. With 10 per cent. concession tax, and 20 per cent. income tax, and the necessity of refunding the capital, a very little extra profit can be available for distribution."

Helsingfors, in Russia, is the only other instance reported upon where the telephone service is in the exclusive control of a private company. The same story comes from there as from Italy, several competing companies, ending in amalgamation and a joint concession. In the case of Helsingfors, with only 80,000 inhabitants, the Company obtained its privileges from the municipality on very easy terms, paying only one mark for every wire in the town; but nothing for its 16 trunk wires along the roads. It has 2,800 subscribers. The subscription is from £5 to £5. 10s. per annum, if the instrument and line are hired, and £3. 10s. if they are bought. Workmen and female operators receive on an average 3s. for a day of 10 hours. No information is afforded as to the profits of the undertaking, nor as to the service of any other town in Russia.

Of municipal telephony the only examples forthcoming are from the Netherlands, Amsterdam and Rotterdam having taken over in 1896 the systems previously worked by private companies, and extending in both places to a radius of $3\frac{1}{8}$ English miles. The concession to the municipalities is granted by the State for a period of 25 years, with option of purchase at any earlier period. Full powers are granted in respect of wayleaves, except as touching property of the Government. The system is double wired, and is a combination of overhead and underground. Amsterdam has a population of 500,000, with subscribers numbering 1,925; Rotterdam a population of 295,000, and 1,320 subscribers. In Amsterdam, each subscriber pays £2. 1s. 8d. entrance fee, and £7. 10s. per annum. In Rotterdam the entrance fee is rather less, and for private (not business) subscribers, the rate is £5. 10s. The service is continuous night and day. No royalty is paid to the State, the only consideration imposed being the obligation to provide all cable wires for connecting subscribers with telegraph offices and trunk lines—both in the hands of the State. The capital outlay is estimated for each connection at £33. 6s. 8d. in Amsterdam, and £45 in Rotterdam. For the first-named place the receipts and expenditure in 1897 have been published, and will be read with interest. The surplus in that year was £3,987. 1s. 8d., expenditure being £10,416. 13s. 4d., against receipts £14,403. 15s. A surplus of over £4,000 was estimated for 1898. In Rotterdam the estimate for that year is given as £5,567—interest and redemption of the capital outlay of £64,667 to be defrayed from that amount. The wages in Amsterdam, which appear to be lower than in Rotterdam, are, for skilled workmen 23s., labourers 20s.; working hours, 7 a.m. to 7 p.m. Girl operators are taken on at 5s. a week, rising to a maximum of 16s. 8d. a week, working seven hours a day, Sunday and night-work (every seventh week) included. Pension for old age or when injured during service, and compensation to relatives if killed, are fixed by the Rotterdam Municipal Council according to years of service and rate of wages.

We now turn from these solitary instances of municipal control to cases of mixed services—partly governmental, partly private enterprise—which are afforded by the much talked-of systems of Sweden and Norway. Beginning with private associations connecting small towns and villages merely for mutual convenience, telephony had a good start in the country districts before the dividend-paying concerns were developed in such places as Stockholm; and still more of the Government system, which did not come into operation until 1891. In that city the Bell Company started in 1880, the Allmänna Company three years later; and both companies, under a national concession, have exercised powers of wayleave greater, probably, than any obtained elsewhere. The competition of the Government, commenced in 1891, resulted in the two systems being connected and the double wire being adopted throughout Stockholm. With a population of 271,638, the Stockholm subscribers number 19,369, of which 12,899 belong to the Allmänna Company, 4,506 to the State service, and 1,964 to the Bell Company. It is not clear, however, whether these figures represent separate subscribers, or whether any of them subscribe to more than one system. The tariff of the State telephone department only is quoted; but it is presumed that the three competitors' charges are alike—viz., an entrance fee of £2. 15s. 6d., and a similar amount per annum for ordinary business purposes, but £4. 8s. 10d. per annum if with the right of an unlimited number of calls. Some reduction is made for limited service, and a private telephone may be had for £2 a year, with an entrance fee of 11s. 1d. The average length of wire within the Stockholm area is given as 1·3 kilo., and the approximate capital outlay per wire estimated at £2. 15s. 6d.; but there is certainly some misunderstanding here, the cost in other places being estimated immensely higher. The State appears to be earning no profit itself, but is threatening with reduced dividends its competitors, one of which (the Allmänna) used to pay 8 per cent. to its shareholders. Wages in Stockholm are 2s. 9d. to 4s. 1d. per 10 hours' day. No holidays except Sundays. For the workwomen employed in the exchanges the pay is 50s. a month. They get one Sunday out of three for a holiday; extra pay for night work. From this we gather that the service is continuous. It is incidentally mentioned that the average cost of a telegram in Sweden and Norway is $9\frac{1}{2}$d.—about 2d. higher than in this country; and this affords an explanation of Government interposition, the State telegraphs having suffered severely by the competition of the telephone companies. Similar reasons, no doubt, operated in the case of Austria-Hungary, where the State allowed the companies a free hand until 1893-5.

According to the account received of the Christiania Telephone Co., wages paid by them in that city are even lower than in Stockholm. Rates of subscription for single lines, not exceeding 1,500 metres, connected with the central station, £4. 8s. 10d. per year; for each additional 500 metres, 8s. 3d. Extra charges are made for calls in excess of 6,000 a year, and guarantees are required for at least three years' subscription if a new line is required 500 metres from the nearest central station. Christiania has a population of 200,000, of whom 6,475 are subscribers to the Company's system. Last year's dividend was $5\frac{1}{2}$ per cent.

From Bergen, a town of 65,000 to 70,000 inhabitants, there is a similar report of the Joint Stock Company's operations, with 1,800 subscribers, and earning apparently the same amount of dividend on capital outlay. But the vice-consul's English is not always perfect, and we quote with confidence only one of his statements: (18) "The service, exclusively ladies, can be said to be generally satisfactory." It should be noted lastly that for these, several private undertakings in Sweden and Norway, no royalties have to be paid to either the State or the municipality, the latter only claiming special rates for its own service.

There remain to be considered only the purely State telephone systems. Of these, the German and Bavarian have been in Government hands from the first; the Swiss also, except for a private venture at Zurich, which was speedily absorbed into the Federal system. In Austria-Hungary, as well as in Belgium, the acquisition of the telephones was postponed until 1893 or thereabouts, the local undertakings until then being in private hands, although the trunk wires as well as the telegraphs were in most instances owned by the State.

In Vienna and Trieste the companies' systems were taken over by the Government for a consideration, the amount of which is not stated; but for the connections in Prague "and everything appertaining thereto," the sum of 1,000,000fl. was paid by the Imperial Government. The Vienna system extends over an area of 69 square miles, 70 per cent. of the wires being double, the remaining 30 per cent. single. The population numbers 1,400,000. At the time of the transfer there were 7,700 subscribers, which in 1897 had increased to 10,573. Within a radius of $1\frac{1}{4}$ miles from the central exchanges the subscription is £8. 6s. 8d. per annum. At these central exchanges, the service is continuous throughout the day and night. The female attendants are paid from 50s. to 70s. a month; labourers 2s. to 3s. a day. Trieste, with 163,979 inhabitants, has 1,020 subscribers. Capital outlay per wire is estimated at about £17. 10s., the average length being

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Installations.	Subscription tariff for the respective groups and systems of—						
	Antwerp.	Brussels.	Charleroy.	Ghent.	Liège.	Louvain.	Verviers.
Connection by single wire*—	Fr. c.	Fr. c.	Fr. c.	Fr. c.	Fr. c.	Fr. c.	Fr. c.
Ordinary station within the radius of 3 kilom. in a straight line from the central office	250 00†	250 00†	225 00†	200 00†	225 00‡	125 00§	200 00†
For each additional kilometre beyond the radius of 3 kilom.	50 00	50 00	50 00	50 00	50 00	30 00	50 00
Additional ordinary station	50 00	50 00	50 00	50 00	50 00	50 00	50 00
Extra telephone receiver	5 00	5 00	5 00	5 00	5 00	5 00	5 00

* Connection by double wire increases by 50 per cent. the subscription tariff of the first ordinary station and line, but such increase may not exceed 100fr. for the first three kilometres.

† Reduction of 50fr. off the subscription tariff for each connection applied for after the first.

‡ Reduction of 50fr. for each connection not exceeding 1,500 metres in a straight line from the central office.

§ Reduction of 10 per cent. off the subscription tariff for each connection applied for after the first.

Half-yearly Subscriptions.—Half-yearly subscribers pay three-fifths of the above-mentioned tariffs, except in the Charleroy group, where the subscription is 120fr. within the radius of three kilometres. The subscriber is bound for three half-yearly terms during three consecutive years.

1,255 metres. The general circumstances are the same as in Vienna. Prague has a population of 320,805, the subscribers to telephone exchanges numbering 2,200. The initial tax is 50fl. for the first 500 metres, and an annual subscription of 50fl. Wages are about the same as in Vienna. In the Prague report mention is made of "telegrams destined for subscribers on the Exchange are telephoned to them"; also that subscribers may telephone their telegrams to the post office for transmission by telegraph.

In Belgium the concessions to private companies expired in 1893, when the telephone systems came under Government control. Such, at least, was the case at Ghent, for which alone particulars on this point are given in the report. Ghent, with its surrounding districts, has a population of 200,000. The subscribers number 900, but whether this is in Ghent proper is not quite clear. Some tabulated particulars as to tariffs in various Belgium towns are given as above:—

In Switzerland the telephone system has been worked by the Federal Government since 1881, and is considered very popular:—Berne, with a population of 53,000, has 2,025 subscribers; Zurich has 157,000 inhabitants, with 4,400 subscribers; Geneva has 3,264 subscribers out of a population numbering 58,700. The underground cables are of double wire throughout; the overhead, as a rule, single wire. The tariff rates are the same all over Switzerland, namely, £4 and £2. 16s. for the first two years respectively, and £1. 12s. for succeeding years, a charge of one halfpenny being made for each communication, "thus proportioning the expense to the use made of the telephone." Workmen's wages range from 3s. to 3s. 5d. a day of 10 hours. Those of the women operators from £48 to £72 a year, their working day being seven to eight hours in winter and eight to nine hours in summer. Once in 15 days they take night duty, the service being continuous. The following table gives some particulars of progress between 1892 and 1896 extracted from the Swiss Government Trade returns:—

	1892.	1893.	1894.	1895.	1896.
Total length of lines, in miles	3,615	4,208	4,874	5,537	6,524
Total length of wires, in miles	16,569	20,672	25,571	32,980	45,969
Number of nets	124	155	189	225	252
„ stations	14,369	16,929	19,814	23,446	28,198
„ subscribers	12,434	14,675	17,192	20,535	25,090
Number of local conversations	7,123,744	8,382,765	9,981,031	12,402,040	13,436,198
Number of interurban conversations	836,268	1,227,454	1,684,922	2,212,707	2,729,570

From Bavaria reports have been received relating to Munich, Stuttgart and Würtemberg; also from Frankfort, Cologne, Hamburg, Leipsic and Berlin, all of which are, of course, under the Imperial German Telegraph Administration; the conditions, therefore, are pretty uniform, resembling those in the City of Berlin, and need not be particularised. It is worth noting, however, that mention is made in the Munich report that the female operators are required to be of good education, and able to "transcribe and translate without serious mistakes at French or English dictation." Probably this rule applies to all Germany and to other countries—Switzerland, for example—as well. Down to February, 1898, the tariff had undergone no change, and the rumour alluded to by Mr. Provand that the Berlin telephone system yielded 14 per cent. profit was described as premature.

The area of Berlin and suburbs, including Potsdam, has a population of 2,314,451, of which 28,785 are subscribers to the telephone service. It has nine principal exchanges, each arranged for 5,000 to 6,000 subscribers, and 35 public stations, besides 95 at stock exchanges. By means of its trunk wires the capital is in communication with about 350 large towns, both within and without the boundaries of the empire. The system is described as single wire throughout, each connection averaging 1·9 kilometres. The chief features of the tariff are:

(*a*) For each telephone instrument erected within the district of the city telephone system, and not more than 5 kilometres (as the crow flies) from the Central Exchange, an annual rent of £7. 10s. (150 marks).

(*b*) For each telephone beyond the above limit, the distance within which connection is possible being decided by the Imperial Post Office, for every 100 metres of additional wire, or part of that length, beyond the 5 kilometre limit, an additional annual payment of 3 marks.

For messages accepted to be transmitted by telegraph a general charge of 10 pfennigs is made, and 1 pfennig for each word. For three minutes' conversation on the trunk wires, the following examples may be given:—With Prague, 2s.; with Amsterdam, Copenhagen, Rotterdam and Vienna, 3s.; Budapesth, 4s. Exchanges are open from 7 a.m. to 10 p.m. Night service between two subscribers can be arranged for by an extra charge of 8s. quarterly. Capital charge for each wire is estimated at £22. Female telephone clerks are employed at the telephone bureaux, and have the position of officials. They receive a daily wage of 2s. 3d. to 8s., according to length of service; and they perform Sunday duty in turn. The girls have to be of good education, and able to pass an examination. Workmen employed on the telephone lines receive 3s. to 4s. 6d. a day. The Berlin Report concludes with the following remark, which is applicable to the whole of the German Imperial telephone service:—

No statistics can be given relative to the financial position, as in consequence of the union of the postal, telegraph and telephone systems under one Administration, the revenue and expenditure are reckoned under one head, and separate data do not exist. The introduction of a different system of charges is in contemplation, but it is not known if the tariff will be lowered in consequence.

Frankfort-on-Main, with a population of 229,279, has 3,909 subscribers; Leipsic (398,448) has 4,294 subscribers; Cologne (321,564) has 3,784 subscribers; Hamburg city proper has 625,552 inhabitants, of whom 12,064 subscribe to the local telephone system. The service is installed for one year certain, with three months' notice after the end of the first year.

A Telephonic News-agency and Music Hall.—In Vienna a firm calling itself the "Telephone Herald" has acquired a concession for a telephonic news-agency and electrophone business in that city, similar to the one already existing in Budapest. News will be communicated to subscribers by telephone at certain hours of the day, and at other hours recitals—musical and otherwise—will be provided. The concession is granted for 25 years, the undertaking paying the Municipality £100 yearly, and an additional 1s. per subscriber yearly for the maintenance of the lines, and a tax of 5 per cent. levied on the net receipts. At the end of the 25 years the wires and apparatus are to become the property of the municipality, but the latter guarantees the undertaking against competition during the first five years.

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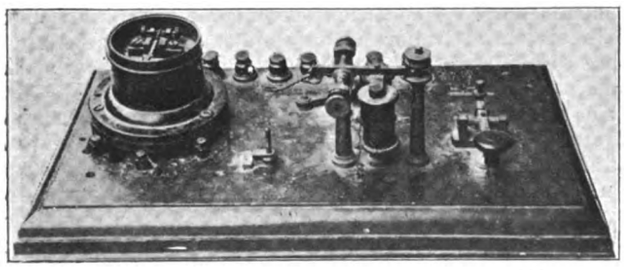
A TELEGRAPHIC RELIC FOUND AT OMDURMAN.

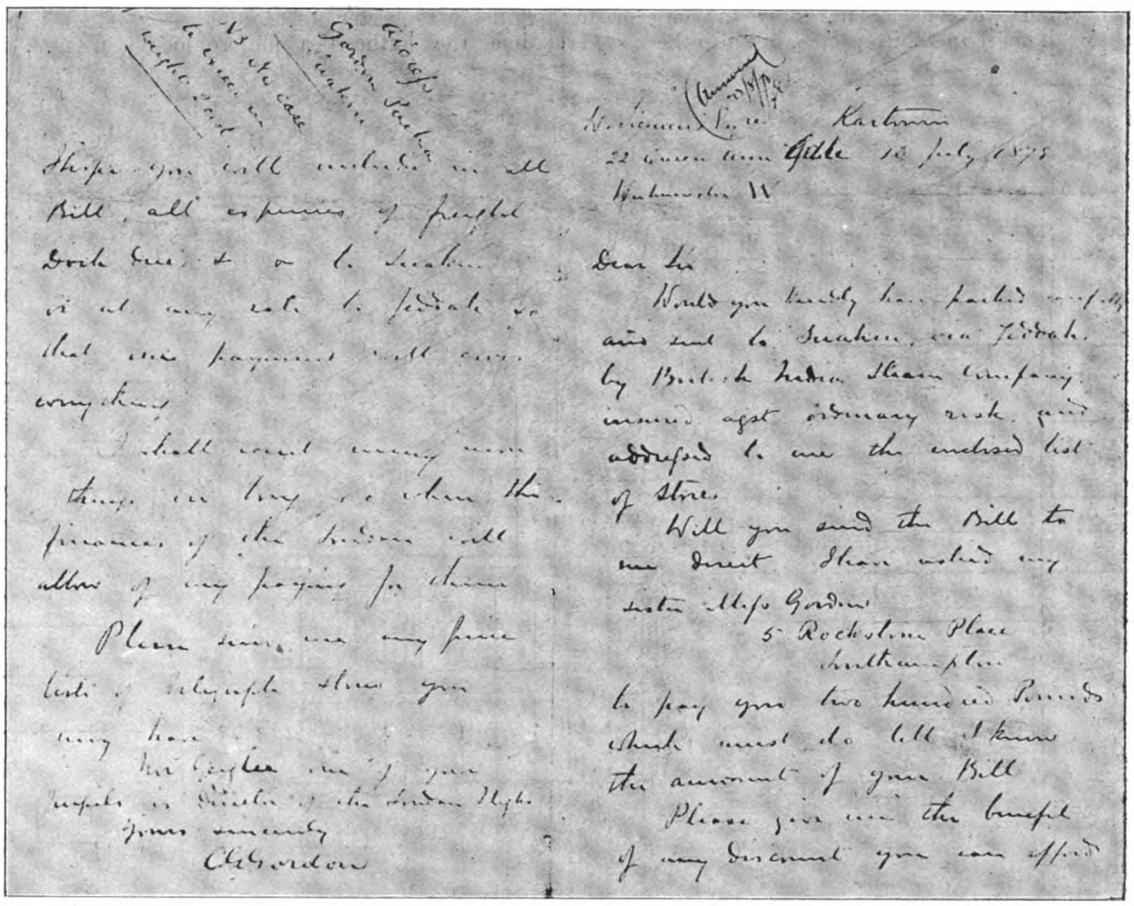
We reproduce below a photograph of an interesting telegraphic relic discovered at Omdurman after the defeat of the Dervishes outside that Soudanese city on September 3, 1898. It appears that after the battle one of the sergeants in the Royal Engineers, working under the Director of Army Telegraphs, of the Egyptian Army, entering the city from the south at the Khar Shambat, noticed an aërial telegraph wire, and, struck by so strange a sight in such a place, followed it



TELEGRAPH SET FOUND AT OMDURMAN, Sept. 3, 1898.

up, and presently found himself at a hut wherein was the instrument shown in the illustration. The instrument was in the charge of an old Egyptian telegraph clerk, who had been held as a prisoner by the Khalifa for the purpose. Since the fall of Khartoum and the building of Omdurman, the Khalifa, it appears, had maintained telegraphic communication between the two cities. From Khar Shambat to the Arsenal, at Omdurman, the line was carried overhead, while from the Arsenal to the dockyard, at Khartoum, a cable had been laid.

In consequence of the relay mounted on the telegraph board bearing the name of Messrs. Siemens Bros. and Co. (Limited) the attention of that firm was called to the relic, and thereby some extremely interesting facts were brought out. Further enquiry showed that this relay was none other than one of 12 ordered of that firm in 1878 by General Gordon. A reduced facsimile of the autograph letter of instruction from General Gordon, dated from Khartoum, accompanies this article, and for this, as well as for our other illustration, we are indebted to the firm in question, in whose possession this valuable letter still remains. The telegraph set was sent home in the condition in which it was found, and is now the property of the officers of the Telegraph Battalion stationed at Aldershot. We understand that it is probable that, by kind permission of these officers, this interesting Soudan trophy will be included in Messrs. Siemens Bros. and Co's. exhibit at the Article Club Exhibition, at the Crystal Palace next summer.



REDUCED FACSIMILE OF LETTER FROM GENERAL GORDON TO W. SIEMENS, ESQ.

W. SIEMENS, ESQ.
22, Queen Ann Gate,
Westminster, W.

(Address, Gordon Pacha, Suakin.)
(N.B.—No case to exceed in weight 2 cwt.)

Kartoum,
13 July 1878.

DEAR SIR,

Would you kindly have packed carefully and sent to Suakin, *vid* Jeddah, by British India Steam Company, insured agst. ordinary risk, and addressed to me the enclosed list of stores.

Will you send the Bill to me direct. I have asked my sister, Miss Gordon, 5, Rochester Place, Southampton, to pay you two hundred Pounds which must do till I know the amount of your Bill.

Please give me the benefit of any discount you can afford. I hope you will include in all Bills all expenses of freight, dock dues &c., on to Suakin, or at any rate to Jeddah, so that one payment will cover everything.

I shall want many more things ere long *i.e.* when the finances of the Soudan will allow of my paying for them.

Please send me any price lists of telegraph stores you may have.

Mr. Geizler, one of your pupils, is Director of the Soudan telegraphs.

Yours sincerely,
C. G. GORDON.

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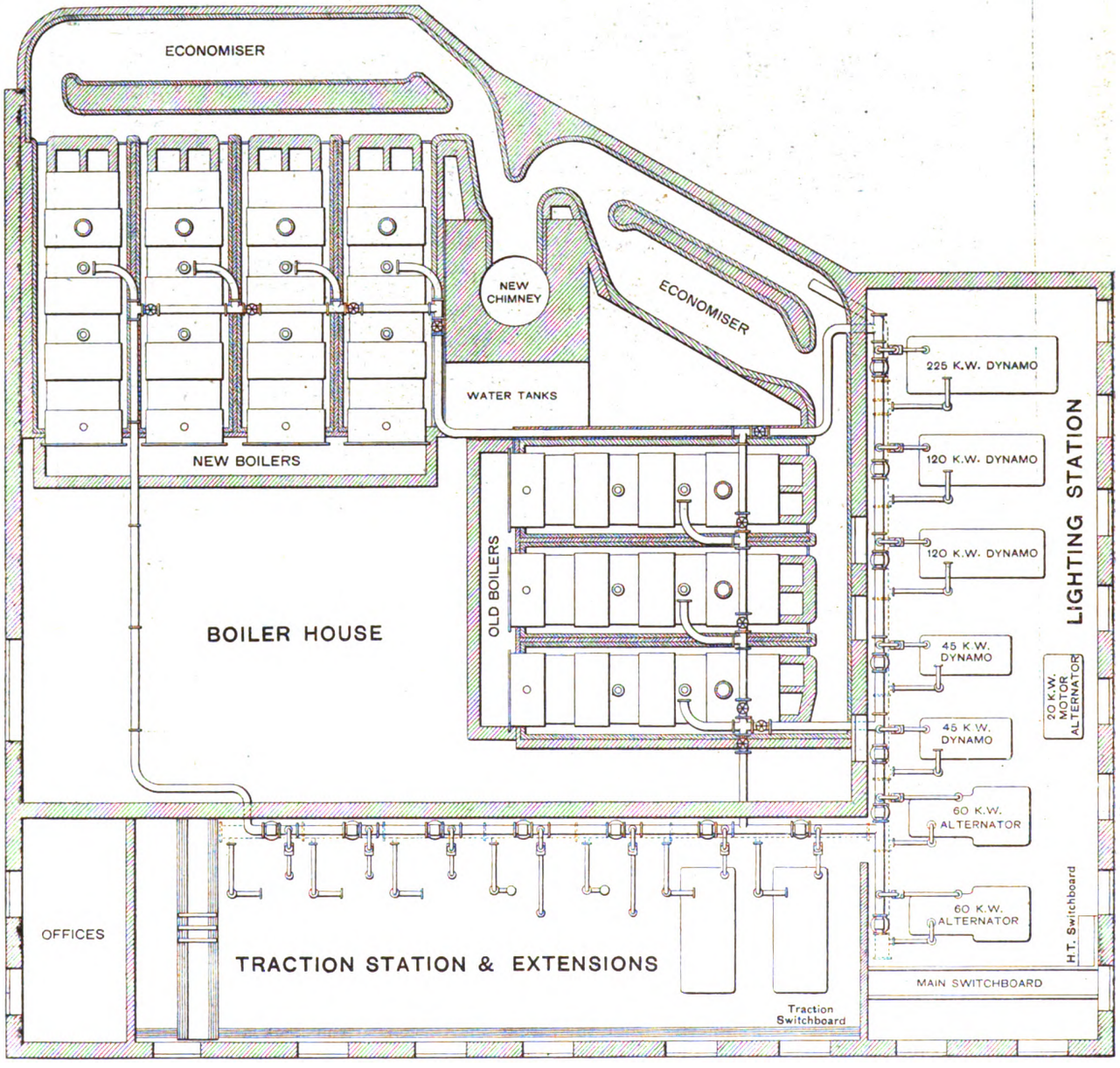
BLACKBURN CORPORATION ELECTRIC TRAMWAYS.

Although the Blackpool electric tramway, which was one of the pioneer electrically equipped lines in this country, has been working with a fair amount of success since the date of its inauguration in 1885, there was until last year, with the exception of the Liverpool Overhead Railway, no other electric line in operation in Lancashire. This is the more remarkable when we consider not only the enterprising characteristics of the Lancashire people, but also the vast net-work of tramways which ramify in all directions outside the larger towns; so far, in fact, have the tramway lines been laid from each town that they often do not end until they reach the terminus of the lines of some other company, whose headquarters are in another centre of population, so that, notwithstanding the fact that Blackburn is some 25 miles distant from Manchester, it is possible to make the entire journey *via* Accrington, the Rossendale Valley, and Bury, by means of tramcars, this particular route covering some 30 miles, whilst across and beyond Manchester the insatiable car traveller could journey for many more miles.

Recently, however, the Lancashire towns have transferred much of their allegiance from steam power and horseflesh to electricity, and last year witnessed the opening of about seven miles of electrically equipped tram lines in Liverpool, and also that of the Blackpool and Fleetwood tram line eight miles long, while the present year sees the opening of four miles of the Blackburn electric tramways, viz., the Preston New-road and Witton sections, and this will in all probability soon be supplemented by the addition of the other sections. And whilst Manchester appears perfectly satisfied to wait what time the authorities philosophically discuss, in polished academic phrases, the various advantages and disadvantages of the overhead trolley, conduit and surface-contact systems, other towns such as Bolton and St. Helens are making rapid progress with their undertakings.



PLAN OF THE BLACKBURN CORPORATION'S COMBINED TRAMWAY AND ELECTRIC SUPPLY STATION.

For some time past the claims of electric traction had been advanced in Blackburn, but it was not until 1896 that any definite steps were taken; at this date the Tramway Corporation (Limited) were not only requiring new cars, but also a large part of the track required relaying, whilst, in addition, there were many complaints from the residential district served by the Preston New-road section that the tram terminus was some 250 yards distant from the railway station, which caused considerable inconvenience, especially in wet weather. Another alteration needed was a separate route for

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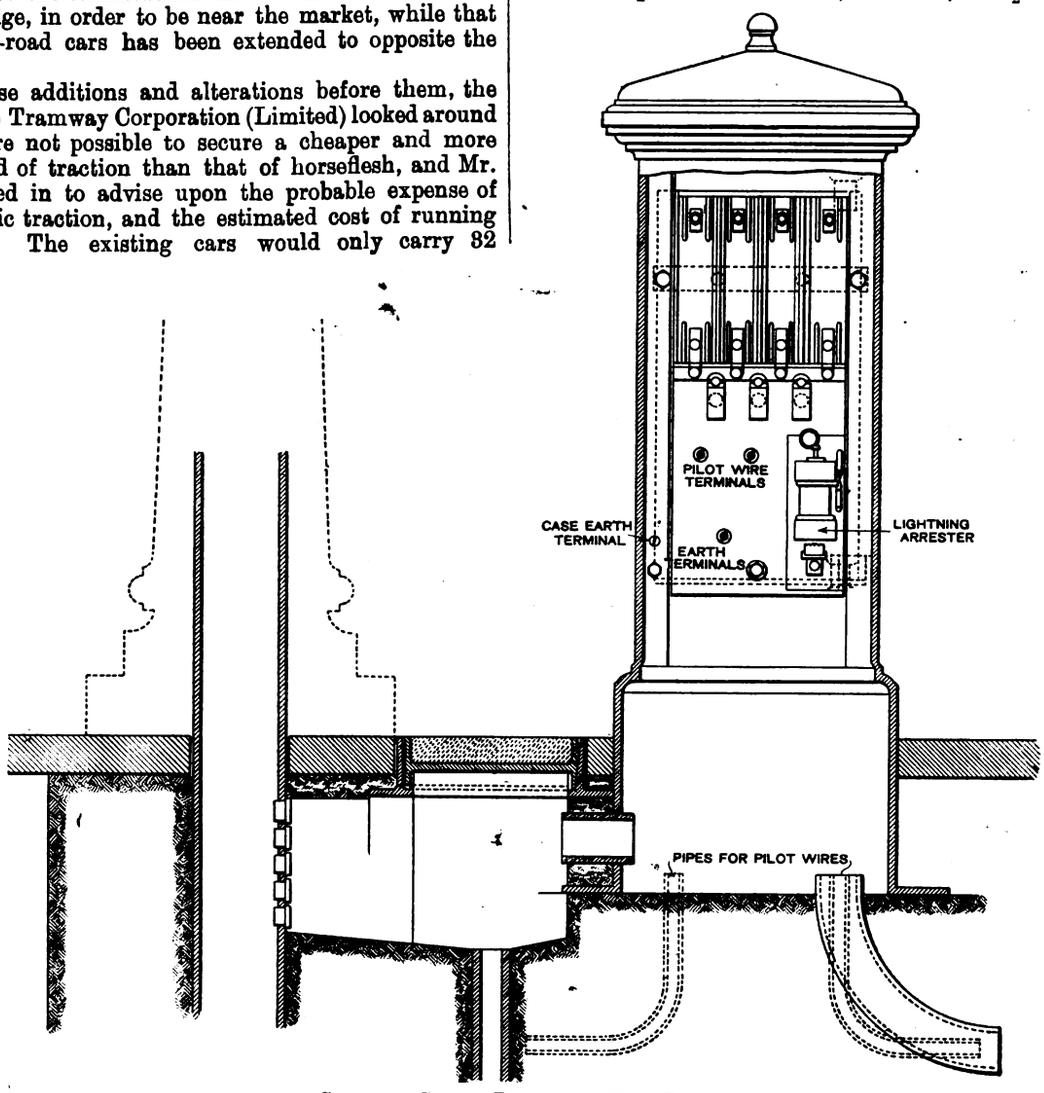
the cars on this section on the down journey along Richmond-terrace and past the theatre, in place of both the up and down lines being carried across the open market-place—a source of serious danger when the market was densely packed. It was readily admitted by the tramway authorities that the distance from the station was an inconvenience, and the easiest way to remedy this was to combine the Preston New-road and Witton sections, and to make the cars run through, stopping opposite the station as the town terminus of each section, in place of at Salford Bridge, as heretofore. It may be mentioned here that, although this was at first the scheme proposed, it has since been found advisable to keep the two sections separate, as a ten-minutes service, will be requisite on the Preston-road section, and a quarter of an hour service on the Witton section. Hence the terminus for the Witton cars is retained at Salford Bridge, in order to be near the market, while that of the Preston-road cars has been extended to opposite the station.

With all these additions and alterations before them, the directors of the Tramway Corporation (Limited) looked around to see if it were not possible to secure a cheaper and more efficient method of traction than that of horseflesh, and Mr. Lacey was called in to advise upon the probable expense of adopting electric traction, and the estimated cost of running per car mile. The existing cars would only carry 32 passengers, and it was deemed advisable to increase the carrying capacity to 48, and upon this basis Mr. Lacey drew up his report. After considerable discussions as to ways and means, the Tramway Corporation (Limited) approached the Corporation with the view of obtaining the power from their lighting station, and a suggestion was made, that, as eventually it was most probable that the Corporation would buy out the tramway company, it might be advisable for the Corporation to erect the overhead line and underground feeders. Mr. Lacey, reporting that the cost of renewals and repairs to the motors, as gathered from data obtained in actual practice on other lines would be 0·20d. per car mile for 180,000 miles per annum.

On Sept. 3, 1896, the directors of the tramway company were able to issue a report to their shareholders containing the outlines of a provisional agreement with the Corporation, and about the same time they called an extraordinary general meeting, to obtain powers to proceed further in the matter. The report stated that (1) the Corporation were willing to erect and maintain the generating plant and underground feeders, and to erect the overhead line, and bond the present rails with copper; (2) the Company were to maintain the overhead line erected by the Corporation, or that the Corporation would do this for £100 per annum; (3) that, according to Mr. Lacey's estimate, the cost of motor repairs and renewals would not exceed £200 per annum; (4) that at the price quoted for seven cars, if the amount were taken at 4 per cent. per annum, with a sinking fund repaying principal and interest over twenty years, the cost would not be one penny per car mile; (5) the Corporation would supply power at the rate of 8d. per car mile for 93,892 miles, or 2½d. per car mile if the car mileage be increased to 160,000 miles per annum; (6) that the alterations and additions to the route would be required in any case, and, therefore, need not enter in the discussion. Finally, the report showed a difference in favour of electric traction of 1·30d. per car mile.



Sectional Switch Pillar and Fuse Box.

The directors had fully made up their minds as to the benefit of electric traction, and added various reasons in favour of this method, and the meeting gave them power to proceed further. Negotiations were renewed with the Corporation, and it was decided to increase the number of cars to eight, with a carrying capacity of 60 each; and, finally, a definite agreement was arrived at, and a contract signed between the Corporation and the Company.

Messrs. Lacey, Clirehugh and Sillar were instructed by the Corporation to prepare specifications for the generating plant and the equipment of the two sections, while the same gentle-

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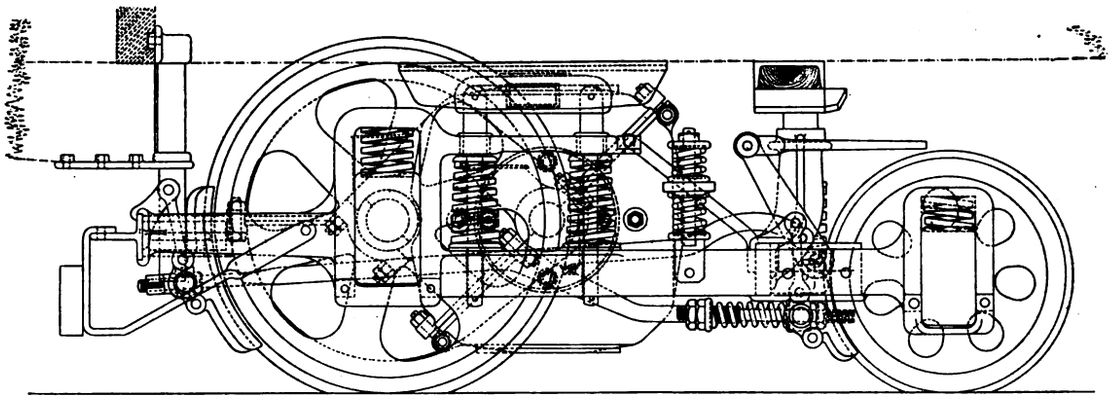
men were advisers to the Company for the tramways; the contract for which was placed with Messrs. Siemens Bros. and Co. (Limited) on March 3, 1898.

While these negotiations were being held, and after they were concluded, an agitation arose for the Corporation to purchase the tramway undertaking. A conference was held between the directors and the Corporation, and in the spring of 1898 the terms of purchase were settled; the authority of the Local Government Board to expend the money was obtained in due course, and the agreement was signed on August 24, 1898, by which the Corporation became the owners of the tramway undertaking.

and Robinson engines. The traction sets consist of two direct-coupled steam dynamos, each of 120 kilowatt capacity; the engines are of Messrs. G. E. Belliss and Co.'s 2-crank, compound type, arranged to work with a boiler pressure of 125lbs. of steam, and to give 200 B.H.P. when run at 375 revolutions per minute; the conditions laid down in the specification for governing when the load is suddenly thrown off, and also for steam consumption per kilowatt hour are very stringent, and from the tests so far made the makers appear to have amply fulfilled the requirements expressed in their contract. The engines are of the manufacturers' latest design, fitted with their new open type cylinder valves, and with an

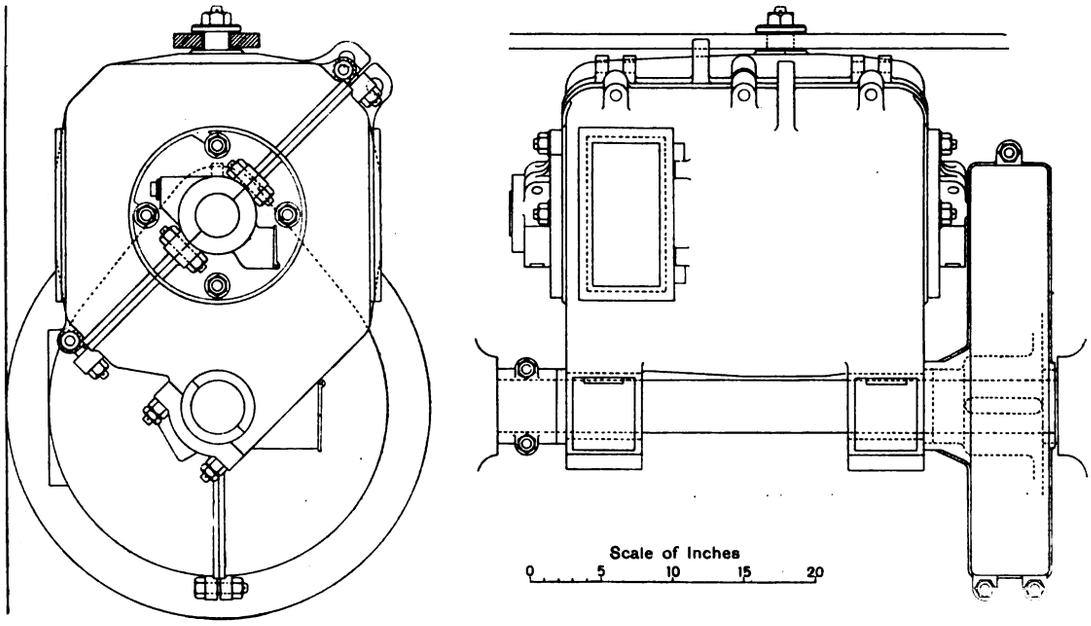


Scale: ¾in. = 1ft.

BRILL MAXIMUM TRACTION TRUCK WITH SIEMENS MOTORS.

The generating station was made as an addition to the existing lighting station, which was most admirably situated for the purpose, being almost in the centre of all the sections—the generating house being built on the site of the old offices and cell room, at right angles to the lighting engine house—while a large part of the yard was roofed in to make an addition to the boiler house, extra room being required for the new boilers, as well as the condensers, economisers, &c., which it was now decided to put down.

oil strainer on each side of the bedplate. Another novelty introduced is the use of an aluminium alloy for the link motion of the throttle valve. The speed varies only 1·9% between 0 and full load. The dynamos were made by Messrs. Siemens Bros. and Co. (Limited), and are of the latest two-pole design, with parallel windings on the armature, and having a commutator at either end. Each of these windings will give 250 volts 240 amperes, and are so connected up that they may be run in series for traction work, or in parallel if



SIEMENS TRAMWAY MOTOR AS USED AT BLACKBURN.

The original lighting station consists of one Mather and Platt direct-current dynamo, with an output of 225 kilowatts, viz., 250 volts and 1,000 amperes, driven by a Belliss engine, four direct-current dynamos of Siemens' make, two with each an output of 200 to 240 volts and 500 amperes, and two with 120 to 150 volts and 800 amperes, all driven by Willans and Robinson's engines, and two Siemens' alternators each 2,000 volts and 80 amperes, which are also direct-coupled to Willans

required to assist the lighting plant. Switch frames for this purpose are fixed at the side of the machines. The machines are compound wound, and fitted with extra long commutators and carbon brushes.

The switchboard, which was made by Messrs. Nalder Bros. and Thompson, is distinct from the lighting board, and is fitted with various recording instruments (as required by the Board of Trade), bus bars, and fuses and switches. The other

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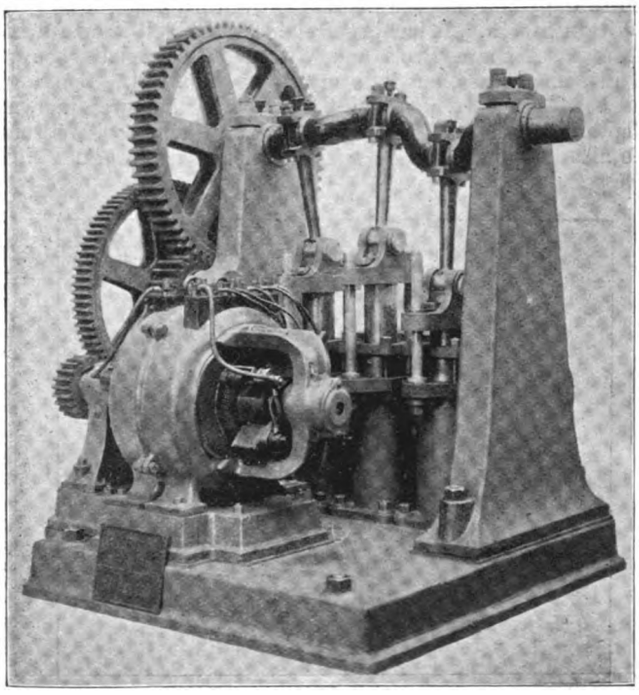
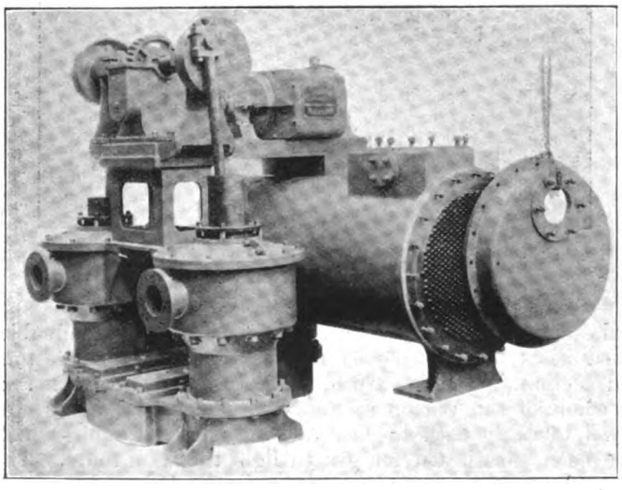
instruments are of the Weston type, and consist of two voltmeters (one on the bus bars, and one on the machines supplied with a two-way switch), and six ammeters (one on each of the two machines, and one on each of the four pairs of feeders). In addition there is a leakage ammeter with two scales, the lower one reading to 0·05 amperes, and the higher one to 0·5 amperes. On this board there are also fixed the regulating switches and shunt rheostats for the generators.



ELECTRICALLY-DRIVEN BOILER FEED PUMPS.

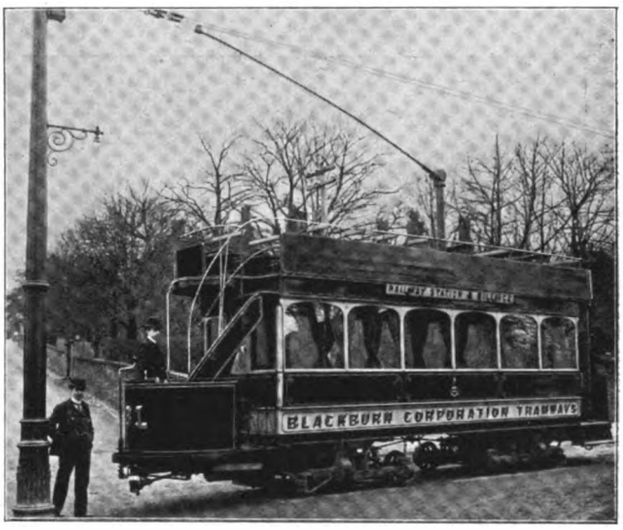
Up to the present time the whole of the engines in the lighting station have been run non-condensing, the exhaust steam from each engine passing into a common main exhaust pipe, and from thence into the chimney. While these additions were being made it was considered advisable to put down a condenser, and also the necessary sets of economisers. The first difficulty that arose was how to get a sufficient reservoir for cooling the condenser water; it was proposed to



ELECTRICALLY-DRIVEN CONDENSER SET.

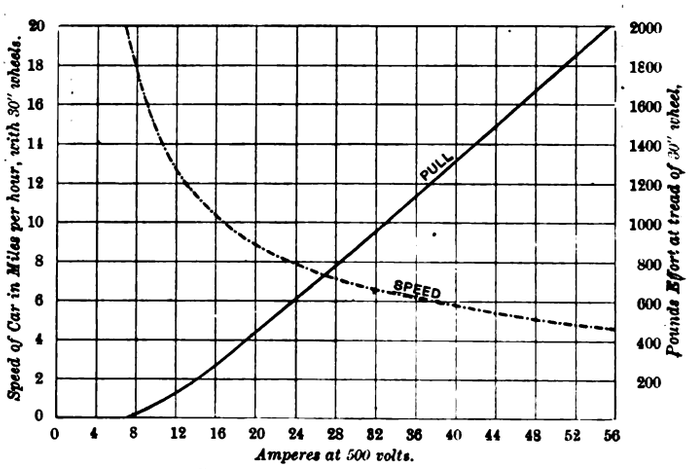
dam the river Blakewater, which flows along one side of the station, and use this for the purpose; but as this stream is not nearly so clear and limpid as it was some 50 years ago, the Health Committee vetoed the proposal, and Mr. Giles, the borough electrical engineer, then proposed several alternative schemes, the one selected being that of arching over the river for a length of some 180ft., and forming a lodge above the river. By an arrangement of sluices this lodge can be supplied from the river, or, if necessary, it can be refilled with water from the town's supply. Mr. Stubbs, the chief borough engineer, successfully carried out the work of forming the concrete floor, the retaining walls on either side and the top and bottom weirs, with their sluices, and the large pipe for the river flow.

The condenser is of the well-known surface type, in which the steam is led by pipes to the outside of a mass of tubes through which cool water is being forced; a centrifugal pump driven by an electric motor is employed for forcing the water through the condenser, the motor being direct-coupled to the pump, and arranged to run at any speed from 850 to 1,000 revolutions per minute. The air pumps, which are two in



MOTOR-CAR FOR BLACKBURN TRAMWAYS.

number, are each 18in. diameter with a 12in. stroke, and are situated at the side of the condenser, and, as will be seen from the photograph, the motor, which is of the four-pole, ironclad type, is carried upon a specially arranged bedplate above the condenser. The air pumps are designed to run at from 30 to 50 revolutions per minute, and the motor from 1,200 to 1,600, the speed being reduced by a worm and wheel gear revolving constantly in a bath of oil; while the thrust of the worm is taken by ball bearings. The condensed steam from the air



TEST CURVES OF SIEMENS TRAMWAY MOTOR.

pumps is taken to a hot well tank, which is situated at the other side of the boiler house. To this hot well are coupled the suction pipes of the boiler feed pumps; while a galvanised iron vapour pipe is carried from the tank up through the boiler house roof, and the condenser water is carried to and cooled in the reservoir before described.

Particular care has been taken throughout, so that in case of any breakdown to any part of the plant, no serious incon-

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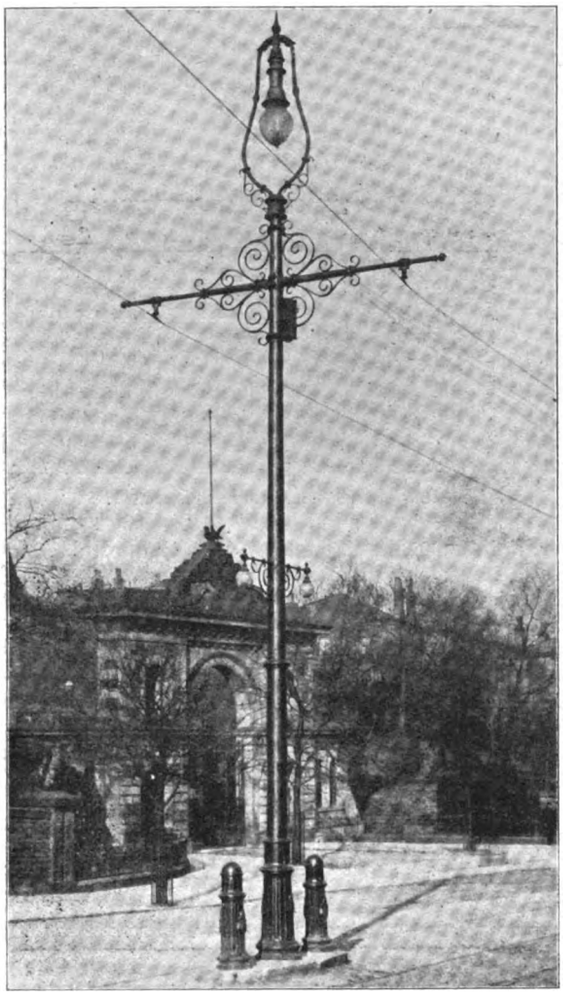
venience will be felt, hence the exhaust pipes, which are 16in. in diameter, are so arranged that the engines can be run either condensing or non-condensing; automatic valves being inserted in such a position that, should the condensers be shut off for any reason, the exhaust steam would pass through them and find egress up the chimney. For the boiler feed system, there is, in addition to the hot well, a cast-iron tank, placed on the top of the building, which is connected to the town's water mains by means of ball valves; there is also a ball valve connection between this tank and the hot well tank. For the boiler feed there are three pumps, two Worthington steam pumps, which are part of the original lighting plant, and a new three-throw ram pump, driven by an electric motor, with double wound armature and two commutators, so that the two windings can be run either in series or parallel.

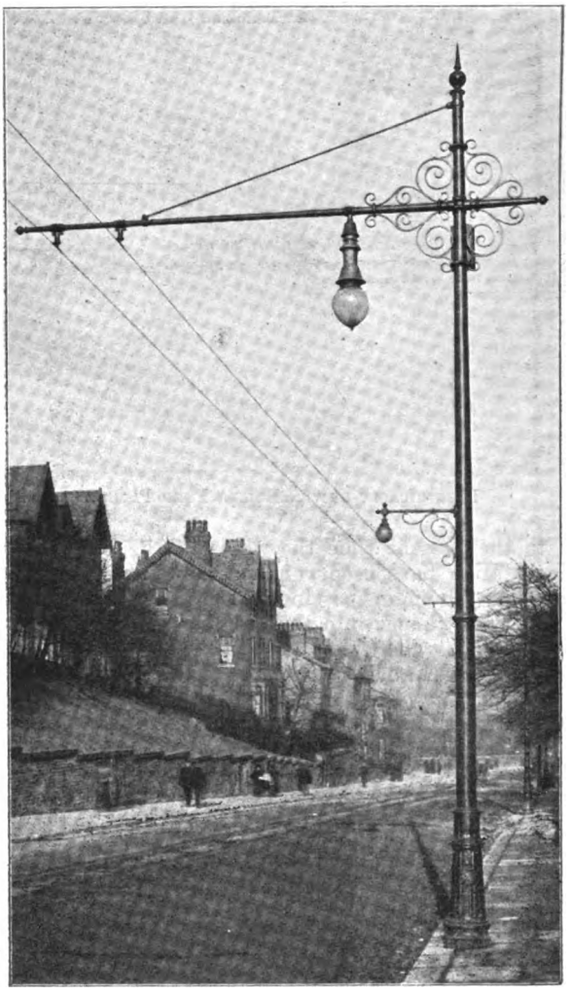


CENTRE-POLE DOUBLE-BRACKET CONSTRUCTION FOR BLACKBURN TRAMWAYS.

There are two banks of boilers, the old bank consisting of three boilers each, 7ft. 6in. in diameter and 28ft. long, and the new bank consisting of two 8ft. 6in. boilers, 30ft. long. These are supplied with Proctor's mechanical stokers, driven by an electric motor, the speed being reduced by means of a Ross's patent reducing gear. The feed pumps are so arranged that either one or all of them may be working at the same time, and by a suitable system of valves the suction water may be taken at will, from the hot well, the tank on the roof or the reservoir; the feed ranges are in duplicate, and arranged so that any pump may be instantly put in connection with either range filter fitted with a McDougall oil bye pass inserted between the pump and main boiler feed range.

Two sets of economisers have been put down, one with 320 tubes for the new bank of boilers, and one with 192 tubes for the old, the scrapers being worked by motors of the enclosed ironclad type. The motors for the air pump and centrifugal pump are of the slotted drum type, with four poles and a series wave winding so that only two lines of brushes are required. The end covers at the commutator end are made to rotate at will, and carry the brushes, which are of carbon, with them; glass windows are also fitted directly over the brushes, so that they may be inspected while running and without removing the cover.

The length of the track is some four miles, and reaches from Billings-lane, beyond Redlam Brow, the former terminus, to Witton Stocks. It has been relaid by the well-known firm of Messrs. Askham Bros. and Wilson with specially heavy rail in some places, but it is mostly of 88lb. rail. Bonding has been carried out effectively with the well-known "Neptune" rail-bond. Messrs. Askham Bros. and Wilson have also supplied the points and special track work. The



SIDE-POLE SINGLE-BRACKET CONSTRUCTION FOR BLACKBURN TRAMWAYS.

overhead trolley is the system which has been adopted, double-armed posts being employed for about half of the Preston-road section, and single-armed for the remainder of this and the whole of the Witton section, the same posts being employed to carry both the arc and incandescent lamps which have been substituted for gas to light the tram route. The Preston-road section is more or less of a climb from beginning to end, the steepest gradient being 1 in 13 for a distance of some 250 yards, while the Witton section is almost level until Redlam Brow is reached, when the ascent is again 1 in 13.

The overhead wire has a cross sectional area of 0·315 square inches, and is carried by cast-iron poles of neat design, with single or double arms, as the case may be. Messrs. Lacey, Clirehugh and Sillar have given very special attention to the design of the poles and arrangements for the overhead line, and we venture to think that an inspection of this part of the

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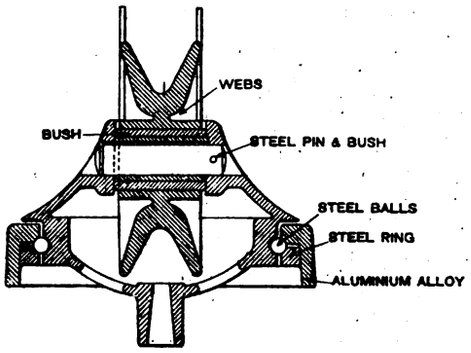
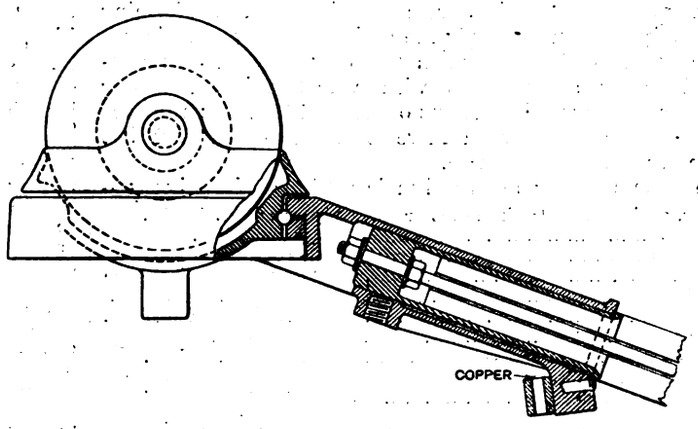
work will go far to remove any objections on æsthetic grounds which can be urged to the overhead trolley system.

Where possible, centre posts are used with double bracket arms. The posts are of four grades in strength, in order to meet the varying lateral stresses occasioned by curves, &c. The two lighter types of poles, used for carrying brackets, consist of two lap-welded taper steel tubes shrunk together, with a cast-iron ornamental moulding placed over the joint. The two heavier types, used for pull-off and anchor posts are made up of three parts shrunk together in the same manner. All the poles have cast-iron ornamental bases, and ornamental brackets, their decoration consisting of wrought-iron scrolls, fixed in the four angles between the body of the pole and the bracket arm. The bracket arms vary in length from 5ft. in the centre pole construction to 16ft. in the case of the side pole construction.





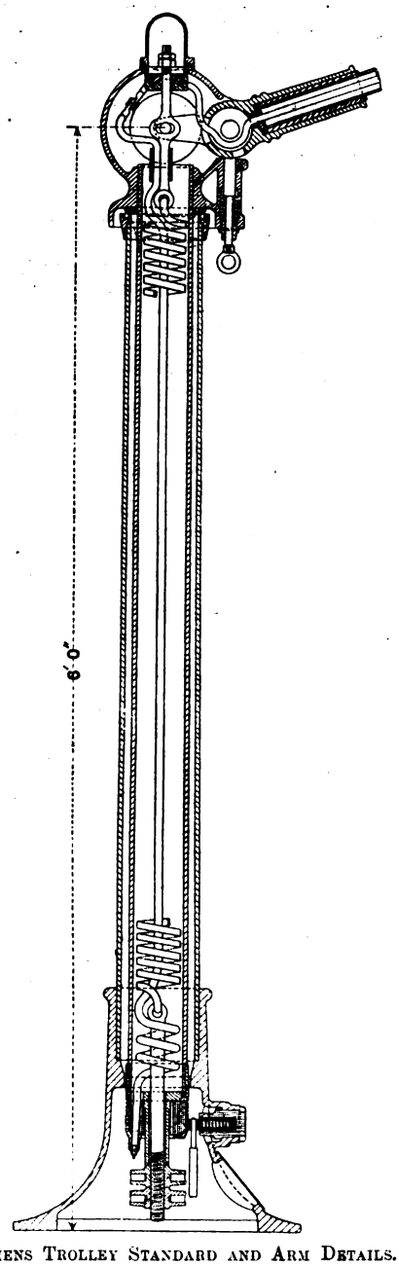
Wherever telephone or telegraph wires cross the track, guard wires of No. 8 gauge galvanised iron wire have been erected over the wire conveying the current for the cars. The two sections are each fed by means of two pairs of feeders, but while on the Witton section there are only three section boxes required, four have been put down on the Preston New-road section, the additional one being required for the down route along Richmond-terrace, which is distinct from the up route across the market and along King William-street, the two routes joining again at Salford Bridge.

The following cables and feeders have been laid :—

Length.	Section.	Distribution.
3,330 yards.	·15 sq. in.	G.S. to Billings.
136 „	·2 „	„ Jubilee-street.
1,240 „	·2 „	„ Witton.
550 „	·2 „	„ „
365 „	No. 310 R.	„ Trolley Wire.
120 „	·3 sq. in.	„ Rail Return.
5,640 „	9/19	(Pilot Wire.)

About every half-mile along the track cast iron boxes are erected on the side of the pavement. The feeders from the station lead into these, and are connected to a bus-bar mounted on a slate base on porcelain insulators. From this bus-bar four high-tension switch fuses connect with the section insulators on the trolley lines by cables leading up the inside of the posts. A lightning arrester is connected between the bus-bars and earth. Terminals from the pilot wire are also brought up on to this slate base for portable telephonic connection and testing purposes.

The cars, which are eight in number, have each a carrying capacity of 60—28 inside and 32 outside. They are of the bogey type, and are propelled by two 25 H.P. motors, which have a large margin of safety, so as to be capable of sustaining for prolonged periods a considerable overload. The motors are of the four-pole enclosed type, with a series-winding of the armature, and, consequently, only two lines of brushes; the machines are shunt wound, a starting switch and regulating resistance being placed on the platform at either end of the car. The motors are placed directly under the car, and are connected to the driving axles by means of machine-cut steel spur wheels, this gearing being protected against mud and dust by being enclosed in iron casing; the brushes are of carbon, and are fitted in holders of Messrs. Siemens' latest design. The cars are each lighted externally and internally by means of ten 16 c.p. lamps, working at 100 volts pressure.



SIEMENS TROLLEY STANDARD AND ARM DETAILS.

These are run on two parallel circuits, each consisting of five lamps in series, and are arranged so that alternate lamps only are on the same circuit.

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As will be seen from our photographs, the same posts are made to carry both the arc and incandescent lamps. The former are of the enclosed long burning type and were made by the Davey Electric Construction Co.; they are supplied with an alternating current of 100 volts, and are fitted with a choking coil; the current is obtained from the sub-station transforming chambers put down to supply the various shops and residents in the districts through which the cars run. The incandescent lamps are supplied with a 230 volt alternating current, and are run in sections of about 12 lamps; they are each of 32 c.p. lamps when there is only one to a post, but of 16 c.p. when there are two.

The principal contractors and makers of plant have been:—

Cars, equipment of track and motors ...	Siemens Bros. and Co.
Boilers	Yates and Thom.
Engines	Belliss and Co.
Switchboard	Nalder Bros. and Thompson
Rails, points, &c.	Askham Bros. and Wilson.
Trucks	Laing, Wharton and Down.
Car bodies	Milnes and Co.
Engine house, plant and switchboard ...	Siemens Bros. and Co.
Condensers, pumps, economisers, enclosed motors and pipes	Ashton, Frost and Co.

As mentioned, Messrs. Lacey, Clirehugh and Sillar have acted throughout as the consulting engineers.

WIRELESS TELEGRAPHY.

The following is a report of the proceedings on the occasion of the second reading of Mr. Marconi's Paper on "Wireless Telegraphy," before the Institution of Electrical Engineers, on the 16th inst.:—

Mr. J. W. SWAN (the President) said that they had with them that evening, in the person of Sir Henry Mance, another inventor of wireless telegraphy. He was the inventor of what was known as the "heliograph," which was a method of wireless telegraphy which depended upon the same general principle as Mr. Marconi's, viz., the agitation of the luminiferous ether as a means of sending signals. He had been informed that under favourable conditions (these conditions being that the apparatus must be very highly elevated, perhaps on a mountain top) it had been possible to send signals a distance of 60 miles. But this, of course, was not the limit, because they had evidence that light passed through millions of miles; but a telegraphic system of that description had the disadvantage that it required a very elevated position, and even with that advantage it was not always possible to get the signals to pass. It required a transparent atmosphere, and he need not remind those who lived in this city of dreadful night that it did occasionally happen that they did not have a transparent atmosphere, and under these conditions (which had been very frequent lately) he thought it would have been quite impracticable to carry on this system of wireless telegraphy. One of the great points of the Marconi system was that it was possible to transmit signals through the densest fog and even through a London fog or obstructions of the nature of mountains. These were very great advantages, and he thought the whole world was greatly indebted to Mr. Marconi for the practical results he had obtained.

Mr. MARCONI, in replying, thanked the Chairman for his kind remarks and the audience for the interest they had taken in the subject, and for the kind manner in which they had received his Paper; this being the first he had ever read in the English language. He was glad to note that many results obtained by Dr. Fleming coincided with his experience. He (Dr. Fleming) had found that a well made coherer was not the uncertain, treacherous and unreliable instrument which it had so often been said to be, and he had also noted the advantages obtainable by the use of the vertical conductor. The reason why the employment of oil in the spark gap was no advantage—rather, in his opinion, a disadvantage—was because oil seemed to offer a very variable opposition to the passage of the discharge Thus, if the oscillator containing the oil had not been used for some hours he found that the potential required to pass a spark through it was far greater than it would be after a few moments of work. It seemed as if the continuous discharge maintained a kind of channel in the oil, after the first discharge, and therefore, if the receiving instrument was at a considerable distance, *i.e.*, near the limit of the distance over which it was possible to signal, he found that while the dots, which were produced by single impulses, were all recorded, the dashes in great part missed. When a comparatively large capacity was connected to each end of the discharging spheres, air seemed to be quite an ideal substance in the spark gap, and curiously enough he had obtained better and absolutely constant results if the spheres were not polished. He had found that the use of mercury in the coherer was necessary in order to obtain the best results. He also found it advantageous—or, as far as commercial work was concerned, necessary—that the tube should be exhausted to about 1mm. The tubes he made were always tested over a distance of 18 miles, and if they failed to give good signals at that distance with a moderate length of vertical wire, they were not considered satisfactory. Although signals had been at times received over a distance of 18 miles by non-exhausted coherers, no reliable results had been obtained in such cases. Probably if they employed a vertical wire 200 feet high instead of 75 feet, they would obtain fair results with non-exhausted coherers, but a mast 200 feet high would not be a very practical piece of apparatus. He had also noticed that tubes of coherers containing air were always decreasing in their sensitiveness, and this would not do for commercial installations. In reply to the questions asked by various members as to the necessity of having the earth connection, his experience had been that in order to obtain the greatest possible distance with a given height, an earth connection at both receiver and transmitter was necessary. If, however, suitable capacities were substituted for the earth, communication could still be maintained, although at a somewhat shorter distance. The results obtained, when capacities were used in place of an earth, were similar to those obtainable when a condenser was inserted in the earth connection, and he believed the result of connecting the earth terminal of one of the instruments to a capacity area was equivalent to inserting a condenser of similar capacity into the earth connection. As had also been noticed by Mr Gavey, he found that a small capacity on the earth wire of the receiver was sufficient to obtain good results, whilst a much larger capacity was required at the transmitter. The fact that signals could be obtained without earth connection might seem, at first sight, as if proving that the earth had nothing whatever to do with the conducting of oscillations from one station to another, the possibility of which he had pointed out in his Paper. But it seemed to him that even if a great part of the oscillations were conducted by the earth, the fact of disconnecting one or both instruments from earth and substituting for the actual metallic earth connection a capacity area was no proof that the earth was unnecessary. With no capacity on the earth end of the coherer or radiator, it was impossible to obtain results; and if a capacity must be there—and especially if it be near the earth or any earthed conductor—was not that equivalent to a condenser inserted into the earth connection? If they considered the very rapid oscillations with which they were dealing, it would be found that a very small condenser, say, $\frac{1}{100000}$ m.f. capacity, was more than ample at the receiving end for allowing the dielectric currents to pass from or to the earth. It was his opinion that unless they could transport the whole apparatus to a very considerable distance from the earth or any earth conductor, it would be impossible to come to any definite conclusion as to whether mother earth was, or was not, taking a very important part in this phenomenon, and he took it that any capacity area so connected to the instrument was only a plate of a condenser, of which the other plate was the earth. It might surprise many of them when he stated that with the instruments connected to earth, if they disconnected the vertical conductor from the receiver, they could still receive good signals at distances of many miles. In this case one might say that the effect must necessarily all come from the earth connection, but it was found that the lower end of the vertical conductor must be in proximity to the receiver, and from this lower end the oscillations jumped across the gap in the same way as the oscillations would traverse the insulation separating the two plates of the condenser. Over a distance of 14 miles he had got signals even if the vertical conductor was separated from the terminal of the receiver by a gap more than 1ft. wide. In this case a metal plate, about 1ft. square, was attached to the terminal of the receiver, and to the end of the vertical wire. This seemed to show that actual metallic connection between certain parts of the instruments was not always necessary, as, with these high frequencies, oscillations could bridge over gaps which might exist in certain connections, in the same way as they traversed the dielectric of the condenser. The results showed that it was not necessary to have an actual metallic connection with earth, as this again could be effected through the ether. It was therefore of no great importance for installations, such as the Fastnet rock, to have what telegraphists call a "good earth," as a capacity would be quite sufficient. In the case of the Fastnet lighthouse, its being built mainly of boiler plate would afford an excellent capacity to which to connect the earth terminal of the instrument. Mr. Millar stated that he had noticed these results in experiments on a smaller scale which he had carried out. He (the speaker) explained Captain Brett's statement that the result of the instruments working at the South Foreland lighthouse without an earth connection came as a surprise to him, by stating that the surprise was not occasioned in view of no earth connection, but because he did not think there was sufficient spare power to enable the receiver to work when the earth connection was substituted by such a small capacity as was used in that instance. Mr. Granville had informed him that it would be impossible to get a radiating or receiving conductor at the Fastnet rock more than 10 or 20 feet away from the mass of conducting metal, but in such instances as the Fastnet, the line would only need to be a small one, and he did not anticipate any difficulty in applying his system to such a place. At Rathlin Island the conductor was suspended from the lighthouse and very near to it, while on the Royal yacht, the wire was sometimes nearly within sparking distance of one of the funnels, but good results were always obtained. Again, on the East Goodwin lightship the wire was very near the iron mast of the ship, and surrounded by a great number of wire stays. In reply to Mr. Gavey's remarks on the question of the law of the height of the vertical conductor, this he had communicated to Mr. Preece on November 10, 1896, as mentioned in his Paper, and it had also been fully discussed in the Italian technical press.* It was very interesting to know that Mr. Gavey, working quite independently at Dover, came to exactly the same conclusions as to this law. In connection with the difference in the height required when working over land and over sea, he had no doubt that over water or over perfectly open space it was easier to telegraph than over undulating land, but his experience was that the difference was by no means so marked as Mr. Gavey had mentioned, viz. 35ft. over water and 50ft. over land. At Salisbury, in the autumn of 1897, he found that 30ft. of vertical height was sufficient for a distance of one

* See *l'Elettricista*, August, 1897, and work of Della Ricia in the *Rivista di Artiglieria a Genio*, 1897-98. Also Lecture of Prof. Bougiovanni at Ferrara, November, 1897. [*See* also a review of Della Ricia's work in *The Electrician* of November 25, 1898, p. 160.—ED. *E.*]

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mile, and it was not until the apparatus had been considerably improved that he had been able to reduce the height at sea to less than 20ft. He was not at all certain that this height would not carry them practically the same distance over land as over sea, although he quite believed that over water the maximum results would always be attained. He had mentioned in his Paper that when signalling between Osborne House and the Royal yacht, even with nine miles of land intervening, the average height of the mast had been 90ft., which gave the figure of 30ft. for the first mile, although all these nine miles were not across clear space. His experience was that it was unnecessary for the stations to be fixed at a height over the water to obtain good results. Indeed he was not at all sure whether having the base of the wire on a height was an advantage. At Spezia the land station was on the sea level, and at Kingstown during the Regatta, the station had been only about 20ft. above the water level —the corresponding station being on a ship in the Irish Sea—and it was worthy of note that it was off Kingstown that the greatest distances yet reached in telegraphing over water, that is, 25 miles, had been obtained. At Alum Bay the station was at a height of 200ft., but at the corresponding station at Poole the pole was fixed in the sand below high-water mark. As to whether 20ft. was a practical working height and had a safe margin, he could confidently state that it was. As a matter of fact, they were at the present moment working across 18 miles with 75ft., and this could readily be reduced by 10ft. at each end if there were any object in doing so. In connection with reflectors, he noticed that Mr. Gavey had suggested the undulations of the ground as the cause of the failure of the experiments with reflectors at Dover at greater distances than half-a-mile. This did not, however, coincide with his own experience, as his first experiments carried out with much smaller reflectors were made at Salisbury, and there he found no difficulty in signalling up to a distance of 1¾ miles. He quite agreed that attention should be turned to this subject, and hoped to give more consideration to it shortly himself. With reference to tuning, he quite agreed with Mr. Gavey that it was difficult to obtain good results by altering the length of the vertical conductors, or even if the conductors were wound up into a coil or solenoid, but there were other methods which he was confident would allow tuning, and he intended to continue on a large scale some experiments which he had made on a small scale some time ago, in this connection. With lightships, however, he thought tuning would be a disadvantage, as if a ship A was tuned with a ship B, another lightship, which might be tuned to another note, could not communicate with either of them. As soon as the cross-channel service was started he intended making large scale syntonic experiments. He thought Mr. Gavey rather over-estimated the effects of lightning. Although numerous vertical wire installations had been working for nearly two years, none had ever been struck by lightning. On the coast of Italy, where many installations had been erected, and where thunderstorms, especially in the summer, were much more frequent and violent than in this country, nothing had ever happened. A lightning conductor higher than the vertical wire could be fitted in the ordinary way if there was any desire for it, without in any way interfering with the efficiency of the system. On board the Royal yacht "Osborne" the top of the wire was well below the top of the lightning conductor. They had, however, anticipated the possibility of danger by making an arrangement whereby the assistant in charge had never to touch or handle the aërial wire, which was always connected to earth both when transmitting and receiving. This prevented any accumulation of atmospheric electricity on it. The method he had adopted for screening the receiver from the violent surgings of the transmitting apparatus was as suggested in his patent of 1896. All the receiving apparatus was enclosed, with the exception of the inker or recorder, in an earthed metallic box. As some oscillations picked up by the inker and connections might, by travelling along the leads, injure the coherer, he choked off such effects by interposing suitable choking coils between the inker connections and the terminals of the receiver. These choking coils consisted of a few turns of insulated wire, each layer being separated from the next by means of sheets of tin foil, in electrical communication with the box. The earthed tin foil prevented oscillations from passing inductively from one turn to the other of the choking coil. In connection with the use of reflectors with the vertical wire system, he was of opinion that, considering the length of wave emitted—calculated by Prof. Ascoli to be four times the length of the vertical conductor—the reflectors would require to be very large indeed to be effective. As to the effect of screening or interposed objects, he had described in his Paper several stations in which hills did not in any way interfere with the transmission. Captain Jackson, of H.M.S. "Defiance," Devonport, had obtained good results even with battleships intervening between the stations. An installation had also been worked by Lieut. Della Ricia, in Brussels, between positions 400 yards apart, although nine houses, and an hotel constructed in great part of iron, intervened between the transmitting and receiving apparatus. As to Mr. Granville's question, whether he found it necessary to use accumulators for working the induction coil, although he was now using accumulators at several stations, so far they had only been employed experimentally. Excellent results had been obtained, up to the present, with dry cells alone, and the 100 M-size cells had remained efficient at Alum Bay for rather more than ten months. The lightship was also worked on dry cells, and he was confident that the battery would last for much longer than a year. The installations at Osborne House, on the Royal yacht, and at Kingstown had been worked by batteries of 50 cells, no accumulators having been used. As to whether the transmission of signals was effected purely by radiation, he was rather uncertain as to the reply that should be given. Doubtless over clear space radiation was the chief factor. He had noticed, and he believed that Dr. Fleming had also noticed the same thing, that if the two conductors were slanting it was necessary that they should be parallel to each other in order to obtain maximum results. Many more experiments, however, would be necessary to throw more light upon this. The reason why messages were not sent over greater distances at public demonstrations was that he did not think it desirable to divide his audience, as it would be necessary to have some of them at the other station. Many of the members of the Institution had seen the system working over long distances, and if any others would care to inspect it, he would be pleased to give them every facility. In reply to Mr. Miller's question as to what was the best composition of the coherer filings, he said that nickel filings mixed with a small percentage of silver and mercury was the best. With regard to the waves being reflected by the surface of the sea or land, he was inclined to believe that this reflection might possibly have much to do with the results, although he had no sure proof or experimental test as to how much or in what measure they did. Prof. S. P. Thompson's suggestions had come as quite new to him. He hoped to have an opportunity of testing this theory experimentally. But he would remind Prof. Thompson that the earth need not always be at the bottom of the aërial conductor, as during certain experiments he had had the earth at the top. At Alum Bay he had suspended the conductor over the edge of the cliff, the instrument and earth connection being at the top, whilst the lower end of the conductor, which was 100ft. long, hung free in space. When the wire was held at about 30ft. from the cliff, it was quite easy to speak to Bournemouth 14 miles distant. It was interesting to note that in this instance no pole was used to suspend the wire as the cliff fulfilled that purpose. This showed that in the case of lighthouses it was unnecessary to have a pole to suspend the wire. They could suspend it from the terrace of the lighthouse and fix it at the lower end or let it dangle in space.

DINNER TO MR. CHARLES GERHARDI.

In recognition of friendly services rendered from time to time to the Spanish nation by Mr. Ch. Gerhardi, His Majesty the King of Spain, through the Queen Regent, was recently graciously pleased to honour Mr. Gerhardi by conferring upon him the Royal and distinguished Order of Knight Commander of Isabel la Católica; and on Saturday evening last, at the Freemason's Tavern, Great Queen-street, London, a party of Mr. Gerhardi's personal friends foregathered to congratulate him upon this auspicious event, and to convey to him at the same time their recognition of his worthiness of the high honour thus bestowed. The chair was occupied by the Iltrmo. Señor Don Nicasio E. Jauralde, financial delegate for Spain in this country, who was supported by Mr. G. Allen, Mr. W. H. Axworthy, Mr. J. Bass, Mr. W. D. Bayley, Mr. A. Brown, Mr. T. A. Bullock, Mr. R. Collett, Mr. J. F. De Cossio, Mr. J. W. Dixon, Mr. George Draper, Mr. L. Franken, Mr. J. Gavey, Mr. G. H. Gerard, Mr. C. Gerhardi, junr., Mr. J. Gramaggini, Mr. R. Kaye Gray, Mr. W. Hibberdine, Mr. A. W. Hibberdine, Mr. W. W. Howell, Mr. F. Howell, Mr. G. C. Jack, Mr. A. Jauralde, Mr. J. W. P. Jauralde, Mr. J. Jeffery, Mr. A. R. Jurado, Mr. S. Laborda, Dr. Ledlie, Mr. C. Lee, Mr. W. F. Lewin, Mr. R. Lopez, Mr. J. F. Mills, Mr. F. Munk, Mr. V. C. Nevares, Mr. W. Norton, Mr. E. Parsoné, Mr. F. T. Preddle, Mr. J. Rippon, Mr. H. A. C. Saunders, Mr. A. T. Serrano, Mr. H. St. L. Smith, Mr. W. Marsden Smith, Mr. J. Swann, Mr. F. O. Thompson, Mr. Geo. Tucker, Mr. E. Walden Vincent, Mr. W. Vincent, Mr. A. H. Walton, Mr. Fred. Ward, Mr. J. Y. Watson and Dr. Wholey.

After an excellent and well-served dinner the toasts of "The Queen" and "The King of Spain and the Queen Regent" were cordially drunk.

The CHAIRMAN then gave the toast of "Our Guest," and referred in feeling terms to the many opportunities which had arisen during the 27 years which had passed since Mr. Gerhardi first became associated with Spain and her people through the Direct Spanish Telegraph Co., and especially in the recent past, and how Mr. Gerhardi had always availed himself of these opportunities to show his sympathy for Spain, both in her joys and her troubles. Their guest that evening was as well-known in Madrid as in the city of London. He had many friends in Spain, and in the dark days now happily over the little friendly services which Mr. Gerhardi had been able to render to Spain, not only in his official capacity, but as a private gentleman, had come especially under the notice of the King and the Queen Regent, and, as some recognition, the Order which they had met to congratulate him upon having received had been bestowed, and most worthily bestowed, upon a true friend to Spain. He was sure they all hoped that this was the stepping-stone to greater honours—and further festivities to celebrate them.

Mr. GERHARDI, on rising to respond, had a hearty reception. He said he saw around him very many of his old friends in the telegraphic service, in which he had laboured for 42 years. He was, he believed, the *doyen* of the telegraph service (so far, at least, as active service was concerned). To these old friends and to all who had assembled that evening he could only say how grateful he felt. He could not live long enough to merit all the kind things that had been said of him. He fully appreciated the high honour that had been conferred upon him, and accepted it as a token of regard for any little service he might have been able to render to Spain in her time of trial as well as in the more pleasant days of old. He had always succeeded in ingratiating himself with Spaniards both in England and in Spain. He felt sure that the results of the recent war would be to leave Spain invigorated and concentrated, and he looked forward to her speedy regeneration. In connection with his telegraphic work, Mr. Gerhardi mentioned that it was he who had wired the news of the victory of Inkerman, and the man who had received this message in England had been good enough to prophesy that great things were in store for the man who had notified this noble victory. He felt that the prophecy had been verified by the high honour of which he had been the recipient, and by the gathering of his friends around him that evening. He was deeply sensible of all their

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kindness, and thanked them heartily for the way in which the toast of his health had been received.

The remaining toast of "The Chairman" was proposed by Mr. E. WALDEN VINCENT, and was warmly received. Mr. Vincent referred to the services rendered to Spain by Señor Don Jauralde, and how highly he was respected in the English capital by all who came in contact with him either in business or in social life.

The proceedings throughout were of an enthusiastic character.

BOOKS RECEIVED.

"Handbuch der Telephonie." By Dr. Victor Wietlisbach. Edited by Dr. Robert Weber. (Vienna, Budapest and Leipsic: A. Hartlebein.)

"*Proceedings* of the Royal Society," No. 409, Vol. LXIV. (London: Harrison and Sons.) Price 2s.

"Unités Electriques Absolues." By M. G. Lippmann. (Paris: G. Carré and C. Maud.) Price 10f.

"The Official Gazette of the United States Patent Office." Nos. 9, 10 and 11, Vol. LXXXVI. Published by authority of Congress. (Washington: Government Printing Office.)

"The Technology Review." No. 1. Vol. I. A Quarterly Magazine, relating to the Massachusetts Institute of Technology. (Boston: The Association of Class Secretaries.) Price 35 cents.

"Temperature Coefficients of 'Conductivity' Copper." By Messrs. Clark, Forde and Taylor. (London: Clark, Forde and Taylor.)

ELECTRICITY WORKS ACCOUNTS.

Liverpool Overhead Railway Co.

The subject of our first table this week is the accounts of the last half-year's working of the Liverpool Overhead Railway. Parallel with the several values for this period we repeat those referring to the corresponding period of 1897, for purposes of comparison. With regard to the capital account, the total amount expended up to December 31st last amounted to £748,152, representing £111,400 per mile of working railway. Of this latter figure £98,800 is the proportion spent on the line, and £17,640 per mile the amount spent on working stock and the generating station.

The total capital received stands the same as in the previous year, the loan capital of £170,000 having been borrowed on terminable mortgage debentures at 4 per cent.

Compared with the corresponding period in 1897 the train mileage has slightly increased—about 0·5 per cent.—while the number of passengers carried shows an increase of 427,431 or about 9·6 per cent.

The revenue and expenditure account has a most gratifying aspect. Although the revenue per passenger has slightly dropped, the receipts per train mile have risen from 24·2d. to 26·23d.—about 8·4 per cent. On the other hand, the expenditure per train mile has remained practically steady at barely 1s. 3d.

It should be pointed out, however, that, with the exception of the item "maintenance of way, works and stations," all the other main divisions of expenditure have increased. "General charges" were lower, but only through the fact that in the 1897 half-year a payment of about a penny per train mile was made to the Liverpool Tramways Co.

As to the financial results, a working profit of £17,623 has been made, representing 2·36 per cent. of the mean capital during the period. Out of this sum £1,500 has been voted to the depreciation fund, and £3,400 paid as interest on loans. The remainder with the balance from the preceding half-year has enabled a dividend at the rate of 4 per cent. per annum, to be paid on the Ordinary shares for the half-year, after satisfying 5 per cent. per annum on the Preference shares.

It should be noticed that, under "General charges," £100 has again been paid into the contingent fund from revenue. This fund now stands at £700, and the renewal fund at £12,400.

An arrangement has been concluded between the Company and the Waterloo and Seaforth and Great Crosby District Councils for the working of a tramway extending from Seaforth station to Cook's road, Crosby, a distance of 2½ miles. The local authorities are to lay the road and rails, and the Company provide the electrical equipment, maintain the rails, and pay the district councils 8½ per cent. per annum interest for 20 years on the cost of laying the rails. This rate covers the interest and sinking fund on the estimated cost. At the end of the above period (when the sinking fund is wiped off) the annual payment would be 4 per cent. for the remaining six years of the lease. The estimated total expenditure by the Company on the equipment is £25,813.

The table given below indicates the growth of the traffic on the overhead line since it was opened on March 6, 1893 :—

Half-year ended	Passengers.	Train mileage.	Dividend.	
			Preference.	Ordinary.
Mar. 6 to June 30, 1893 ...	1,370,742	...	...	...
Dec. 31, 1893	2,475,639	243,539	5%	1%
June 30, 1894	2,861,437	...	5%	1%
Dec. 31, 1894	3,641,379	314,472	5%	2%
June 30, 1895	3,460,060	311,346	5%	2½%
Dec. 31, 1895	3,780,375	321,417	5%	3½%
June 30, 1896	3,739,575	313,010	5%	2¾%
Dec. 31, 1896	3,919,134	320,993	5%	3%
June 30, 1897	4,269,260	363,399	5%	3%
Dec. 31, 1897	4,467,490	371,773	5%	3½%
June 30, 1898	4,472,941	362,690	5%	3%
Dec. 31, 1898	4,467,490	371,773	5%	3½%

City and South London Railway Co.

The accounts analysed are those for the half-year ended December 31st last. For purposes of comparison we have repeated the analysis of the accounts for the corresponding period in 1897.

The share capital received amounts to £1,146,348, of which £816,548 has been raised on Ordinary stock and shares, and £329,800 on Five per Cent. Preference shares. £187,701 represents the loan capital, which has been borrowed on Four per Cent. Debenture stock. Up to December 31st last a total of £1,428,208 has been expended, representing £155,200 per mile of railway in operation.

The accounts indicate a satisfactory maintenance of the steady progress which has characterised the working of the line hitherto. Both the train mileage and the number of passengers carried have increased, the latter by about 3¾ per cent., as compared with the corresponding half-year in 1897. The revenue per passenger has remained constant at 1·91d., but per train mile has risen 0·68d. An almost corresponding rise has taken place in the expenses per train mile, which have grown from 15·66d. to 15·88d. It may be noticed that the revenue and expenditure per mile of line have substantially risen, and that the various items of the latter have remained very constant.

The following table is interesting as showing the increase in the traffic since the line was opened :—

Half-year ended	No. of passengers* carried.	Receipts.†	Ratio of expenditure to total revenue.	Per cent dividend.	
				Pref.	Ord.
Dec 31, 1890 (11 days)	165,000	£1,568	...	...	...
June 30, 1891	2,412,343	19,403	79%	5	...
Dec. 31, 1891	2,749,055	19,799	76%	5	...
June 30, 1892	2,813,162	20,931	70%	5	⅛
Dec. 31, 1892	3,117,602	22,003	67·9%	5	⅝
June 30, 1893	3,146,656	22,458	64·6%	5	¾
Dec. 31, 1893	3,093,351	22,068	64·6%	5	⅝
June 30, 1894	3,383,154	23,565	61·7%	5	1
Dec. 31, 1894	3,275,649	23,541	60·9%	5	1¼
June 30, 1895	3,113,199	23,711	61·6%	5	1⅛
Dec. 31, 1895	3,172,438	23,780	59·6%	5	1¼
June 30, 1996	3,192,672	24,022	60·0%	5	1⅜
Dec. 31, 1896	3,368,480	25,456	56·8%	5	1¾
June 30, 1897	3,437,810	26,403	57·6%	5	2
Dec. 31, 1897	3,337,861	25,473	56·7%	5	1¾
June 30, 1898	3,478,977	26,357	56·7%	5	2¼
Dec. 31, 1898	3,462,814	26,320	56·2%	5	2

* Exclusive of season ticket holders.
† From passenger traffic inclusive of season tickets.

Out of the £12,090 working profit for the half-year, £2,905 has been paid in interest, and the surplus, with £1,005

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balance from the immediately preceding half-year, has afforded a dividend on the Ordinary shares of 2 per cent. after meeting the 5 per cent. dividend on the Preference shares.

Considering the fine weather which characterised the latter part of last year, the above results are very satisfactory. Both tunnels of the extension from the Borough to Moorgate-street station, and also the subway to the Central London Railway, are completed, while the three stations are almost finished. It is anticipated that the extension from Stockwell to Clapham Common will be completed for traffic early next autumn. The generating station at Stockwell is being extended by the erection of a new boiler and engine house which will be ready for the machinery this month. It will be noticed that the rolling stock has been increased by the addition of three locomotives. Thirty additional coaches also are being delivered.

	LIVERPOOL OVERHEAD RAILWAY.				CITY AND SOUTH LONDON RAILWAY.			
Worked by	The Liverpool Overhead Railway Co.				The City and South London Railway Co.			
Date of Commencement of Working	March 6, 1893.				December 20, 1890.			
System	Third-rail surface conductor at 600 volts.				Third-rail surface conductor at 500 volts.			
Chief Engineer	S. B. Cottrell.				P. V. McMahon.			
Half-year ended	December 31, 1897.		December 31, 1898.		December 31, 1897.		December 31, 1898.	
QUANTITIES.								
Train mileage	*371,773*		*373,560*		*230,396*		*234,166*	
Passengers Carried	4,467,490		4,891,921		3,337,861[a]		3,462,814[a]	
Length of railway authorised	7 ml. 5 ch.		7 ml. 5 ch.		6 ml. 64·5 ch.		6 ml. 64·5 ch.	
Length of railway constructed	6 ml. 57 ch.		6 ml. 57 ch.		3 ml. 12 ch.		3 ml. 12 ch.	
Length of Railway Worked	**6 ml. 57 ch.**		**6 ml. 57 ch.**		**3 ml. 12 ch.**		**3 ml. 12 ch.**	
Length of railway under construction	nil		nil		3 ml. 12 ch.		3 ml. 52·5 ch.	
Rolling stock, number of cars	7*		7*		54		54	
„ number of locomotives	44[a]		44[a]		17		20	
CAPITAL.								
Authorised (Total)	**£760,000**		**£760,000**		**£2,065,000**		**£2,198,000**	
Authorised (share)	570,000		570,000		1,580,000		1,680,000	
Authorised (loan)	190,000		190,000		485,000		518,000	
Received (Total)	**740,000[b]**		**740,000[b]**		**1,139,820[b]**		**1,347,283[c]**	
Received (share)	570,000		570,000		921,910		1,146,348	
Received (loan)	170,000		170,000		155,501		187,701	
	Total.	Per mile of working railway.	Total.	Per mile of working railway.	Total.	Per mile of working railway.	Total.	Per mile of working railway.
Expended (Total)	**£737,304**	**£109,850**	**£748,152**	**£111,400**	**£1,118,836**	**£355,000**	**£1,428,208**	**£453,200**
On line open for traffic	623,280	92,885	629,726	93,800	840,010	267,000	841,800	267,000
On line in course of construction	—	—	—	—	210,061	73,000	532,450	169,000
On working stock, including power station	114,024	16,985	118,426	17,640	48,765	15,460	53,958	17,120
Balance of Capital Account	**7,168**	**1,068**	**- 3,681[d]**	**548·5**	**20,983**	**6,660**	**- 80,925[f]**	**25,680**
Renewal Fund	**9,600**	**1,430**	**12,400**	**1,848**	—	—	—	—
Contingent Fund	**500**	**74·5**	**700**	**104·2**	—	—	—	—
REVENUE.	Total.	Per train mile.	Total.	Per train mile.	Total.	Per train mile.	Total.	Per train mile.
Total	**£37,583**	**24·20d.**	**£40,841**	**26·23d.**	**£26,529**	**27·60d.**	**£27,588**	**28·28d.**
Passenger traffic	36,995	23·87d.	40,072	25·73d.	25,473	26·50d.	26,320	26·96d.
Parcels, rents, transfer fees, &c.	588[e]	0·380d.	769[e]	0·494d.	1,056	1·100d.	1,268	1·300d.
EXPENDITURE.								
Total	**£22,940**	**14·80d.**	**£23,218**	**14·920d.**	**£15,035**	**15·66d.**	**£15,498**	**15·88d.**
Maintenance of way, works, & stations (*less* depreciation)	*3,345*	*2·160d.*	*3,327*	*2·137d.*	*596*	*0·620d.*	*810*	*0·830d.*
Maintenance of way	909	0·587d.	1,320	0·848d.	500	0·520d.	624	0·640d.
Repairs of structure, stations, &c.	2,436	1·570d.	2,007	1·290d.	96	0·100d.	186	0·191d.
Locomotive power	*5,747*	*3·710d.*	*6,085*	*3·910d.*	*5,600*	*5·840d.*	*5,512*	*5·650d.*
Coal and coke	950	0·614d.	1,093	0·702d.	1,433	1·490d.	1,530	1·568d.
Wages at power station	2,979	1·920d.	3,108	1·997d.	2,517[g]	2·620d.	2,440[g]	2 500d.
Oil and stores	512	0·331d.	744	0·478d.	426	0·444d.	336	0·334d.
Repairs and renewals	1,306	0·843d.	1,140	0·732d.	1,224	1·280d.	1,206	1·236d.
Repairs and renewals of cars	*587*	*0·379d.*	*823*	*0·528d.*	*461*	*0·480d.*	*554*	*0·568d.*
Traffic expenses	*7,937*	*5·130d.*	*8,672*	*5·570d.*	*5,838*	*6·080d.*	*6,018*	*6·165d.*
Salaries and wages	5,787	3·740d.	5,925	3·805d.	3,784	3·940d.	3,921	4·020d.
Other charges	2,150	1·387d.	2,747	1·765d.	2,054	2·140d.	2,097	2·149d.
General charges	*3,237*	*2·090d.*	*2,185*	*1·404d.*	*1,722*	*1·790d.*	*1,821*	*1·866d.*
Directors	350	0·226d.	350	0·225d.	650	0·677d.	650	0·666d.
Salaries of Secretary, General Manager, and Clerks	901	0·581d.	1,063	0·683d.	480	0·500d.	489	0·501d.
Other charges	1,986[c]	1·283d.	772[f]	0·496d.	592	0·617d.	682	0·699d.
Rent, rates, taxes, &c.	*1,749*	*1·129d.*	*1,767*	*1·135d.*	*759*	*0·790d.*	*724*	*0·742d.*
Miscellaneous items	*338*	*0·218d.*	*358*	*0·230d.*	*58[c]*	*0·060d.*	*59[h]*	*0 060d.*
FINANCIAL RESULTS.	Total.	Per cent. to mean capital expended.	Total.	Per cent. to mean capital expended.	Total.	Per cent. to mean capital expended.	Total.	Per cent. to mean capital expended.
Working Profit for Half-year	**£14,618**	**1·993%**	**£17,623**	**2·360%**	**£11,493**	**1·049%**	**£12,090**	**0·896%**
Sum carried to depreciation fund	1,300	0·1773%	1,500	0·201%	—	—	—	—
Net interest on loans	3,400	0·464%	3,400	0·456%	3,372	0·316%	2,905	0·215%
Balance from last half-year's account	3,810	0·520%	3,864	0·518%	1,035	0·092%	1,005	0·075%
Balance Available for Dividend	**13,753**	**1·873%**	**16,586**	**2·222%**	**9,156**	**0·836%**	**10,191**	**0·755%**
Ordinary Dividend paid at per cent. per annum	**3½%**	—	**4%**	—	**1⅝%[d]**	—	**2%**	—
Percentage of total expenditure to revenue	61%	—	56·8%	—	56·7%	—	56·2%	—
Revenue per Mile of Working Railway	**£5,600**	—	**£6,090**	—	**£8,420**	—	**£8,760**	—
Expenditure per mile of working railway	£3,420	—	£3,460	—	£4,770	—	£4,920	—
Revenue per Passenger	2·019d.	—	2·002d.	—	1·91d.	—	1·914d.	—

LIVERPOOL OVERHEAD RAILWAY.—REMARKS—* Trailers. *a* Motor carriages. *b* Exclusive of £4,471 received as premium on issue of mortgage debentures. *c* Includes £100 to contingent fund, £110 to insurance, £195 to office expenses, and £1,500 to Liverpool Tramways and Omnibus Co. *d* Over-expended. *e* Including general interest, £24 in last half year of 1897, and £184 in last half year of 1898. *f* Including auditing, £53; contingent fund, £100; insurance, £252; and office and travelling expenses, £363.

CITY AND SOUTH LONDON RAILWAY.—REMARKS—*a* Exclusive of season ticket holders. *b* Includes £62,409 received from "premium account." *c* Of which passenger duty is £53 and law £5. *d* Also a dividend of 5 per cent. per annum on the Preference shares. *e* Includes £13,234 from "premium account." *f* Over-expended. *g* Includes wages connected with working of locomotives. *h* Of which passenger duty is £53 and law £6.

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Alterations to existing Advertisements and Copy for new Advertisements should reach the Publisher on Tuesday, but in any case not later than Wednesday morning.

MUNICIPAL ELECTRIC SUPPLY BUSINESS.

There lies before us a document purporting to be a return, to the order of the House of Commons, "of the water, gas, tramway, electric lighting and other reproductive undertakings carried on by municipal boroughs" in England and Wales. The return bears the date March 6, 1899, and embodies financial statistics covering a period of five years ended March 31, 1898. Ostensibly it represents the capital invested in, and the amount of business, profit and loss involved by, municipal trading undertakings in the two countries named, no regard being paid to similar undertakings in Scotland and Ireland. A document of this description, provided it were drawn up in an impartial spirit, and were both accurate and complete, would afford means for reliable judgment to be arrived at as to the commercial characteristics of municipal trading. It would not only indicate the precise allocation of capital to the various departments of such trade, *e.g.*, electric lighting and tramways, but would also be a valuable guide in comparing municipal undertakings of any description with similar undertakings worked by private or joint stock enterprise. At the present moment, therefore, this document should come quite opportunely, when throughout the land and in our legislative assembly the question of municipal trading is being actively discussed.

The undertakings classified under various heads and embodied in this return comprise waterworks, gasworks, tramways, electric lighting, markets, baths, &c., cemeteries, working-class dwellings, piers, &c., and a miscellaneous collection not specified. Harbours, public libraries, and some few other species of trading undertakings are, however, not included. The "total capital, inclusive of borrowed capital," provided by the municipal authorities, amounted at the date specified to £88,152,595. We believe that the aggregate

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local debt for England and Wales at the beginning of last year was approximately 260 millions sterling; so that the capital invested in trading works represents about 34 per cent., or slightly over one-third of the total municipal debt. As a matter of fact, however, the proportion is very much in excess of this, for the enlightened compilers of the return before us appear to have been oblivious of the fact that such a place as London is in existence, or else they have been content to regard the undertakings of metropolitan vestries as not coming into the category of works "carried on by municipal boroughs." At any rate, London is completely ignored. Taking the return as it stands, however, we note that the total capital borrowed was £83,379,931, of which £11,720,904 had been repaid, leaving £71,883,232 as the outstanding debt. The aggregate accumulated sinking fund stood at £3,203,597. So much for the capital account: let us now consider the business done. During the five years ended March 31st last the average aggregate annual income was £8,898,376, representing a turn-over of about 10 per cent. of the total capital. The average annual "working expenses" are set down at £5,819,597, so that the item designated as the "average net profit" is given as £3,613,668. This last item represents 4 per cent. of the capital, and we might almost have been persuaded by this item to believe in the lucrativeness of municipal trading, were it not that closer inspection revealed that what is termed the "average net profit" is far from representing money wholly available for expropriation to purposes outside the requirements of the business. It is not exactly what a business firm or company would regard as money available for distribution as dividends. To begin with, practically the whole of the so-called net profit, viz., a sum of £3,127,271, has been paid away as interest on borrowed capital, and in repayment of capital; and out of the residuum only the paltry sum of £81,167—less than one-tenth per cent. on the total capital—has been set aside for depreciation of property. Thus the clear profit on the combined efforts of the municipalities during the past five years is only some £400,000 per annum—less than ½ per cent. on the capital invested. Assuredly the debate as to what should be done with municipal profits need not yet grow heated; a starving depreciation fund implores the sympathy of the disputants, and can absorb all the profits and much more before it will be over-fed.

Sufficient has been said to reveal both the general scope of this Parliamentary return and the general trend of municipal trading. Let us now consider in greater detail the one item in the return which possesses especial interest for electrical engineers, viz., "Electric Lighting." The "summary," from which our foregoing quotations have been made, sets forth that the total capital invested, on March 31st last, in municipal electric lighting undertakings in England and Wales was £3,416,711. As, however, London has been ignored, this excludes the considerable capital acquired by the metropolitan vestries, and some £485,500 should therefore be added to the total. It is next stated that the capital actually borrowed was £3,108,533, of which only £108,848 has been repaid, leaving a balance of £2,990,582 yet to be repaid. It appears that the aggregate sinking fund stood at £101,642. Examination of the detailed tabular statement which follows the summary reveals that only 55 electric supply undertakings have been considered; but the omissions, excepting those in London, are of trifling importance. Proceeding with the summary, we find that the "average annual income" during the past five years was £304,499, or 9 per cent. on the capital. Out of this £168,755 was spent in "working expenses," leaving £137,320, or 4 per cent. on the capital, as the sum representing what the compilers of the return are pleased to call net profit. Considering, however, that no less than £126,659 has been paid out in interest and repayment of loans, and that the poor little sum of £3,747 has been dignified with the chilly distinction of being made into a depreciation fund, it is evident that there has been precious little real profit-making. Add £126,659 to £3,747, and substract from £137,320, and you get the item £6,914 as the average annual real profit of municipal electric supply during the five years ending March 31st last. It represents the magnificent return of just ½ per cent. on the capital invested. No doubt we shall be told that municipal authorities despise profits and all the sordid things beloved of mere money-making companies. Be that as it may, it is at least to be expected of municipal works that they should be run with a clear balance-sheet. Examination of the return shows that in the majority of such works this requirement is not realised. Of the 55 electrical undertakings considered, 44 are said to have made a net profit, but we find that there were no less than 49 concerns for which for five years nothing had been set aside for depreciation. Further, it is evident that the six concerns which had had regard to depreciation had only mustered £3,747 between them, not more than $\frac{1}{10}$ per cent. on the capital. We may go still further, and discover that although 44 undertakings are stated to have made a net profit averaged over five years, only 19 have been able to pay interest and repay loans without drawing upon the District Rates, or some other outside source. Indeed, it is evident all through the return that it is the good management of a few large undertakings, such as those at Brighton, Manchester and Liverpool, and not an all-round or fairly general success, that has imparted to the return the semblance of satisfactory results which is so apt to be the most illusory feature of statistical documents on municipal trading. The good deeds of the few are treated as works of supererogation that can cover the sins of the multitude. This principle of ethics cannot be admitted, at any rate, to apply to municipal or any other form of trading.

REVIEWS.

The Free Expansion of Gases. By J. S. Ames, Ph.D. (London and New York: Harper Bros. 1898.)

This little treatise forms one of Harper's series of Scientific Memoirs, and embodies memoirs by Guy-Lussac, Joule and Thomson (Kelvin). The translating and editing have been undertaken by Dr. Ames, who is editor of the series. The work presents in a compact form, and one easy of reference by students of physics, the general mathematical treatment of the physics of the expansion of gases. It is illustrated with diagrams that serve to elucidate the text, rather than with mere pictures, and the book throughout is equipped with a number of valuable tables of constants and other physical quantities relating to the thermodynamics of gases.

Prismatic and Diffraction Spectra. By J. S. Ames, Ph.D. (London and New York: Harper Bros. 1898.)

This is another of Harper's Scientific Memoirs, and embodies the memoirs of Joseph von Fraunhofer, famous as the discoverer of the transverse lines in the luminous spectrum. The book is uniform with the one referred to in the previous review, and gives an admirable and succinct account of the investigations in radiation and absorption lines. The work includes a translation of a Paper giving a short account of the results of new experiments by Fraunhofer on "The Laws of Light and their Theory," this Paper having been read in 1823, besides a quantity of other literary contributions from Fraunhofer's pen.

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ELECTRIC TRACTION AND ITS APPLICATION TO SUBURBAN AND METROPOLITAN RAILWAYS.*

BY PHILIP DAWSON.

There is no longer room for doubt that electricity is the one pre-eminently successful motive power for tramways. This is proved by the rapid growth of electric traction. The words "experimental line" have fallen out of use, yet it is only a few years ago that those who ventured to foretell that the trolley system would be generally introduced into this country were ridiculed. There is no country in which electric traction is advancing more rapidly, and in which finer plants are being installed than in Great Britain. The day is not far off when horses and steam will have disappeared from the streets as far as tramways are concerned, and when the horse 'bus as a competitor will be no longer known. The problem of greatest importance, however, in which electric traction will be a principal factor, is the rapid transportation of large crowds from and to their business in our cities. The object of this Paper is to investigate in a general way the special requirements of this service, and to demonstrate the special adaptability of electric traction to it.

It is evident that the only solution of rapid transit lies in railways, which must be either overhead or underground, and of both London possesses a greater mileage than any other town in the world. The factor of initial expenditure must restrict the number of tracks available for the up and down traffic. The stopping places on such lines must of necessity not be far apart, and to diminish the crowds on the platforms and to increase the number of passengers the trains must follow each other with the greatest possible frequency. Consequently, the average speed of the trains must be increased as much as possible without unduly diminishing the distance between two consecutive trains, which would be dangerous. Steam locomotives have probably reached their approximate maximum development, and the results so far obtained with them for the class of traffic in question are far from satisfactory. They do not get up speed rapidly, owing chiefly to the torque on the driving axles constantly varying in consequence of the reciprocating motion of the pistons. They are not economical as their fuel consumption is practically the same whether they are exerting their fullest power, coasting or standing still, and their maintenance is very costly.

There is a commercial limit as far as distance is concerned beyond which transmitting power electrically will not pay. But that limit varies with each case, and cannot be ascertained except by the most careful calculation after all the conditions that maintain have been minutely examined. England was the first country to introduce electric traction on railways, both underground and overhead, as instanced by the City and South London, and Liverpool overhead electric railways. But, to prove commercially that very much heavier traffic could be handled, that much greater distances could be traversed, and to develop on a large scale the necessary machinery was again left to America, and hence the necessity of being practically confined to American experience and examples in this Paper. There are practically three methods of handling electrically the traffic on a railway, namely:—1. By locomotives or motor cars hauling a train of trailer cars. (2) By independent motor cars. (3) By a set of independent motor cars formed into a train and handled from the front car or from a so-called controller car. Each car, however, can be separated from the train, and then becomes an independent motor car. As regards the supply of the necessary current for the motors, there are three distinct methods:—Firstly, by accumulators or storage batteries which may be carried either on the motor car or locomotive, or on a tender. Secondly, by having a car containing a stationary engine, dynamo and boiler, which supplies the necessary current to the motors on the cars comprising the train of which it is part, and as proposed by W. Heilmann. Thirdly, by continuous or multiphase current supplied directly from a generating station or from a sub-station which, in its turn, gets its supply of energy from the main station, the current being distributed either in the form of direct or polyphase to conductors running along the lines, and from which the power is supplied through sliding contacts on the cars to the motors. The two former methods, as far as this Paper is concerned, will not be discussed, as sufficient data are not available to justify their being considered. The system of transmission of energy to the motors by means of conductors laid along the track, will, therefore, alone be considered. This method allows of several variations as far as the generation and distribution of power is concerned, amongst which the chief may be set down as follows:—(*a*) One continuous current generating station supplying current direct to contact rail. Where drop in pressure owing to distance becomes excessive, a negative "booster" may be used—it serves, so to speak, to pump back the current to the station, and is self-regulating, not taking at any period more power than is actually required to pump the current back. Should there be one or two lines too long to enable them to be worked this way, polyphase high tension generators should supply the power to one or more sub-stations along the line, as may be found necessary, in which rotary converters are located, which transform the current back into continuous. The polyphase generators to be driven by continuous current motors in the generating station. As an example of such a station, the new Dublin tramway power house may be taken. (*b*) One central station generating continuous current with sub-stations in which accumulators are located along the road, and which are charged by means of a booster and special cables. As an example of this system, the Leeds tramways may be taken as designed by, and carried out by, the late lamented Dr. John Hopkinson. (*c*) A series of stations, as described under (*a*) and (*b*), situated at various distances and connected together one with the other. As an example of this, the tramways and light railways in and round Boston, Mass, may be taken, owned by the Boston Elevated Railway Company, which has absorbed the well-known West End Company.

Data of Boston Elevated Railway.

Track miles operated	305
Number of cars	2,648
Car miles run during 1898	29,787,000
Passengers carried during 1898	172,764,300
Number of power stations	5
Total capacity of power stations in kilowatts	16,100
Total rated indicated horse power of engines	24,000

(*d*) A power station generating polyphase currents, which, by means of static step-up transformers, are transmitted at tensions which run from 2,500 to 40,000 volts to sub-stations where static step-down transformers reduce them to pressures of 300 to 350 volts, the current at this pressure enters rotary transformers, which deliver direct current at 500 to 550 volts to the line. As an example of this later system, the Central London Railway, which is now under construction, may be mentioned. (*e*) A three-wire system with continuous current, the rails or return forming the neutral wire. This has been tried and found wanting, and the engineers of the Central London Railway most carefully investigated its possibility and decided in favour of polyphase transmission and rotary converters, and rightly so. From careful calculations and the investigation of what has been done both in Europe and America, there is no getting behind the fact that for any power station which will exceed 4,000 kilowatts in capacity, the polyphase system is nearly certain to prove commercially the only admissible one. This statement is upheld by such an authority as Mr. H. F. Parshall, M.I.C.E. It is evident that in the particular cases at present under consideration (suburban and metropolitan communication), more than 4,000 kilowatts will be under consideration, and therefore nothing, as far as the power station and transmission is concerned, but polyphase currents will be considered.

There are two distinct varieties of service to be catered for. One that on a system like the Metropolitan and District, where the stops are frequent and the runs short. The other the case of long distance lines with few stops. In the present Paper it is only proposed to consider the first variety. In this case the use of polyphase motors need not be considered, as for work entailing frequent stopping and starting they have not up to date proved satisfactory.

A short examination of the importance of rapid acceleration on lines having stopping places at short intervals is interesting. Practical experience with electrically-driven motor cars, or locomotives, on the experimental track of the General Electric Co., at Schenectady, has proved that it is perfectly feasible to attain a speed of 30 miles an hour 10sec. after starting from a standstill. Assuming a level track, and that during 65sec. the current is cut off, and the train allowed to coast, that the brakes are then put on, the train will be brought to a standstill 15sec. later, and the total time from start to stop will be 90sec. Under these conditions it will be found that the average speed will have been 23·16 miles an hour, and that the total distance run will be about 0·55 of a mile. Assuming that instead of attaining the 30 miles an hour in 10sec., it took 30sec., and that this full speed of 30 miles an hour was kept up for 40sec. longer, and the brakes then put on, the train would be brought to a standstill in 90sec., and the average speed would work out as 21·66 miles an hour, or an average speed of about 10 per cent. less than in the previous case, the consumption of power, however, being much greater. It is evident that the most important point is to attain a high average speed, and to keep the maximum speed attained as low as possible, as by so doing less power is required in braking the train, and also less power is required to run the train. The time between the moment when the maximum speed is attained, and when the brakes are put on, should be at least from four to six times that required for stopping the train, so as to allow for errors in judgment on the part of the driver, and also to enable him to make up lost time. On the Manhattan Elevated Railway, in New York, the trains which are drawn by steam locomotives take 20

* Paper read before the Society of Arts, March 22, 1899.

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American rating.			H.P. imputed	Amps. (full load).		Full load.	Commercial efficiency.			Approx. weight of armature and commutator.	Approx. weight of generator complete.	Diam. of shaft in inches.	English rating at 500 volts constant potential.			
Poles.	Kw.	Speed. Revs. per minute.		500 volts.	600 volts.		75% load.	50% load.	25% load.				Classification.	Amps. Full load.	Approx. H.P. to drive.	Approx. weight of steam engine in lbs.
6	165	200	237	300	275	93½	93¼	92½	89	6,000	13,100	9	150 – 200	300	212	42,500
6	225	200	321	410	375	94	93¾	93	89½	7,000	21,000	9 – 10½	200 – 180	400	285	50,000
6	225	150	321	410	375	94	93¾	93	89½	13,900	34,300	9 – 11½	200 – 135	400	285	55,000
6	225	120	321	410	375	94	93¾	93	89½	14,520	37,000	9 – 11½	200 – 110	400	285	85,000
6	325	100	464	590	542	94	93¾	93	89½	17,000	45,500	9 – 11½	300 – 135	600	428	144,000
6	325	150	464	590	542	94	93¾	93	89½	21,000	61,000	11½ – 14	300 – 90	600	428	85,000
6	425	150	607	773	710	94	93¾	93	89½	25,500	60,000	14 – 16	385 – 135	770	550	94,000
8	425	120	607	773	710	94	93¾	93	89½	29,000	65,000	14 – 16	385 – 110	770	550	100,000
8	425	100	607	773	710	94	93¾	93	89½	31,000	72,000	15 – 18	385 – 90	770	550	180,000
8	425	80	607	773	710	94	93¾	93	89½	32,000	75,000	15 – 18	385 – 75	770	550	198,000
8	525	125	750	956	877	94	93¾	93	89½	31,000	72,000	16 – 18	480 – 115	960	685	181,000
10	525	100	750	956	877	94	93¾	93	89½	27,000	69,000	16 – 18	480 – 90	960	685	187,000
10	555	90	750	956	877	94	93¾	93	89½	32,500	76,600	16 – 18	480 – 80	960	685	192,000
10	525	75	750	956	877	94	93¾	93	89½	36,000	87,000	16 – 18	480 – 70	960	685	198,000
12	850	120	1,206	1,545	1,420	94½	94¼	93¾	90	40,000	100,000	19 – 22	800 – 110	1,600	1,135	215,000
12	850	100	1,206	1,545	1,420	94½	94¼	93¾	90	44,000	107,000	19 – 22	800 – 90	1,600	1,135	237,000
12	850	80	1,206	1,545	1,420	94½	94¼	93¾	90	47,000	116,000	19 – 22	800 – 75	1,600	1,135	285,000
12	1,050	80	1,482	1,910	1,755	95	94¾	94	90¼	55,000	130,000	22 – 25	950 – 75	1,900	1,341	300,000
12	1,200	80	1,698	2,180	2,000	95	94¾	94	90¼	68,000	158,000	24 – 27	1,100 – 75	2,200	1,556	415,000
16	1,600	75	2,260	2,910	2,670	95	94¾	94	90¼	70,000	160,000	24 – 27	1,500 – 70	3,000	2,120	460,000

Metropolitan Elevated, Chicago.

Number of cars in train.	Average speed (not including stops) in miles per hour.	Average current (not including stops) in amperes.	Board of Trade units delivered at switch-load per ton mile.
4	14·4	148·7	0·050
4	14·0	153·2	0·053
4	14·5	151·8	0·050
3	14·7	137·4	0·063
3	15·1	135·6	0·058
2	15·3	90·1	0·058
2	16·8	106·6	0·059
4	12·2	101·1	0·042

Railway Co.	No. of cars.	Weight of trains in lbs.	Tractive effort per ton.				Maximum speed in miles per hour.	Distance run.
			Maximum for given time.		Average for total time.			
			sec.	lbs.	sec.	lbs.		feet
Metropolitan Elevated, Chicago	2	88,000	10	177	40	107	34·8	1,020
Lake-st. Elevated, Chic.	2	88,000	10	135	40	84	27·6	870
Alley Elevated, Chicago	3	144,000	10	135	40	98	28·6	840
Illinois Central, Chicago	4	300,000	10	95	40	79	25·60	750
Manhattan Elevated, N.Y.	4	190,000	10	88	40	67	21·00	615

Distance 2,000ft., to be run over in 75 seconds, or at an approximate Average Speed of 16 Miles per Hour.

Time during which power applied in secs.	Maximum speed attained in miles per hour.	Time during which brakes applied.	Average power-consumption, per ton, in B.T. units.
7·5	25·75	10·0	0·035
12·5	26·00	10·5	0·036
16·5	26 25	11·5	0·038
24·5	27·15	12·5	0·0475
31·0	28·25	14·0	0·0480
39·0	30·50	17·0	0·0575
53·0	36·50	22·0	0 0840

Distance to be run 2,000ft.

Tractive effort per ton in lbs.	Maximum speed in miles per hour.	Time in seconds during which brakes applied.	Time in which 2,000 feet run.	Average speed in miles per hour.	Board of Trade units per ton mile.
	62·5	41·0	41·0	33	0·300
300	53·0	34·0	52·0	26	0·196
150	46·0	26·0	58·0	23	0·160
100	40·0	24·5	67·5	20	0·130
65	34·3	22·0	82·0	17	0·100
45	27·5	15·0	98·0	13¾	0·075
35·6	23·0	12·0	127·0	10½	0·057
27·6	17·5	11·0	160·0	8	0·045

seconds to attain a speed of 14 miles an hour, or less than half the speed in double the time as compared with electric traction just mentioned. A much larger current will be required to attain a rapid acceleration than to obtain a slow one, but the current will be required during a much shorter time, and the total energy supplied will be less in the case of rapid than of slow acceleration. This fact must not be lost sight of when calculating the feeders for such a system, and the train service should be arranged in such a way that as few trains as possible start together. Furthermore, the more rapid the acceleration required the larger will the motors have to be, and, therefore, there will be a limit, above which it will not be advantageous to push the rapidity of acceleration. In new tunnel lines, such as are now being constructed all over London, it will be evident that it is an advantage to have the stations built with a down grade for the trains to start, so as to help the motors and reduce the current required at starting; and that, similarly, it will be an advantage to have an up grade when nearing a station, so as to reduce the amount of power required in braking. By properly choosing these gradients it is found that a total economy of from 40 to 50 per cent. in the total power required by a train may be made. According to Mr. Potter's tests, it was found that, during acceleration, an average power of 32 amperes per ton of weight of train was required.

With a complete train composed of one motor car and two passenger cars, weighing complete 148,000lb., a maximum horizontal effort of 9,750lb. was required in acceleration, the maximum current was 780 amperes at 500 volts, the maximum speed attained was 32 miles an hour, and the time taken to attain the speed was 34sec., the motor car being equipped with two 200 H.P. motors.

In another case, with a train composed of one motor car, equipped with two 125 H.P. motors and one trailer car, total weight of train being 103,000lb., a maximum speed of 31 miles an hour was attained in 37 seconds, the maximum current being 500 amperes, and the maximum horizontal effort required to attain acceleration 5,640lb. In a series of tests made on the Nantasket Beach line it was found that with a heavy motor car, 51ft. in length overall, carrying 100 passengers, weighing 31 tons, on an average distance of 2,980ft. between stations, a maximum speed of 40 miles an hour was attained, the average speed being 18 miles per hour, and the power required was 0·098 Board of Trade units per ton mile. In an experiment with a train composed of one motor car and one trailer car, weighing 57 tons, with an average distance between stations of 4,280ft., a maximum speed of 37 miles was attained, the average speed being 17 miles an hour, the power required being 0·067 Board of Trade units per ton mile.

From a comparison of the actual results obtained on the elevated electric railways of Chicago and on the Metropolitan and District line in London, we see that whereas the maximum speed of 25 miles an hour is obtained in 10 seconds with electric traction, it takes 33 seconds to do it with steam locomotives—and that whilst the electrically propelled train could do the distance of 1,880ft. in 66 seconds, with steam it would take 93 seconds, or nearly half as much time again. If in the case of electric traction the power is cut off the moment the maximum speed of 25 miles an hour is obtained, and the train allowed to coast before the brakes are put on, the distance considered would be done in 76 seconds, and that the steam driven train even then would take more than 25 per cent. more time to do the same distance.

(To be continued.)

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CORRESPONDENCE.

THE THEORY OF THE MARCONI TELEGRAPH.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Having had the pleasure of attending both meetings in connection with Mr. Marconi's paper on Wireless Telegraphy I, in common doubtless with many others, was struck by the entire absence of any attempt on the part of Mr. Marconi to afford his listeners any theoretical explanation of his system of signalling through space. It seems to me that this is a great omission, and must tend to place Mr. Marconi at a disadvantage, which he should at once rectify by availing himself of your columns to give us now what we are entitled to. Should he fail to do so I trust that some of your correspondents will step into the breach and take up the position which ought to have been occupied by Mr. Marconi. The interesting messages quoted by him in his Paper are a sufficient proof of the practicability of conductionless telegraphy, and should satisfy all concerned that it possesses a certain commercial value; but this is not enough for those interested in the scientific aspect of the question, and who have so long and patiently waited to hear Mr. Marconi expound the laws which underlie the results obtained. So far, such information as we have gained on these points has come from others rather than from Mr. Marconi himself, and, under the circumstances, this is a sufficiently singular fact.—Yours, &c.,

CONDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: From your leader on "Wireless Telegraphy," in this week's *Electrician*, it appears that you have quite misunderstood my remarks.

I did not propose a theory of discharge from given points, as you suggest, but merely gave the points on an electrical machine as an illustration of the fact, that on a charged conductor the electric force is greater near the convex parts than near the flat or concave surface.

I did not imply that there was any discharge from the wire, but only that the displacement current in the ether must be greater the further the given portion of the wire is from the earth.—Yours, &c.,

J. ERSKINE-MURRAY.

Poole, March 21, 1899.

THE WEHNELT INTERRUPTER.

TO THE EDITOR OF THE ELECTRICIAN.

The new Wehnelt interrupter for induction coils would suggest the search after a mechanical method of arriving at a high rate of interruption of current, without risk of burning the contacts, notably, as is the case when *one* terminal alone is constantly in circuit (by the magnetic make and break).

The following idea is proposed with some diffidence; as it would probably—if of practical value—have been suggested by others: but it is this:—

Could not a wheel be constructed—driven by a separate current, if desired—consisting of a convenient number of sectors, insulated from each other near the periphery, but connected at the axis. A brush (or, perhaps, pulley revolving) or other convenient arrangement for ensuring a sliding contact, would glide over the surface of the revolving wheel or disc, near or on its periphery.* The rest is sufficiently obvious. One terminal of the exciting battery would be connected with the axis of the wheel, the brush would be connected through the primary of the induction coil to the other terminal of the battery. A condenser could, of course, be inserted at will, and would at least diminish the sparking, if found otherwise not without advantage.

The object of the idea is naturally to do away with the evil of *one* terminal alone as interrupting mechanism (with attendant heating), and to secure full control of rate of breaking current—by varying at option speed of wheel—results which are very imperfectly attained with the Wehnelt, or with the mercurial make and break mechanism. Your readers may judge what value (if any) the above suggestion may possess, if you think it well to accord this a place in *The Electrician*.

Hamburg, March 21, 1899. S. TOLVER PRESTON.

* The brush could, by a screw, be made to vary the position of contact on the revolving disc, at will—if thought advantageous.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Perhaps the following may be new to some others who are using Dr. Wehnelt's interrupter. In experimenting I connected the interrupter with the 100 volt circuit without any coil. It then refused to work, one bubble just being off at the moment of making contact.

Further experimenting shows that self-induction is required to make the brake work. Perhaps the action is in this wise. On the current being switched on, the positive pole is immediately afterwards insulated by a layer of oxide and the current ceases. The counter current induced in the coil can then act, and for a moment converts the positive pole into a negative one, absorbing the oxide and setting free a little hydrogen, and so the action goes on.

That this is the case I found by collecting the gas given off from the "positive" pole and applying a light, when there was a brisk explosion, leaving, however, a considerable amount of oxygen and ozone in the tube.—Yours, &c., ALEX. HILL.

THE NERNST ELECTRIC LAMP.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice from the abstract of the discussion on Mr. Swinburne's Paper, given in your issue of Feb. 24, that Prof. Ayrton did me the honour to refer to views which I have held for a number of years regarding the source of light in the Welsbach mantle, and I may say also in the calcium light. I thought that it might interest some of your readers to have a more explicit statement of what these views have been, and still are, and I enclose a statement [subjoined], which is being sent to the *Electrical Review*, New York, at the request of its editor.—Yours, &c., ELIHU THOMSON.

Lynn, Mass., March 10, 1899.

STATEMENT.

Some six or seven years ago, when the Welsbach burner first came into prominence, I made some experimental tests, which convinced me that the light of the burner was not merely due to the material being brought to a high temperature by the hot gases of the flame, and the experiments also convinced me that the material of the burner itself did not possess any peculiar property of luminescence, except under specific conditions of use. I may say that these views have been freely communicated to my associates and others ever since I first held them.

I found that the material, when introduced into the flame of an arc and very highly heated, did not shine with any greater light than a piece of carbon filament would under similar conditions, and it appeared to me that what was necessary to develop the light-giving quality was to immerse the material of the mantle in gases undergoing conbustion, *i.e.*, in gases containing combustible and free oxygen. This was illustrated by the use of an ordinary blow-pipe flame; when a piece of a mantle was placed in the reducing flame it glowed brightly, but when carried out to the point of the flame (where the combustion was completed) it glowed far more faintly, though the temperature of the gases was doubtless as high in one case as in the other.

This led me to make other experiments, which, in general, confirmed the view here expressed: that the light given out by a Welsbach mantle is, in my opinion, largely due to union of the gases taking place within the pores. Gases may possibly be condensed within the pores, and there caused to unite, producing high temperatures; or the material of the mantle itself may be intermediary in a set of chemical changes, which result in the oxidization of the carbon and hydrogen of the flame.

It is interesting to note in this particular that the calcium light in which a jet of oxygen and hydrogen, or hydrocarbon gas, is projected upon a piece of lime, probably embodies the same principle of action. Frequently, in working with the calcium light many years ago, I have been struck with the

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great difference between the amount of light given out by the lime when the tip of the hydrogen flame only reached the lime after the combustion was fairly complete, as compared with that given out when the lime was, so to speak, pushed right into the flame where active combustion was taking place. In the former case there was but little emission of light, and in the latter a light of great brilliancy was evolved.

It is well known that a properly adjusted calcium light represents a high luminosity and intense light emission for the small spot of lime heated. It is also well known that at that spot the character of the lime undergoes a change. It is gradually volatilised or eaten away just as the material of the Welsbach mantle is gradually carried off. This is noticed especially at those parts exposed to the flame in its most intensely active zone of combustion.

I have never been a believer in any special luminesence idea in connection with the mantle constituents, and it is a source of some satisfaction to me that views akin to those I have held for so long a time appear to be gradually gaining ground. (Signed) ELIHU THOMSON.

PARLIAMENTARY INTELLIGENCE.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT CO.'S BILL.

The Select Committee which is considering the group of Bills dealing with the supply of electricity to London resumed, on the 17th inst., the consideration of the Bill of the St. James's and Pall Mall Electric Light Co. The opposition of the Vestry of St. James's, Westminster, was opened by Mr. Freeman.

Mr. HENRY MONSON, Surveyor to the Vestry, said that when coals were being unloaded at the works of the promoters in Carnaby-street the thoroughfare was blocked. There was a clause in the Bill, which said that not more than 20 houses inhabited by working classes should be taken, but 40 tenements would be acquired.

The CHAIRMAN asked if there were any precedents in which, in a case like this, it had been decided that more than 20 houses were being taken.

Lord R. CECIL: There is no decision given to that effect. The ordinary rule of Parliament has been to have a clause in these Bills forbidding more than 20 houses belonging to the working classes being taken away without the consent of the Home Office. The petitioners desire the promoters to insert a penalty, the effect of which will be, not only to forbid us from taking 20 houses, but to render us liable to a fine of £500 if we do take them. That we have put into the filled-up Bill. We submit that the Home Office is the proper authority to raise this point if anybody is.

A MEMBER OF THE COMMITTEE: Are the promoters prepared to make a proposal for rehousing the 340 people who will be dispossessed?

Lord R. CECIL: We say that that is a delusive number. The question is not the number of persons who will be disturbed, but the number of persons of the working classes. It includes people employed in our own works.

WITNESS denied that the present works had improved the neighbourhood; noxious smells and heat came from the works. They had received complaints of the Company's works from householders.

By Lord R. CECIL: Has not the street become more respectable since the Company came there?—The particular street in which the works are situate is more respectable.

The CHAIRMAN: Has the rateable value of the neighourhood gone down?

WITNESS: Well, I do not put it in that light ——.

I understood you to say that this new station would reduce the rateable value of the surrounding property. Has the present building had that effect?—What I say is that the works will have that effect. I take as the foundation of that statement the complaints made as to the nuisance in Mason's-yard.

Tell us about Ganton-street. Has the rateable value of the property been reduced since the present station has been built?—I don't think it has, but I think it is likely to decrease.

Dr. JAMES EVANS, Medical Officer of Health for St. James's, said complaints had been made as to the smoke and cinders discharged from the chimney of the works in Mason's-yard. This was due to the chimney being overworked.

Other evidence was given as to noise and vibration.

Mr. RUSSELL, Q.C., addressed the Committee in support of the Craven Trustees' petition. The trustees, as owners of the land which was proposed to be taken, and of property surrounding it on three sides, protested against being deprived of their property, and said that if the Bill were passed care should be taken to provide for their adequate compensation. He submitted that the promoters were present, not in the public interest, but for their own benefit as a commercial undertaking. Their desire was to prevent another electrical company with whom they were in competition from having an advantage over them between now and the time when the works under the next Bill—the Central Electric Supply Bill—would be constructed.

Sir JOHN WHITTAKER ELLIS, as an expert surveyor and valuer, gave evidence against the Bill, and expressed the opinion that the effect of the construction of the proposed works would be to drive out of the district a large number of the inhabitants. Large factories always had that effect. To his mind, both for the sake of preventing a nuisance and avoiding the dispersal of the population, it would be wisest for the promoters to go into the suburbs to establish their new works. The electric light companies should do what the gas companies had had to do. It was said that the Lands Clauses Acts would give the petitioners the compensation to which they were entitled, but it was difficult to say whether adequate compensation would be given.

Mr. BOYLE, Q.C., then addressed the Committee for the remaining petitioners.

Mr. BALFOUR BROWNE summed up the case for the promoters. He submitted that being at Carnaby-street with the authority of Parliament, and having a large amount of plant there, and, further, being in want of an increased supply of electricity, it was only right that they should be allowed to so extend their works as to give them all the energy they required pending the construction of the proposed new works on the Regent's Canal. They were only proposing at Carnaby-street an extension sufficient to last them up to 1901. They only desired to have 2,500 H.P. in addition to the 4,500 they possessed at present. The Bill was really in the interests of the public, who had a right to be supplied with what electricity they required. With regard to the evidence as to the nuisance he held that the petitioners should be left to the remedy afforded by the general law in regard to the Carnaby-street works, present or future. If a nuisance were created and property were injured thereby the question would be how much compensation should be paid.

The Committee remained for a short time in deliberation, and the CHAIRMAN said they had decided to pass the preamble subject to the condition that Ganton-street should be widened. This would apply to that part of the street on which the new works would abut. As to the existing works the question would remain open and in the meantime the Committee would visit the station.

The Select Committee of the House of Commons engaged in considering the scheme of the St. James's and Pall Mall Electric Light Co., for the extension of their works, met again on Monday. As previously announced, the preamble of the measure was passed.

Several clauses were now brought up on behalf of the St. James's Vestry, one to effect the payment of rates in respect of the new site during the progress of works.

Lord R. CECIL objected to this clause being considered, as no condition of the kind had been laid down in the decision of the Committee.

The Committee declined to insert in the Bill a new clause proposed by Mr. BERKELEY, with regard to the repairing of a sewer, which would be interfered with by the proposed new works; Lord ROBERT CECIL pointing out that there was nothing in the Bill which would give the promoters power to interfere with the sewer in question.

A new clause was proposed to prevent the promoters from damaging the roadway adjacent to the new works during their construction, or to require compensation to be made for such damage. This clause also the Committee declined to accept, holding that the Company were entitled to use the roads for their traffic, and that any wrong doing on their part would be met by the ordinary law.

A clause was agreed to, providing that the works in Ganton-street, whilst they were in progress, should not be left in "an unsightly condition."

The Committee refused to insert a clause giving power to the Vestry to regulate the traffic of the Company. They considered that the regulation of the traffic should rest with the police.

A new clause, submitted by the Vestry, dealing with the displacement of the working classes and the provision in the Bill which stated that not more than 20 houses should be demolished, was rejected by the Committee on the ground that the Home Office already possessed sufficient power to deal with this matter. In like manner clauses dealing with the question of the committal of nuisances by the promoters at their works were rejected on the ground that the ordinary law was sufficiently strong to cover the point.

A clause providing for the widening of Ganton-street was submitted and approved.

THE CENTRAL ELECTRIC SUPPLY BILL.

The same Committee as had been discussing the St. James' and Pall Mall Co.'s Bill considered this Bill.

The counsel engaged were: For the promoters, Mr. Balfour Browne, Q.C., Mr. Pember, Q.C., Mr. R. Wallace, Q.C., and Lord Robert Cecil; for the Metropolitan Electric Supply Co., Mr. J. D. Fitzgerald, Q.C., and Mr. Moone; for the London County Council, Mr. Worsley Taylor, Q.C., and Mr. Du Cane; and for the Marylebone Vestry, Mr. Talbot.

Mr. BALFOUR BROWNE said the object of the Bill was to confer on the Central Electric Supply Co. (Limited) power to construct works and supply electrical energy, &c. It was lucky, he said, that the Bill had been referred to this Committee, because in the inquiry which had just taken place they had heard a good deal about the present proposal. The principle of the measure was one which was inquired into and reported upon by the Joint Committee of last year. He was sorry to see that a considerable number of the petitioners—amongst the others, the London County Council and the Vestry of Marylebone—absolutely ignored that report altogether, and raised arguments which were in place before that Committee, and which were put before it, but which, now that the Committee had reported, seemed to him to be entirely out of place. The promoters were proposing to make a new generating station in the parish of Marylebone, close to the Regent's Canal and the Central London Railway. They were proposing to go outside their own district. The promoters were the St. James's and Pall Mall Electric Lighting Co. and the Westminster Electric Supply Corporation. The time would rapidly come when the capacity of the two existing generating stations of the former Company would be exhausted. These two companies were combining to go outside their districts to make the proposed works on the Regent's Canal—in a most suitable

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position, in accordance with the report of the Joint Committee of last year. To connect the Company's works with the proposed station, they would have to lay trunk lines through the streets, and the breaking up of streets was also in conformity with the report of the Committee. These were the two principles which he was here to propound and which were reported on in his favour in the report of the Joint Committee. Of course, the companies would still be open to action if they conducted their works without due care, and the companies were bound to give the same notices and *locus standi* to the local authority in the district in which the new works would be constructed as though they were in the area of supply. The promotors were giving the Marylebone Vestry power to dictate the route which should be followed by the companies' wires. The Vestry asked for power to purchase the works, but they would not supply the Marylebone district, and such a proposal had never been contemplated in the Act of Parliament. If the petitioners were to receive power to buy the works it might enable them to supply not only their own district but half London. The promoters were ready to supply electricity in bulk to a large number of authorities far beyond Marylebone. The promoters wished to be near the Regent's Canal with their new works, to be near the railway, and to have access to the canal to obtain water for condensing. The Westminster Company supplied Hanover-square and adjoining districts, including the Houses of Parliament. The proposed capital would be guaranteed by the two companies, and each would be entitled to take a supply of electricity from the new works. The two companies would receive their supply of current at cost price so long as they took equal amounts, but if one company wanted more than the other it would have to pay a sum sufficient to cover cost and capital. The Westminster Company was started in 1890, had 4,700 consumers, and supplied 350,000 lamps. It had three stations, two of which were nearly at the end of their tether, and the remaining station would be unable to meet the demands upon it after next winter at latest.

Mr. BOULNOIS, M.P., a Director of the Westminster Electric Supply Corporation and of the Central Electric Supply Co., said it was impossible to get a suitable new station in the Westminster district except on most exorbitant terms. There would be no objection to making it clear in the Bill that the promoters would not take power under it to supply electricity to Marylebone.

The CHAIRMAN: If we give you North Bank, which is a public thoroughfare, what would you give the public in return?

WITNESS: We should give them handsome rates. The railway has destroyed the value of the property, I do not think that we can give anything beyond rates.

Prof. A. B. W. KENNEDY gave evidence to show the necessity for extending the sources of supply of electric energy. He denied that the proposed works would be a nuisance to anyone, or would be prejudicial to other companies.

Mr. SYDNEY T. DOBSON (engineer to the St. James' and Pall Mall Company) stated that the generating accommodation of his company was nearly exhausted. The Regent's Canal site had been chosen last year, and would be a very convenient one. Instead of damaging the parish of Marylebone, it would be a great gain to them, as it would give low rates and bring a large number of wage earners into the district. The present rateable value of the property to be acquired was over £3,000. The promoters had not yet settled as to whether the electricity which it was proposed to generate would be continuous or alternating current. If continuous it would be at a high voltage. The combined requirements of the two companies would amount to 18,000 H.P., but power was sought in the Bill to obtain between 40,000 and 45,000 H.P. The cables of the promoters would cross the main transmission main of the Metropolitan Electric Supply Co.

The CHAIRMAN: You stated on the last Bill that at your present works you use Welsh coal. Would you be obliged to use Welsh coal at the proposed new works?

WITNESS: If we can arrange our furnaces so as to avoid committing a nuisance from smoke and dirt it is probable that we should use a cheaper coal. This would probably save us 3s. or 4s. per ton.

You propose to use triple-expansion engines at high pressure? Yes; and so save a great deal in the matter of coal.

So that at these works, in addition to the economy you would effect by using triple-expansion engines, you would also effect a considerable economy in using a cheaper coal, and in having that coal delivered at a cheaper rate on the canal than elsewhere?—Yes.

So that, as a matter of fact, you can produce electricity at the proposed works at a much less cost per unit than you can at either of the works you now have?—Yes.

Sir FREDERICK BRAMWELL, C.E., said he had inspected the proposed site, and considered it extremely suitable for a generating station.

Mr. R. WALLACE, Q.C.: Do you know of cases where lighting supplies are generated in districts which are not served by those supplies?

WITNESS: The Gas Light and Coke Co. and other gas companies.

Do you agree with what was said by the last witness?—Yes; but he omitted to mention the mechanical fire-feeder. If that is used, cheap coal can be used with less risk of creating a nuisance.

This was the case for the promoters.

Mr. WORSLEY TAYLOR, Q.C., for the London County Council, said his clients did not want to prevent this or any other company from extending the facilities they possessed for supplying electric current to the public, but they did want to see that the powers given should be consistent with public policy. The question was whether the Committee would tear up the statutes which at present governed all electric lighting Bills. The Committee, he thought, would hesitate long before they would take on themselves, as a private Bill Committee, doing what should only be done after careful consideration by Parliament. Did they know a case in which Parliament had departed from the practice, namely, that where there were compulsory powers granted to the company, as a *quid pro quo* for that grant there was something put on those who got them in the shape of obligation or regulation or both? The Company, for their own profit were asking for compulsory powers without incurring a single obligation to the public. He objected to the promoters having their Bill without being under the ordinary obligations as to price, inspection, public safety, regulation of works, and so on. Under the general law it was not competent for the promoters to give preferential terms, and they would be bound to give a supply equally to every one in the district. The go-by was given to all these provisions, and two companies, subject to all the conditions of the Acts of 1882 and 1888, would be able to get to a great extent out of them by this joint measure. He asked the Committee if they decided that the preamble was proved to insert clauses in the Bill for the protection of the public?

Mr. BENN, L.C.C., said he thought that in any Bill dealing with the supply of electricity in London, especially any measure proposing to supply electricity in bulk, adequate provision should be inserted to enable some local authority to purchase the works at the expiration of a specified time. There should also be provisions in the Bill incorporating the provisions as to price and regulation inserted in ordinary electric lighting Bills under the Acts of 1882 and 1888. His main objection to the Bill was the absence of a clause relating to the obligation to sell to the local authority—if the local authority desired to buy—at the expiration of 42 years.

Assuming nobody has power to purchase the generating station, and assuming that the distributing companies are purchased by the local authority, would not the result be that the station in Marylebone would have no custom?—Yes.

Would not that be an awkward position for the owners of the generating station to be left in?—That would be an argument for the central authority stepping in as purchaser where it is obviously impossible for the local authority to purchase. You have the power to step in, as you have power at the end of 42 years to take away the area of supply.

The local authority would be in the possession of the mains and of the transforming stations, which would be of no value to them?—These things would be of no use without the generating station.

Would not the people in possession of the generating station be at the mercy of the local authority?—I am not so sure of that; at any rate, the danger to the Company would be very small.

You think the London County Council should have the power to purchase for all London?—Oh, no! What we say is, that the local authority, if it thinks it would be advantageous to purchase a generating station outside its area, should have power to do so. Two or more local authorities should have power to do the same thing if they think it desirable.

In reply to further questions, WITNESS said that as to the Board of Trade, Sir Courtenay Boyle before the Electric Energy Committee, had distinctly stated that he thought a purchase clause should be inserted in these electric supply Bills. It would be practically impossible for the local authorities to put up generating stations of their own. Westminster, for instance, would find it as difficult to get a new site in its area of supply as did the Westminster Company.

By the COMMITTEE: He could not say that if the two promoting companies were bought up their interest in the Central Electric Supply Co. would go with their area of supply. That was a question for lawyers. That was the case for the London County Council.

Mr. E. R. MOORE, for the Metropolitan Electric Supply Co., pointed out that his company generated electricity at Willesden, and carried their transmission main through Marylebone and Paddington for the supply of those districts. It was of importance that there should be no interference with that transmission main. The promoters should be prohibited from supplying Marylebone; they should also be prohibited from disturbing the petitioners' mains for the purpose of supplying other than the two promoting companies with electricity; and, finally, the petitioners should be allowed some voice in saying by what route the promoters should lay their mains.

Mr. TALBOT, Q.C., for the Marylebone Vestry, contended that adequate provision should be made for the protection of the rates of the petitioners. He also protested against the proposal to generate electricity for the six other companies (besides the two promoting companies) mentioned in the schedule. Because these works were a nuisance in Westminster and St. James's it was unfair to foist them on Marylebone. Let the Duke of Westminster find another site for generating works; at any rate, let him face the alternative of either doing that or letting his tenants go without the supply of electricity they needed.

Mr. BALFOUR BROWNE, replying for the promoters, likened the new works to an outside reservoir belonging to a water works company. Every drop of water sold from that reservoir would be subject to the terms regulating the area of supply. As to the insertion of regulations with regard to price, and so forth, Mr. Taylor seemed to forget that this Bill was not for the supply of electricity to consumers, it was for the manufacture of electricity at a cheap rate to be sold to the distributing companies. If they did not supply cheaply they would not get customers. As to the question of purchase, which was the gravamen of the case of the petitioners, the subject was fully considered last year, both by the Electrical Energy Committee and the Committee on the Metropolitan Electrical Supply Co. The London County Council had no power to purchase electrical works. It was true that they had passed a resolution in favour of such purchase, but the passing of a resolution did not give legislative powers.

The CHAIRMAN: The preamble is proved. With regard to Mr. Worsley Taylor's arguments in favour of purchase the Committee do not see their way to depart from the decision arrived at by the two Committees which considered the Bill of last year. The Committee wish to state their view of the large reduction in the cost of production of electrical energy they consider a reduction in price to the consumer should be made from time to time without waiting for the Board of Trade to do so.

Mr. BALFOUR BROWNE: We have done it already by 50 per cent.

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The CHAIRMAN: The Committee are of opinion that by these improvements the Company will be able to make a still further reduction.

Mr. BALFOUR BROWNE said he hoped they would.

The CHAIRMAN said that some clauses should be drawn to meet the wishes of the Board of Trade.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING BILL.

The same Select Committee dealt with the County of London and Brush Provincial Electric Lighting Co.'s Bill, against which a large number of petitions had been deposited.

Mr. Pember, Q.C., Mr. Balfour Browne, Q.C., Mr. Moon and Mr. Shaw appeared for the Bill; while Mr. F. W. Pember, Mr. Lewis Coward, Mr. Arnold Statham, Mr. Corrie Grant, Mr. Earle, Mr. Dickenson, Mr. Vesey Knox, Mr. Shiress Will, Q.C., the Hon. F. Thesiger, Mr. E. Boyle, Q.C., Mr. Archibald Willis, Mr. Claude Baggallay, Q.C., Mr. A. V. Frere, Mr. Selignan, Mr. Castle, Q.C., Mr. Littler, C.B., Q.C., Mr. G. J. Talbot, Mr. A. G. Rickards, Mr. Pope, Q.C., Mr. Wedderburn, Q.C., Mr. Worsley Taylor, Q.C., Mr. Du Cane, and Mr. Wheeler, Q.C., appeared for the various petitioners. Nor does this galaxy of legal talent exhaust the list. Some of the opponents of the Bill "reserved" counsel, some were represented by Parliamentary agents, and others were unrepresented by counsel.

Mr. PEMBER, Q.C., said the Company's district of supply included a large number of parishes, and they had a very difficult outline or series of outlines to deal with in the way of mains and generating stations. The fewer generating stations a company of this kind could manage to do with the more economically would they be able to supply the large bundle of districts within their area; and it was also essential if the districts were to be supplied in the most economical way that the Company should be able to carry the mains from point to point by as short routes as were practicable. These were two axioms which underlay a proper and effective and economical supply of electricity. The object of the Bill was to enable the Company to purchase additional land for the extension of its generating station at the City-road on the Regent's Canal. They proposed also the extension of their generating station at Wandsworth on the river Wandle, and they asked the Committee to give them power to purchase by compulsion a site for a generating station in the parish of Camberwell on the Surrey Canal. Powers were also sought to enable the promotors to lay mains to connect their various stations with outlying areas of supply through the intervening districts where necessary; and lastly, the promoters proposed to modify the provisions of section 9 of the Electric Lighting Act of 1882 as to the accounts to be rendered by the Company. The Board of Trade could insist that different annual accounts should be kept in relation to every single Order granted. Inasmuch as the Orders granted in the case of this Company were very numerous, covering a large district, it had become a very cumbersome thing to keep separate accounts for them all. A provision was, therefore, inserted in the Bill to obviate this.

The CHAIRMAN asked how long the case was likely to last.

Mr. WORSLEY TAYLOR, Q.C. (for the London County Council), said the Bill was an exceedingly complex one, and there would no doubt be individual points raised, but the petitioners had come to the conclusion that there were certain petitions which involved substantially the same points. They had decided that, saving the right of each individual to go into his own particular case, there should be, substantially, one cross-examination raising points of principle.

Mr. PEMBER, Q.C., continued: The Electrical Energy Committee which sat last year had reported that the proved public advantage of an electrical supply warranted the granting of compulsory powers for the acquisition of sites for generating stations. They had also considered whether a site for a generating station should be given where it was not within the area of supply, and were of opinion that powers for the compulsory acquisition of land for generating stations and of lands or easements for the laying of pipes and so forth in outside districts should be given on condition that the local authority in the district affected had the same rights of petitioning and opposing as though they were the authority over the area of supply, and that similar powers should be given to the authorities through whose districts pipes were laid. Local authorities should have the option of themselves opening up the streets at the undertakers' expense. On the point as to whether compulsory powers should be given in relation to a supply of electricity over numerous districts the Committee reported that such powers should be conferred where sufficient public advantage could be shown in the laying down of plant for high voltage. The promotors of this Bill already had power to supply a great number of districts. Another question the Committee dealt with was whether compulsory powers should be given to local authorities in the district of the generating stations to purchase the works at the end of 42 years. On this point the Committee suggested that the Board of Trade should have power to insert a purchase clause if good cause were shown for such a course. Amongst the main objections to the Bill was that of the County Council, who considered it faulty in containing no clause giving power of purchase to the local authority. The Council seemed unable to learn anything. They quoted the Acts of 1882 and 1888; but those Acts referred to electric lighting, and were passed when electrical energy was little understood. The London County Council were not the authorities to purchase; the local authorities under the Bill being independent of the Council. Another petition declared it was not needful for the promotors to come into the petitioners' district, as the supply to be generated there would be for the use of outside districts. But that was a power dealt with by the Committee of last year in the manner he had pointed out. Whitechapel also petitioned. That district had power to supply electric light, but did not use it.

Mr. TALBOT (for the Whitechapel Board of Works): We are spending money on it.

Mr. PEMBER said the present Bill had evidently galvanised the Board of Works into life. They had gone the length of consulting an engineer, but he should be curious to know what they had spent and how they had spent it. The learned counsel having dealt with the remaining petitions,

Mr. W. H. PREECE said there were now over 30 electric generating stations in London, and if small stations continued to be construted the progress would be so great that the stations would become a nuisance. It was far preferable to supply electricity in bulk from a few central stations scattered on the rivers or on the main lines of railways. The larger the station and the more continuous the output the cheaper would be the cost of electrical energy. The sites proposed, which he had carefully inspected, were admirably fitted for the purpose, and were not likely to prove a nuisance,

If you could keep your plant at full work for 24 hours at what price could you supply electricity?—At 1d. per unit. If in full work for 15 hours the price might be brought down to 2d. At present the plant was only in full work some three hours a day, and the supply could not be given at less than 4½d. per unit. He looked to the Metropolitan Railway Co. using electricity in the future, and also to the London County Council using that motive power for its tramways. There would then be a large current required, and the supply would be obtained in part from some of the proposed works.

If your expectations are realised, what will the cost of electricity be reduced to?—If we assume that the electric light now would be supplied at 4½d. per unit, and if we could from these great central stations secure the supply of current for tramway and electric railway purposes during 12 or 14 hours a day, the cost of electric lighting in London would come down to 3d. per unit, or 2½d.

By Mr. LEWIS COWARD (for the Fulham Vestry): Seeing that Fulham was taking measures to supply electricity itself, it would look like unfair competition for the promoters to go into that district.

Mr. A. J. LAWSON, Engineer and Manager to the promoters, said the present generating stations had a capacity of 70,000 8 c.p lamps. The proposed addition would give them a capacity for supplying 120,0 0 lamps. The demands on the Company were largely increasing in St Luke's, in Clerkenwell, in Holborn and St. Giles, and in Wandsworth. At the latter place, when the present site was enlarged, they would have a capacity to supply 240,000 8 c.p. lamps, and would possess 10,600 H.P. At Camberwell they would get under the Bill, with their existing works, about the same capacity as at Wandsworth. But in all cases 25 per cent. must be taken off for reserve. The demand at Wandsworth would be for 180,000 lamps in 5 years in Camberwell 100,000 lamps and in St. George the Martyr and St. Olave parishes (supplied from Camberwell) 30,000 lamps, making altogether 310,000. In all the areas the demand in five years was expected to reach 440,000 lamps. The proposed Camberwell station, on the Peckham branch of the Surrey Canal, was on a good site. They would get all the water required for condensing, and the site also afforded cheap carriage of coal. Both these conveniences formed important factors in the economical production of electricity. The Company did not at present want to connect their works north of the Thames with those on the south side. They did, however, desire to connect the works on the north side and those on the south side with each other. St. George's-in-the-East was asking for a supply of electric lighting, but the Company could not get there without the compulsory powers sought in the Bill. The petitions against the Bill resolved themselves into questions of compensation, or were based on a misconception. In the matter of charges the Company had offered an all-night supply for 3d. per unit, the ordinary charge being 7d. for the first hour and a-half and 3d. afterwards. As to account-keeping, at St. Luke's there were three separate systems of accounts, two of which applied to the one district of Holborn. They had to do that because the Company had obtained three Orders. The supply for the whole of that district came from one place, being produced by the same set of engines. In the case of Camberwell the circumstances were different, as the Company had a separate purchase clause in regard to that place. They had, therefore, excluded it from the accounts clause in the Bill. Their supply to Whitechapel would last five years they estimated; at the end of that time the works would have to be extended, and they would then have to extend the existing station. Whitechapel had obtained an Order for the supply of electricity, had asked for tenders, and had made a contract for carrying out electricity works. To get to St. George's-in-the-East it would be convenient to pass through both Whitechapel and Bethnal Green. There was room at the St. Luke's generating station for two more sets of engines. The works were sufficient for the district at present But even if they were not proposing to supply the outlying districts they would have to come to Parliament for power to extend their works. The Company were seeking to supply 12 new districts covering 28,000 acres, with a population of 1,213,000. He did not think the Company would require further generating stations for these districts. They would extend the existing stations. The Company's cables would not injure the water company's mains. The cables would carry an alternating current, and there would, therefore, be danger of electrolysis in the case of the water pipes.

Mr. WEDDERBURN, Q.C. (for the Blackheath and District Electric Light Co.), cross-examined witness to show that the promoters were not applying for power to supply any district which would require them to go through the district of the petitioners. Witness, however, said that it was desirable to have wayleaves to supply not only districts which they at present possessed, but which in the future they might acquire.

By Mr. ARNOLD STATHAM (for the parishes of Islington and Lambeth): The promoters were seeking to traverse the district of Islington in order to supply Hackney, as they were applying for an order for that district.

By Mr. TALBOT (for the Camberwell Vestry): The Camberwell Vestry had a purchase clause in the Company's original Provisional Order relating to that district.

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Do you propose to give powers of purchase in regard to the proposed new generating station at Camberwell?

Mr. PEMBER, Q.C.: We do not propose to deal with that matter at all. We propose to leave it to the general law to say whether or not the original purchase clause will include the generating station for the construction of which powers are now sought.

Cross-examination continued: It was proposed to use the new generating station in Camberwell for the supply of the whole of their southern districts in case of emergency. It was not proposed to go east of Camberwell.

By Mr. DICKENSON (for the District Board of Wandsworth): The Wandsworth generating station would be used if necessary for the supply of outside districts. The local authority had the right to purchase, after a specified period, but only that part of the undertaking used for the supply of Wandsworth. When the proposed works were carried out it would be impossible to dissociate the part of the works supplying Wandsworth from the part supplying other places.

The Committee then adjourned.

HAMPSTEAD, EUSTON AND CHARING CROSS ELECTRIC LINE.

On Monday, a Select Committee of the House of Commons, presided over by Mr. Jeffreys, began the consideration of a group of Bills, having for their object the provision of electric railway facilities on the north side of the Thames. The first was the Central London Railway Bill, but the opposition had been withdrawn.

The Committee then considered the Hampstead, Euston and Charing Cross Railway.

Mr. WORSLEY TAYLOR, Q.C., for the promoters, said the scheme was authorised originally in the session of 1893, and was one of several similar proposals specially considered by a strong Joint Committee of Parliament, and generally approved in 1892. The object was the relief of the congestion of traffic in the centre of London, and the facilitation of traffic from that centre outwards to a boundary which, owing to the rapid and continuous growth of London, must always be a receding one. The promoters wished to obtain an extension of time for the taking of the necessary lands and the construction of works already sanctioned; to secure authorisation for the construction of three new railways which would greatly improve the scheme both in the interests of the public and of the Company; and as a natural consequence of the extended works, the raising of further capital. The present Bill would bring the proposed line in direct connection with the Midland at Kentish Town, the North-Western at Euston, and the South Eastern at Charing Cross. The Directors of all three lines approved the Bill. The length of the line was 4½ miles. Dealing with the petition of the County Council asking more favourable provisions as to workmen's trains, counsel said he thought the Company were already sufficiently burdened by the obligations imposed upon them by the Cheap Trains Act. The promoters were, however, desirous, if possible, of meeting the County Council in the matter, and he suggested the insertion of a similar clause to that put into the City and Brixton Bill last year providing that at least 12 trains should be run before 7 a.m. at a charge of not more than ½d. per mile, and that the holder should be entitled to return by any train during the day.

(Later in the day a clause was agreed to extending the time up to which cheap trains should be run to 8 a.m. at the termini, and fixing 1d. as the charge for the single and 2d. for the double journey, the holder to have the right to return by any train during the day.)

Mr. A. WILLIS, General Manager of the South Eastern Railway, gave evidence generally in support of the scheme. The new scheme, by which a connection would be made between the South Eastern at Charing Cross, and the electric line, by means of lifts or a subway at Craven-street or Villiers-street, would be of great assistance to the local traffic; and he considered that it was the best electrical enterprise that had yet been promoted in London.

Mr. W. R. GALBRAITH, C.E., Consulting Engineer to the London and South-Western Railway, and Engineer to the Waterloo and City Railway, said he was, in conjunction with Sir Douglas Fox, engineer of the present scheme. The levels at Charing Cross had been altered from those set down in the original scheme to avoid underpining. The cost of the proposed new lines and works was estimated at £290,000.

Mr. GEO. H. TURNER, General Manager of the Midland Railway, strongly supported the scheme. He thought any scheme which dealt with the difficulty at present confronting the managers of all the great lines—viz., that of dealing with suburban traffic—should be encouraged.

The Bill was reported to the House for second reading.

LEGAL INTELLIGENCE.

W. T. Glover and Co. (Limited) v. William James Glover and Co. (established 1818) (Limited).

On Monday, in the Chancery of Lancashire, before Vice-Chancellor Hall, Q.C., leave was granted to serve notice of motion for Monday next in this action, which is brought by the plaintiffs for an injunction to restrain the defendants from carrying on business as makers of electric cables, wires, &c., under any title of which "Glover" forms a part.

Factory Prosecution.

At Bilston County Court, Mr. N. C. A. Neville, stipendiary magistrate, gave judgment in the prosecution of the Bilston District Council, for not posting up a copy of the Factory Act in the market hall, which is lighted by electricity produced on the premises. At the first hearing it transpired that the building was used for the generation of electric current for the market hall. The contention of the prosecution was that the hall was a factory because electricity was manufactured by way of trade for the purpose of gain. The defence was that the building was not used for the purpose stated, and that it could not be a factory, because electricity was not an article as defined by the Act. In giving judgment Mr. Neville said that according to the dictionary an article was described as a commodity, and a commodity was that which was useful or advantageous. Electricity, being made at the works, required mechanical power and manual labour, and it would, therefore, come within the meaning of the Factory and Workshops Act if it was an article—as he believed it was—and was used for the purpose of gain. Electricity could be manufactured, stored, moved about, converted into different uses, and stolen. The Council obtained a benefit by producing current in the market, and it must be said to be a gain within the meaning of the Act. A nominal penalty of 2s. 6d. and costs (£1. 17s. 6d.) was imposed.

Alexander v. Margowski and The Automatic Telephone Co. (Limited).

In the Chancery Division yesterday (Thursday), before Mr. Justice North, Mr. M. Alexander sought to obtain an interim injunction restraining Mr. Max Margowski and the Automatic Telephone Co. from acting upon a resolution for removing the plaintiff from his office as director. The resolution was said to have been passed at an extraordinary general meeting of the company, but the plaintiff alleged that no such resolution was ever put to the meeting, which was of a very disorderly character throughout, and that had it been put to the meeting, it would have been lost by an overwhelming majority. In giving judgment, his Lordship said he could not see a tittle of evidence to justify the statement of the Chairman (Mr. Margowski) that the resolution had been carried by a tremendous majority. The proceedings at the meeting were irregular from beginning to end, and it was a disgraceful act on the part of the Chairman to declare that the resolution had been carried when it was not put to the meeting at all. The Chairman knew very well that the resolution had not been carried, and if there had been a show of hands upon the subject, it would have been enormously in favour of rejecting the resolution. The Chairman and a number of persons present at the meeting seemed to have forgotten altogether how to behave as gentlemen and men of business. The attempt to remove Mr. Alexander from his office as director failed, and the injunction would be granted; but as the parties all round were wrong from beginning to end, he would not give either side a penny of costs.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NOW READY.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free; abroad 11s.

"The Students' Guide to Submarine Cable Testing."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition now ready.*

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves."—By Dr. O. J. Lodge, with many original illustrations. *Enlarged Edition*, 2s. 6d. net, 2s. 9d. post free.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s. *New edition ready May 1, 1899.*

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The "Big Blue Book" for 1899 is Now Ready. The Directory Division has been corrected up to Feb. 8, 1899, and all the latest new names, changes of address, &c., will be found included. The Handbook Division has been much extended, many valuable tables having been added. The volume contains, also, the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways, finally corrected to Feb. 9, 1899. The price of the Directory and Handbook remains the same—10s., post free 10s. 9d.; abroad, post free, 12s. (United States 13s. 6d.).

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TENDERS INVITED.

The *Poplar* (London) District Board of Works invite tenders for the execution of the following contracts:—(*a*) Engine and pump room equipment and all electrical plant except battery; (*b*) boiler house equipment; (*c*) battery and battery stands; (*d*) public street lighting. Specifications, &c., may be obtained from the clerk to the Board (Mr. Leonard Potts), 117, High-street, Poplar, London, E., on and after 23rd inst. Further particulars are given in an advertisement, and tenders must be sent to Mr. Potts by 10 a.m. of Tuesday, April 25.

The *Tynemouth* Corporation invite tenders for the supply and erection of the following plant:—(2) boilers, &c., (3) economisers and fittings, (4) ejector-condenser, circulating pumps, tanks and pipework, and water cooler, (5) pumps, feed pipes, &c., (6) travelling crane, (7) traction switchboard, (8) lighting switchboard, (9) accumulators, (10) cables, and (11) traction steam dynamo. An advertisement contains additional information. Specifications, &c., may be obtained on and after 20th inst., at the offices of the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's Gate, Westminster, S.W., and tenders must be sent in to the town clerk (Mr. Horatio A. Adamson), by noon of April 15.

The Great Northern Railway Co. (Ireland) invite tenders for the following works in connection with their line between Sutton and Howth:—Cables for feeders, returns, potential lines, &c., 6 motor and 6 trailer cars, overhead construction, and battery and booster. Specifications can be obtained from the secretary (Mr. T. Morrison), Amiens-street, Dublin, with whom tenders must be lodged by April 20. Specifications may also be seen at, but not obtained from, the office of Prof. Alex. B. W. Kennedy, 17, Victoria-street, London, S.W. Further particulars are given in an advertisement.

As advertised elsewhere the Directors of the Lancashire and Yorkshire Railway invite tenders for the supply of stores during the 12 months ending April 30, 1900, including signal and telegraph fittings, signal, telegraph and electric light wires, screws, oil, springs, wire, &c. Further particulars and forms of tender may be obtained at the Stores Department, Osborne-street, Manchester, and samples may be inspected at the Sample Room from the 20th to the 30th inst. inclusive. Tenders must be lodged with the secretary (Mr. C. W. Bayley), Hunt's Bank, Manchester, by 10 a.m. of Monday, April 3.

The Corporation of *West Hartlepool* invite offers from firms or companies for "free" wiring of premises in the district. Further particulars are given in an advertisement, and offers must be lodged with the town clerk (Mr. Higson Simpson) by April 15.

The Electric Light committee of the *Salford* Corporation invite tenders for stores, particulars of which are set out in an advertisement. Tender forms, &c., may be obtained from the borough electrical engineer (Mr. Chas. L. Turner), Walness-road electricity works, Broughton, Salford.

As announced in an advertisement, the *Rhyl* District Council invite terms from engineers for preparing plans, specifications, &c., for a refuse destructor. Further information may be obtained from the town surveyor (Mr. Robert Hughes). Terms must be in by April 3.

The *Edinburgh* Corporation invite tenders for installing the electric light at the City Chambers (extension buildings). Specifications, &c., can be obtained from the resident electrical engineer (Mr. F. A. Newington), 5, Dewar-place, and tenders must reach the town clerk (Mr. Thomas Hunter, W.S.), City Chambers, Edinburgh, by 10th April. See also advertisement.

The *Barking* District Council invite tenders for the supply and erection of one 80-kilowatt steam dynamo, with necessary pipework and accessories. Tenders, addressed to chairman of Council, by 27th inst.

The *Sunderland* Corporation invite tenders for (*a*) india-rubber covered cables, (*b*) cast and wrought iron pipes and street service boxes, (*c*) stoneware casings and bearers, and (*d*) house fuse boxes. Tenders, addressed to Chairman of Lighting committee, must be delivered at town clerk's office by 30th inst.

The *Doncaster* Corporation invite tenders for the supply and erection of (*b*) three mild steel Lancashire double-flued boilers; (*c*) three sets of steam dynamos, two sets of larger steam dynamos, condensing plant, &c., and a 6-ton overhead traveller; (*d*) storage battery of 136 cells, having a capacity of 750 ampere-hours; (*e*) electrical instruments and other apparatus; (*f*) underground armoured cables, &c. Tenders to town clerk by 28th inst.

The Corporation of *Peterborough* invite tenders for the supply and erection of the following electric lighting plant:—(1) Lancashire boilers and economiser; (2) Steam dynamos, balancers and boosters; (3) Secondary battery and accessories; (4) Switchboard and instruments; (5) piping, tank, condensers and pumps; (6) insulated cables. Tenders to town clerk by Thursday, April 20.

The *Paddington* (London) Guardians invite tenders for wiring the workhouse in Harrow-road. Tenders before 5 p.m. of 28th inst.

The Electric Lighting committee of the *Rothesay* Town Council invite tenders for the supply and erection of two 20 H P. coupled engines and dynamos, switchboard, cables, arc lamps and posts, feed pump, &c. Tenders to town clerk by noon of 27th inst.

The *Southend* Corporation invite tenders for the temporary transfer of their provisional order. Tenders to town clerk by April 6.

The *Wolverhampton* Lighting Committee invite tenders for supplying and erecting about 110 tons of steel stanchions, girders and decking at electricity works. Tenders to borough engineer by April 8.

The *Morecambe* District Council require tenders for mechanical stokers for two Babcock-Wilcox boilers. Particulars from Engineer.

The *Coventry* Corporation invite tenders for extension of the electricity buildings. Tenders to town clerk by 28th inst.

The Guardians of the Poor of *Rochdale* Union require tenders for a complete electric light installation at the workhouse buildings and cottage homes. Specifications, &c., can be obtained from the consulting engineers (Messrs. Crews and Handford, Cross-street Chambers, Manchester), and tenders must be sent in to Mr. R. A. Leach, clerk, Union Offices, Townhead, Rochdale, not later than April 12. An advertisement gives further particulars.

The *Edinburgh* Corporation invite tenders for the supply and erection of water tube boilers at Dewar-place station. Tenders to town clerk by April 3.

The *Aberdeen* Corporation invite tenders for the supply and erection of the following materials for the equipment of their George-street and Woodside tramway route:—(*a*) permanent way and roadwork, (*b*) overhead line construction, (*c*) feeder and test cables, (*d*) tramway cars and all accessories, and (*e*) switchboard, instruments, &c. Tenders to town clerk (Mr. W. Gordon) by 10 a.m. of 29th inst.

The *Aberdeen* Corporation also invite tenders for supply of:—(1) two Babcock-Wilcox boilers, (2) one 180-kilowatt steam dynamo (Belliss or Willans and Robinson engine), with steam and exhaust pipes, and one 75-kilowatt balancing set. Tenders to town clerk by April 5.

TENDERS RECEIVED AND ACCEPTED.

The Greenock Board of Police have accepted the following tenders:—Babcock and Wilcox (water tube boiler, economiser and mechanical stokers), £1,956; Carrick and Ritchie (overhead travelling crane), £450; India Rubber Company (steam dynamos, boosters, switchboard, accumulators, complete piping arrangements, feed heater, and feed pumps), £11,517. 10s.; Callender's Company (low tension mains, and erection of arc lamps, poles, &c.), £12,603. 3s. 2d. The tender of Mr. M'Ewan has been accepted for the erection of the electricity building.

The following tenders have been received for the electric lighting of Emmanuel Church, South Croydon:—

Brush Company (*accepted*)	£230 0	Moody Bros.	£263 12
Planet Elec. Eng. Co	385 0	Bergtheil and Young	255 0
Belshaw and Co.	303 0		

The contract is to be carried out under the supervision of the consulting engineer, Mr. W. Howard Tasker, M.I.E.E.

The Fire Brigade committee of the London County Council have accepted the offer of the National Free Wiring Co. to extend the wiring at the chief fire station, Southwark, S.E., for £86. 10s.

The Wolverhampton Corporation have accepted the tender of Mr. H. Gough for extending the electricity station building.

The West Hartlepool Corporation have accepted the tender of Mr. George Marshall, Darlington, for the erection of electricity supply buildings at £11,473, to be completed within eight months.

The Fulham Vestry have given the contract for the erection of electricity supply and refuse destructor buildings to Mr. G. Minter, at £22,970. Messrs. Wilkinson Bros., whose tender was originally accepted, declined to accept the Vestry's condition that the works should be completed in six months. Mr. Minter guarantees to erect the buildings in 10 months.

The tender of Messrs. Gimson and Co. for the supply of cast-iron tank at the Wimbledon electricity works at £109. 10s. has been accepted.

APPOINTMENTS VACANT AND FILLED.

The Middleton Corporation invite applications for the position of resident electrical engineer. Further particulars are given in an advertisement, and applications (addressed to chairman of the Gas and Electric Lighting committee) must be delivered at the office of the town clerk (Mr. Frederick Entwistle) by 29th inst.

A thoroughly competent manager is required for large india rubber works to be established on the continent. Some further particulars are given in an advertisement.

As advertised elsewhere, the Edinburgh Corporation invite applications for the position of assistant to the superintendent of mains. Applications to resident electrical engineer (Mr. F. A. Newington), 5, Dewar-place, Edinburgh, on or before Monday, April 3.

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The Wolverhampton Corporation require a mains superintendent, at a commencing salary of £104 per annum. Applications to borough electrical engineer (Mr. C. E. C. Shawfield) by Tuesday, April 4. See advertisement.

There are vacancies for two improvers as switchboard attendants at the Portsmouth electricity works. Applications by April 3. See advertisement.

The Corporation of Devonport require an electrical engineer competent to devise electric lighting and tramway scheme for the borough. Applications to town clerk by 29th inst.

The Stafford Gas and Electricity committee require a chief clerk and cashier. Salary £130 per annum. Applications to Town Clerk by noon 25th inst.

Mr. Herbert A. Jones has been appointed manager of the Phœnix Dynamo Manufacturing Co. Mr. Jones has been with the E P.S. Co. for about nine years, formerly upon their laboratory staff and for the last six years as commercial representative in the north of England and Scotland.

Mr. Angus M'Lean, B.Sc., lecturer and demonstrator in experimental physics at Glasgow and West of Scotland Technical College, has been appointed principal of the new Paisley Technical School at a salary of £300 per annum. Mr. M'Lean was educated at the Glasgow University where he graduated B.Sc. with honours in mathematics and natural philosophy.

Mr. William Deeley has been appointed clerk of works in connection with the erection of the Buxton electricity station building.

Mr. M. Roberts, superintendent of the Post Office general factory at Mount Pleasant, London, has been appointed by the Postmaster-General second assistant engineer-in-chief to the Post Office.

BUSINESS NOTICES.

In consequence of increase of business, Messrs. Williamson and Joseph (Limited) have appointed Mr. John G. Dixon, 55, Norfolk-chambers, Norfolk-street, Sheffield, to represent them in the north of England from Derby. Messrs. Ross and Co., 95, Bath-street, Glasgow, have been appointed agents for Scotland, and Mr. A. F. Sargeant, 51, Lincoln's Inn, Corporation-street, Birmingham, will represent the company in Birmingham and surrounding districts.

The offices of the South London Electric Supply Corporation (Limited) will, from March 25 next, be removed from 28, Victoria-street, Westminster, S.W., to Bengeworth-road, Loughborough Junction, London, S.E.

Owing to increase of business in the Leeds district Messrs. Laing, Wharton and Down (Limited) have appointed Mr. Douglas J. Callow (until recently engineer to the Brewster Engineering and the Reedy Elevator Cos. of New York) as district manager and representative. Mr. Callow has had experience in contracting work in this country and in America, and it specially conversant with electric light, power and lift work. The telegraphic address is "Laying," Leeds; telephone, 2,247 Central. Mr. C. T. Taylor remains on the staff as assistant engineer.

The editorial and general offices of *Lightning* have been removed to 8, Bream's-buildings, Chancery-lane, London, E.C.

The following correspondence has appeared in connection with the recent issue of the prospectus of William James Glover and Co. (established 1818) (Limited):—

"With reference to the advertisements which have appeared of a new company under the name of William James Glover and Co. (established 1818) (Limited), described as electrical cable makers, wire drawers, &c., I desire to call the attention of the public to the fact that this company has no connection with our company, W. T. Glover and Co. (Limited) or the business carried on by our predecessors, W. T. Glover and Co., the well-known manufacturers of electric cables, of this address. My directors have insutructed our company's solicitors to take proceedings against the new company to prevent the use of the name of 'Glover' in connection with electric cables, and a writ has been issued for this purpose and will be served and further proceedings taken without delay.—For W. T. Glover and Co. (Limited), S. HARTFORD, Secretary, Salford, Manchester, March 18, 1899."

"Our attention has been drawn to a prospectus issued by Messrs. William James Glover (established 1818) (Limited), in which it is stated that the company had taken over, from a Mr. G. E. Heyl-Dia, an English patent, No. 2610, of 1899. In order to avoid any possible misunderstanding, we beg to draw attention to the fact that it is a mistake to describe this as a patent. It is at present merely an application for the grant of a patent, and for an idea that we regard (from the description given in the prospectus) as a serious infringement of one or more of this company's existing patents; and further, it is our intention in due course to strongly oppose the grant of the patent on this ground. We may mention that we are filing a caveat at the Patent Office in connection with this matter, and intend to neglect no proper steps to protect our interest.—For the British Insulated Wire Company (Limited), EDWD. TRACEY, Secretary, March 18, 1899."

"We have read Messrs. W. T. Glover and Co's. (Limited) letter, and we beg to say our firm has been in existence since the year 1818, under the same name, William James Glover and Co. Cable making is not a monopoly of Messrs. W. T. Glover and Co. (Limited), of Salford, or any other company. Before registering our company, we not only consulted our solicitors as to the name of this company, but have also submitted the matter to the decision of the Registrar of Joint Stock Companies, at Somerset House, and obtained his approval and certificate of incorporation. The animus prompting this letter to the papers is obvious, and we regret that Messrs. W. T. Glover and Co. (Limited), of Salford, fear the competition of this company so much as to lead them to take such a step.—WILLIAM JAMES GLOVER AND CO. (established 1818) (LIMITED), G. E. HEYL-DIA, Managing Director, 55, Market-street, Manchester, March 20, 1899."

"In reply to the letter of the British Insulated Wire Co., we beg to say that the patent Heyl-Dia, 1899, does not form any part of the assets included in the valuation of this company, nor is the company in any way dependent upon this patent for the making of electric cables. The complete specification in connection with Mr. Heyl-Dia's application has been filed, and in due course the British Insulated Wire Co. will be able to obtain a copy thereof, but until then we fail to see that there is any justification whatever for their letter. This company, we may say, is indemnified by Mr. Heyl-Dia against any costs that may be incurred in perfecting the patent in question, and the patentee in due course will be prepared to meet the opposition of the British Insulated Wire Co. or any other objectors and maintain his title to the invention. The object and intention of the British Insulated Wire Co. is obvious, but unworthy of them.—WILLIAM JAMES GLOVER AND CO. (established 1818) (LIMITED), G. E. HEYL-DIA, Managing Director, 55, Market-street, Manchester, March 20, 1899."

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting of the Edison-Gower-Bell Telephone Co., of Europe, Limited (old company), will be held on April 27 at 186, Shaftesbury-avenue, London, W.C., to receive an account of the winding-up. Mr. R. Rodgers is liquidator.

Claims against Veale and Co., Limited (old company), St. Austell, must be sent in by April 12 to the liquidator, Mr. J. M. Coon, St. Austell.

A meeting of Pearson's Automatic Fire Indicator Co. (Limited) will take place at 100, St. Martin's-lane, London, W.C., on April 21, to receive an account of the winding up. The undertaking has been acquired by the Pearson Fire Alarm System (Limited).

A receiving order has been made against A. W. Charles and J. S. Blackwell, trading as the Central Electrical and Engineering Co., Church-gate, Leicester, and 22, Kennington-road, London, S.E, on their own petition. The first meeting of creditors takes place on 28th inst., and the public examination on April 26, both at Bankruptcy-buildings, London, W.C.

The summary of the affairs of Frederick Marson, electrician, &c., 1, Poplar-avenue, Leicester, shows unsecured liabilities, £478. 5s. 8d., assets estimated at £675. 7s. 1d., surplus £197. The debtor attributes his failure to ill-health. He started in business as an ironmonger in 1886, and has traded at various addresses at Leicester since that date. He executed a deed of arrangement in May last, and undertook to pay 20s. in the £ in four quarterly instalments, but nothing has been paid under this arrangement.

Plant for Sale.—Messrs. Laing, Wharton and Down, 82A, New Bond-street, W., have electric lighting plant for sale, further particulars of which are given in an advertisement elsewhere.

The Electrical Company have for disposal a complete electric lighting plant. Further particulars are given in an advertisement, and the whole may be seen in working order at 122, Charing Cross-road, London, W.C.

Electrical Plant Contracts.—The following contracts for electric lighting and traction plant have been recently placed with the British Thomson-Houston Co.:—

Extensions to overhead line construction, for Leeds city tramways; two direct-connected 1,100 H.P. lighting sets (Belliss engines), for Glasgow Corporation; two 93-kilowatt generators and Belliss engines, three-machine booster and two-machine booster, for Govan; two 500-kilowatt extension generators, for Sheffield tramways; a 500-kilowatt, 2,100-volt, direct-connected alternator and Belliss engine, for Croydon; two 325-kilowatt, direct-connected generators and Belliss engines, with switchboard, for Messrs. Vickers, Sons and Maxim (Limited), Sheffield; nine double-motor equipments, for Dudley and Stourbridge electric tramways; one 150-kilowatt and one 75-kilowatt generators and four-machine booster balancer, for Lowestoft Corporation; three car trucks, with double-motor equipments and magnetic brakes, for Manchester Corporation tramways; six double-motor equipments, with magnetic brakes, for extension to Colombo tramway plant; two 220-kilowatt generators, direct-connected to Ball and Wood engines, for proposed Wolstanton power station of Potteries extension tramways.

Retirement.—Mr. John Doherty, superintending engineer of the north-western district of Post Office telegraphs, retires on April 7, having reached the compulsory age limit of 65. Mr. Doherty has been associated with telegraph work since 1852 when, under the late Mr. W. T. Henley, he was engaged in superintending the laying of the underground telegraph of the Lancashire and Yorkshire Railway system between Manchester and Liverpool. The syndicate with which Mr. Henley was at that time connected afterwards became the Magnetic Telegraph Co., later (in 1851) the British Telegraph Co., and, still later, the British and Irish Tele-

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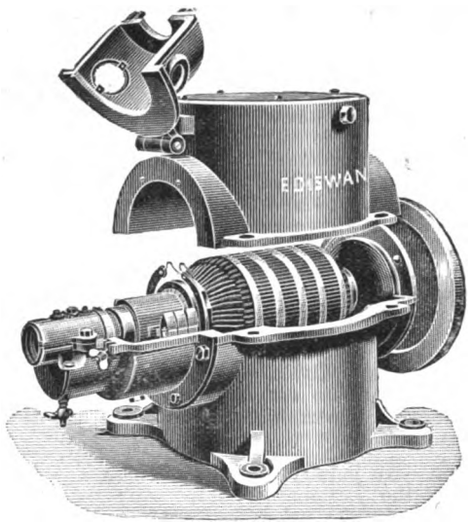
graph Co. Mr. Doherty, in 1858, was connected with the construction of the telegraph lines of the Red Sea Telegraph Co. He subsequently returned to England and rejoined Mr. Henley at the North Woolwich Works and, in 1860, accepted service with the United Kingdom Telegraph Co., whose executive officer in the Manchester district Mr. Doherty remained until the period of the acquisition of the telegraphs by the State in 1870. Since that time he has held the position from which he now retires.

Ediswan Enclosed Motor (New Type).—We illustrate below the new type of Ediswan enclosed motor, recently introduced. The body of this motor consists of two steel castings, which form the enclosing framework and the magnetic circuit. They are fitted together at a broad joint, which in no way interferes with the completeness of the magnetic circuit. The material used is a specially soft cast steel having a magnetic permeability superior to wrought iron, enabling the weight of the motor to be reduced to the smallest amount possible. Gun-metal bearings are fitted in cast-iron brackets, which form the end pieces of the motor. The brasses are several times as long as the diameter of the shaft. Great stiffness is thus secured, and accessibility to the wearing parts is perfect. Effective lubrication is provided for by large oil chambers cast in the lower parts of the brackets, capable of holding an ample supply of oil for a considerable time. Two chains are provided to each bearing, and the oil most effectively distributed over the rubbing surfaces by means of channels, and carried back into the reservoir. The parts are arranged so that it is impossible to overfill the reservoirs, and thus cause the oil to creep into the main body of the motor. The smallest sizes of these motors have two brushes each side,



the larger ones two or more according to the output. All the brush gear terminals and internal connections are at once accessible by lifting the lid provided over the commutator box. The upper half of the body can be easily removed with its own magnet coil attached. The connecting wires to the source of supply are passed in through ebonite glands in the commutator box, placed opposite to the terminals into which those wires have to go. The armature is of the slotted drum type, and the whole motor is of substantial design, capable (it is claimed by the makers) of running continuously without over heating at the full load marked. It is designed also to stand 20 per cent. over-load for an hour or more without injury. It is completely enclosed and dust proof, the commutator cover having a glass window in it, enabling the commutator to be inspected without opening the case.

Volenite.—Some time back, damaging statements were published concerning the works and process owned by Volenite, Limited, and Mr. H. J. Fuller, M.Inst.C.E.I., was appointed to inspect the Company's works at Alperton, Wembley, and to report generally. His report is just published, and is very favourable to the Company's prospects. On the subject of the value of volenite as an insulating material, Mr. Fuller reports: "I am only specially interested in two uses of the material, that for making joints and that for electrical purposes. I have had a piece of the original and greatly inferior stuff put into a previously troublesome joint in the principal steam main of, probably, the largest boiler works in England. It has remained perfectly tight and satisfactory for more than ten months, and is as good to-day as when first put in. As regards di-electric qualities, I have submitted to the largest electrical firm in the world certain samples. I have received the definite result of the tests (applied not with the object of finding out how good the stuff might be, but to find out its weak points, if any), and I am in a position to state that a piece of only seven one-hundreths ($\frac{7}{100}$ths) of an inch in thickness was only pierced by a current at an electrical pressure of 27,000 volts; while another piece, $\frac{13}{32}$nds of an inch thick, resisted the application of 59,000 volts. These pressures are respectively 54 and 118 times the pressure to-day employed in electric traction. In long-distance transmission the cost of the transmission line decreases as the pressure of current increases in a well-understood ratio, high electrical pressure demands absolutely safe insulation, and the absence of the latter has been a drawback hitherto seriously felt. I have suggested to your chemist the preparation of an insulating varnish for application to armature windings, &c., which would be of the highest value, and I understand that he is able to manufacture this. My opinion is that operations with your new fibre have either already resulted in, or are on the verge of reaching, nothing more nor less than chemically manufactured india-rubber at a nominal fraction of its cost. You should be able to command a very large business for electrical purposes."

Alleged Infringement.—In connection with a note appearing in our last issue we have received the following:—

TO THE EDITOR OF THE ELECTRICIAN.

Sir: With reference to the paragraph under the above heading, in your issue of the 17th inst., will you permit me, as author of the Defendant's book referred to, to point out that it was largely an amplification of articles published by me in January and February, 1894, and of a book published by me in March, 1896. Two of the expressions chiefly relied upon by the Plaintiff as evidence of plagiarism were actually used by me in an article published in the *Practical Engineer* in May and June, 1896. As Mr. Lewis's book was only published late in 1896, and was never seen by me before February, 1897, the weakness of the plaintiff's case is apparent. Unfortunately our counsel was not called upon for any reply, and had, therefore, no opportunity of exposing the frivolity of the charges made. Had you been acquainted with the facts of the case, or had you even heard the plaintiff's speech, you would hardly have made the comments you have or expressed such sympathy with him. As I am sure you desire to be just to both your readers and myself, I trust you may find space for this letter.—Yours, &c., FRANCIS G. BURTON.

Poynton, Cheshire, March 20, 1899.

We commented upon the case as it was reported, and our sympathy is certainly with Mr. Lewis in this matter, mainly from the fact that in the remarks made by Mr. Justice Cozens Hardy he distinctly stated "that use had admittedly been made of the plaintiff's book." If this is so, justice demands that due acknowledgment of this indebtedness should have been made by the defendants in their book. We have a letter before us from Mr. Lewis which states: "My words had been used by the defendants in no less than 109 paragraphs on the same subject, and a number of my forms copied almost *verbatim*." If this statement is accurate, or fairly accurate, Mr. Lewis is suffering from a great wrong. We think the tone of Mr. Burton's letter above hardly improves matters. We have certainly no desire to misjudge the particular matter under notice. Our comments were directed against an extremely prevalent custom of culling wholesalely from published works in order to produce cheap editions of books which may reasonably be expected to have a fair sale. Our remarks apply particularly to pocketbook and reference book compilers, who are by far the greatest sinners in this regard.

Langdon-Davies Motors.—The Langdon-Davies Electric Motor Co. have issued the terms upon which the hire and hire-purchase of motors can be arranged, the object of the Company being to supply these motors to small users who cannot afford to buy them outright.

Castings.—Messrs. John Shaw and Co., Maryhill Iron Works, Glasgow, forward a copy of a new list of castings, which include dynamo beds, armature castings, cast-iron columns, pipes and a large variety of jobbing castings of all kinds.

"The Journal."—Parts 137 and 138 of the *Journal* of the Institution of Electrical Engineers are now ready. Particulars of the contents of these numbers are sent out in an advertisement.

Directory of Delagoa.—A useful directory and year-book of local information regarding the town and port of Lourenço Marques has been sent us by Messrs. A. W. Bailey and Co., of that town. The information includes much that is likely to interest traders on this side. It is well got up, and is published at 2s. 6d.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from March 15 to March 21, with the ports of destination:—

Argentina—Buenos Ayres, £3,973 (including £539 telegraph material); La Plata, £108 (including £88 telegraph material). *Australasia*—Brisbane, £227 (including £209 telegraph material); Melbourne, £47; Sydney, £554; Wellington, £369 (including £190 telegraph material). *Belgium*—Ghent, £25; Ostend, £85. *British Guiana*—Berbice, £13. *Burma*—Rangoon, £16. *Ceylon*—Colombo, £65. *Chili*—Boca, £106 (telegraph material). *China*—Shanghai, £229; Tientsin, £104 (telegraph material). *Ecuador*—Limon, £86 (telegraph material). *Egypt*—Alexandria, £173. *France*—Boulogne, £159. *Germany*—Hamburg, £200. *Holland*—Amsterdam, £200. *India*—Bombay, £316 (including £180 telegraph material);

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Calcutta, £258. *Mexico*—Santa Cruz, £35. *Norway*—Christiania, £63. *Russia*—Odessa, £20 (telegraph material). *South Africa*—Cape Town, £328; Delagoa Bay, £95; Durban, £446 (including £103 telegraph material); Port Elizabeth, £391. *Spain*—Barcelona, £31. *Straits Settlements*—Singapore, £120. *Sweden*—Gothenburg, £72; Stockholm, £128 (telegraph material). Total £9,042, against £83,403 in the corresponding week last year (March 16 to March 22).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Alleged Fraud.—At the Guildhall Police Court yesterday (Thursday) Claud Vautin, electro-metallurgist, &c., was again charged with obtaining securities and bonds by fraud. The case was again adjourned.

Ayr.—On the recommendation of the burgh electrical engineer (Mr. Arthur J. Fuller), the Corporation have decided to fix the charge for current for motive power at 3d. per unit, with a minimum charge of 15s. per annum.

Bangor-Donaghadee Electric Tramway.—An inquiry into the engineering details of this tramway has been held at Bangor. All the local authorities affected by the scheme had signified their approval. Mr. Plummer, C.E., engineer to the promoters, submitted plans, and said the overhead trolley system would be adopted. The gauge would be 3ft. 6in., and 70lb. rails would be put down. There would be eight bogie cars, lighted and heated electrically. The generating station would be near Groomspout. After some objection to minor details of the scheme had been heard the inquiry closed.

Blackburn.—The mayor has been invited to open the electric tramways on the 29th inst. The cars on the Preston-road section commenced running on Monday.

Bridge of Allan (N.B.).—The Lighting committee is considering a proposal by Edmondson's Electricity Corporation for electrically lighting this village, together with Dunblane.

Cable Communication with Australia.—Owing to the simultaneous interruption of the Government landlines in South and West Australia, it has been, this week, impossible to transmit telegrams beyond the Eastern Extension Company's cable terminus at Port Darwin. Communication was restored yesterday.

Chester.—Extensions of the electric lighting mains, estimated to cost £1,500, were authorised at the last meeting of the Council, when it was also decided to adopt electric lighting in a number of streets in which mains are already laid, at a cost of £530.

Church Lighting.—SS. Peter and Paul's, Cork, is one of the latest churches to adopt electric lighting. The wiring contract was executed by the local branch of Messrs. Dobsons and Curtis Bros. (Limited). The introduction of the electric light should add to the attractions of this handsome edifice, which is built on the decorated Gothic style, and is one of the finest churches in a city abounding in places of public worship. At all events there will be no further complaints of the deterioration of the internal decoration by gas. Current is taken from the mains of the Cork Electric Tramways and Lighting Co.

City of London.—The Common Council yesterday (Thursday) rejected Mr. Brooke Hitching's motion to approach the City of London Electric Lighting Company with a view to ascertain the price and terms on which the company would be prepared to sell their undertaking to the Corporation. In view of the forthcoming Board of Trade inquiry, it was considered that a discussion on the matter was inopportune.

Colwyn Bay.—The Council have adopted a report from their consulting engineer (Mr. S. V. Clirehugh), recommending the adoption of an extended scheme of electric lighting and the substitution of steam for gas driven plant. A further loan of £4,000 is to be raised.

Dublin.—The proposal of the Municipal Industries Syndicate, to take over the electricity undertaking of the Corporation, has been "taken as read."

Edinburgh.—From Feb. 23 to March 19 the applications for electric current were equal to 5,471 8 c.p. lamps, and the number connected up from the 1st to the 17th inst. were equivalent to 6,500 8 c.p. lamps. The Electric committee recommended the acceptance of an estimate amounting to £8,827 for the formation of a subway between the Macdonald-road station and Picardy-place.

Electricity in Rhodesia.—In the Telukive district of Rhodesia there is installed at the Bonsor Mine a 150 H.P. three-phase plant working at 600 volts. The current generated is used for lighting, hauling, pumping, corn cutting, and driving a sawmill. The Kaffir huts in the neighbourhood (occupied by whites) are lighted by electricity! All the plant is American.

Farnborough.—The Council have finally decided to transfer their electric lighting powers to Power and Traction (Limited).

Glasgow.—At a special meeting of the Corporation the report by Mr. H. F. Parshall on the generation of current for the tramways department was considered and approved. An abstract of the report appeared in our issue of the 10th inst.

Bailie Maclay announced that the Electricity Committee had already lighted up one-half of the electric car route between Mitchell-street and Springburn. The whole of the new engines and dynamos would be in working order within the next few days. The Committee was now in a position to supply all demands for current.

Grays (Essex).—In a supplemental report Mr. A. H. Preece estimates the cost of erecting a refuse destructor in connection with the proposed electricity station at £2,500. It has been decided to combine both schemes, and a committee has been appointed to visit places where destructors are in operation, and to collect information for the guidance of the Council.

Greenock.—The following amended offer has been made by the Directors of the British Electric Traction Co. in connection with the electric tramway scheme for this district:—Rental of Corporation line between Rue End-street and Berryburn, £1,050 a year; minimum quantity of electric current to be purchased each year by company from Corporation, 500,000 units, at 1¾d. per unit for first 200,000, 1½d. for next 100,000, 1¼d. for next 100,000, 1d. for next 100,000 and all power beyond. The company undertakes not to erect a generating station so long as the Corporation gives a satisfactory supply of power.

Islington (London).—The Works committee are to report upon an offer of the National Telephone Company to establish a large exchange, capable of accommodating 4,000 subscribers for Islington, provided the Vestry would give facilities for carrying out the work by means of underground wires.

Some time ago the Vestry let the contract for extending the electricity station building to Messrs. Patman and Fotheringham. This firm refused to sign the Vestry's declaration as to the payment of trade union rates of wages, though they offered to pay the full rate of wages in each class of labour as agreed upon between the Master Builders' Association and the trade unions. The firm had also intimated their objection to the condition that contractors should cause a list of the rates of wages paid to workmen to be exhibited in such a place on or contiguous to the work as should enable any workman engaged thereon to have free excess to the list. Other firms who submitted tenders had also intimated that they would not accept a contract if the Vestry's conditions were insisted upon. The Vestry decided that the conditions be waived on the present occasion.

Japanese Submarine Cable.—A submarine telegraph cable has been laid by the Japanese authorities between various points on the Japanese coast. The cable starts at Kuzuha and traverses the coast to Yamaguchi.

Leamington.—An inquiry was held here on Tuesday into the applications of the Leamington Corporation and the Midland Electric Lighting Co. for provisional orders. Mr. C. A. Russell, Q.C., for the Corporation, sketched the history of the Corporation's relations with the company, which commenced supplying current in 1887. He submitted that the last thing the company really wanted was a provisional order. They had begun the supply of current under an agreement with the Corporation, and they would not have applied for an order if they had not been driven to it. He contended that what the company wanted was perpetual and unlimited rights and privileges, and not an order. He asked the Board to grant the Corporation's application. Evidence was given, on behalf of the Corporation, to the effect that the supply of current was not satisfactory. Mr. R. Hammond, consulting engineer to the Corporation, said that it would be putting on the Corporation too onerous a burden in paying for the existing plant, &c., the price which was shown by the present capital of the company. He considered the clause proposed by the Corporation, to take over practically that portion of the plant which would be serviceable to them, was an extremely equitable clause, and one which should be satisfactory. It would be an injustice to ask the Corporation to take it over at cost price. He thought that with modern plant they would be able to supply electricity in Leamington cheaper than the company were now supplying it. Mr. Mahmorran, Q.C., for the Company, said his clients engaged in electric light supply in 1887, when electric lighting was in its infancy. It was not until 1897 that they were able to pay a small dividend and they felt that just at the time when there was some likelihood of getting a return for the expenditure incurred, it was more than hard—it was unjust—to seek to deprive them of their undertaking at a ruinous price, that is, if the suggested Board of Trade clause were inserted. He maintained that the present case required exceptional treatment. Mr. Chamberlain originally intended to obtain an order but there was some delay, and in 1890 the Corporation came in and opposed them. The complaint as to the lighting only referred to the street lighting. If the agreement with the Corporation was *ultra vires* in the first instance then the moral obligation was all the greater, and the company had the more need

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of the protection of the Board of Trade. The supply of current, he urged, had not been unsatisfactory. Mr. Arthur Chamberlain said Councillor Fell and Mr. Passman (town clerk) were promoters of the original company in Leamington. The original company was established in 1881, and he was asked to take over the company, pay its debts, and start electricity works in Leamington. He agreed that if he found sufficient support in the town he would do so. The letter he wrote to the Council, and which the Corporation had set out in their objections, was that of a business man proposing generally to put his goods before business men. That letter fairly showed what was the position between them. A temporary installation was his idea at the time, with a portable engine and boiler. The support of the Council was the one thing upon which he then relied. The company had carried on the concern for twelve years, and never had a penny interest. They were now turning the corner, and it was proposed to confiscate their property. He should prefer his freedom rather than the Board of Trade should grant two orders. He had previously applied to the Board for an order, and it was not fair to charge him with breakdowns after that application. Mr. J. C. Vaudrey thought the breakdown of the mains was due to accident and could not have been avoided. The present electrical supply at Leamington was capable of meeting any demand upon it, and could be extended to a considerable extent. Mr. F. W. E. Jones, engineer to the company, also gave evidence, and the inquiry closed.

Leatherhead.—The consideration of the electric lighting scheme prepared by Messrs. Handcock and Dykes has been deferred for six weeks. In the meantime the gas company have promised to improve its lighting.

Leith.—The charge for electric current for power purposes has been reduced from 3d. to 1½d. per unit. For lighting purposes a scale of discounts for large consumers is to be drawn up.

Light Railways.—A proposal has been made by a London syndicate to construct a light (electric) railway from Whitehaven, through Workington to Maryport. The company also propose to supply current for public and private lighting at the latter town.

The Board of Trade have authorised the construction of a light (electric) railway from Liverpool to Prescot, and also from the esplanade to the Isle of Wight Railway Co.'s station at Ventnor.

Liverpool.—The following charges for electric current come into operation on April 1:—For lighting 4d. per unit; for power up to 3,000 units per quarter 2d. per unit, for each unit over 3,000 units 1d. per unit; for street lighting 2d. per unit; for lighting municipal buildings, &c., 3d. per unit.

Manchester.—The Electricity committee have received the sanction of the Board of Trade to their scheme for supplying electric current in the districts of Levenshulme, Moss Side and Withington.

Marylebone (London).—The Bill presented to Parliament by the Marylebone Vestry for the acquisition of that portion of the Metropolitan Electric Supply Co.'s undertaking which supplies Marylebone parish, not having complied with the standing orders, has been withdrawn. This is the second Bill presented by the Vestry to Parliament. We fear the ratepayers may come to regard the expense of these proceedings out of proportion to the advantage derived.

Montrose.—Edmondson's Electricity Corporation have acquired a site for an electricity generating station in Blackfriars-street, Montrose.

Newcastle-onTyne.—The Tramways committee have asked Prof. Kennedy to visit Newcastle before his departure to America on behalf of the London County Council, in order that they may have a consultation with him and Mr. Charles Hopkinson as to the system of traction to be adopted on the local tramways.

New Malden (Surrey).—The ratepayers in the Malden and Coombe districts are anxious to obtain a supply of electric current from the Kingston electricity works. It was announced at the last meeting of the Council that the Board of Trade had been seen in connection with the proposed extension of the Kingston mains, and the Board is against extending the scope of the provisional order to include Coombe.

Newmarket.—Electric current was supplied for the first time on the 11th inst. The boilers at the electricity works were supplied by Messrs. Davey, Paxman and Co., the engines by Messrs. Willans and Robinson, the dynamos by Messrs. Thos. Parker (Limited), and the storage battery by the D.P. Battery Co. Current is supplied on the three-wire system, and the capacity of the plant is equal to 3,000 8-c.p. lamps.

Paddington (London).—Owing to the Vestry's objection to certain works proposed to be executed by the Metropolitan Electric Supply Co., under their provisional order (1890), and their Act (1898), the Company appealed to the Board of Trade to appoint an arbitrator, and Major P. Cardew has been instructed to hold an inquiry into the merits of the appeal.

Patent Law in the Soudan.—It has been decided that no registration of trade marks before the Mixed Tribunals of Egypt can be held to protect the rights of their owners in the Soudan.

Proposed Liverpool-Manchester Electric Railway.—The first meeting of the committee recently formed for the purpose of investigating the proposal to construct an electric express railway between Liverpool and Manchester, was held at the Manchester Town Hall on Wednesday, when a sub-committee of twelve was formed to enquire into and report upon the engineering and commercial feasibility of Mr. Behr's scheme. The sub-committee include Sir W. H. Bailey, Mr. William Mather and Ald. Higginbottom, of Manchester, and Messrs. C. Petrie, S. B. Cottrell and A. Bromley-Holmes, Liverpool, an eminently practical group.

Riga (Russia).—It is announced that the Russian Ministry of the Interior has under consideration a project for constructing a network of electric railways in Riga. The Corporation of the town are acting with the Ministry in this matter. It is probable that a loan will be granted the Municipality at low interest to carry out the scheme, which is estimated to cost £160,000.

San Paulo Gas Co.—This company are putting down electric lighting plant for the supply of current to the new passenger stations of the San Paulo Railway Co., and for supplying current for private lighting in San Paulo and district.

Smoke Nuisance.—At Southwark last week the City of London Electric Lighting Co. was summoned for permitting black smoke to issue from the chimney at their generating station at Bankside, on certain specified dates. Mr. Topham, who prosecuted (or shall we say persecuted?) on behalf of the St. Saviour's Board of Works, stated that the Company was recently fined £100 at the Court for similar offences. Mr. Passmore (for the defence) to a witness for the Board of Works: Is it not a fact that your Board would not prosecute were they not egged on by the London County Council? Witness: Originally the County Council did bring pressure to bear, but I do not know anything about it recently. Mr. Pasmore said he did not purpose calling any witnesses, but to frankly explain to the Court how seriously handicapped the company was. Since the case was before the magistrate the company had commenced the work of reconstructing their furnaces, so that of 32 on their premises 18 were now under reconstruction. This had diminished their producing capacity, and they were being threatened by the City Corporation for not supplying current at the necessary pressure. Mr. Slade said he saw no difference between the present case and that previously before the Court, and inflicted the maximum penalty—£10 on each of the six summonses—£60 in all.

Telephone Statistics.—The statistical department of the Swedish Government has recently prepared an approximate list of the number of telephones in use in the different countries of the world, and these particulars are set out below. It will be seen that for Great Britain and Ireland and France the figures are only up to 1894, whereas for Canada the figures include those for 1898. In other cases the figures given are much below those known to us to be correct at a recent date.

	Instruments in use. Number.	Distance covered by lines. Miles.	Kilometres.
Sweden (1897)	56,50)	74,568	120,000
Norway (1897)	20,678	33,481	53,889
Denmark (1895)	10,500	9,321	15,000
Finland (1895)	7,351	13,049	21,000
Great Britain and Ireland (1894)	69,645	83,401	134,215
Holland	8,000	4,971	8,000
Belgium (1895)	9,227	16,235	26,127
Germany (1896)	151,101	147,093	2?6,712
Austria (1896)	21,616	46,375	74,630
Hungary (1896)	10,293	17,940	28,870
Switzerland (1897)	28,846	47,594	76,593
France (1894)	27,736	63,230	101,754
Italy (1896)	11,991	13,049	21,000
Spain	11,038	14,282	22,984
Russia	18,495	40,391	65,000
Roumania	750	141	227
Bulgaria (1893)	300	372	600
Japan (1897)	3,232	5,262	8,468
British India	1,601	2,296	3,695
French India	89	345	556
Philippines	452	592	954
Algiers	335	224	361
Tunis	200	281	452
Senegal	50	54	87
The Cape and Natal	600	1,100	1,770
United States (1896)	772,627	805,711	1,296,655
Cuba	1,818	1,181	1,900
Canada (1898)	33,500	44,020	70,840
Mexico (1896)	9,000	11,807	19,000
Paraguay (1891)	500	625	1,006
Uruguay (1896)	3,269	8,117	13,063
Australia	823	2,390	3,846
Total	**1,288,163**	**1,509,499**	**2,429,254**

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Southampton.—Current was switched on to the public lamps on Thursday evening last by the Mayor (Mr. G. A. E. Hussey).

Telephone in Manchester.—The special Telephone Committee of the Manchester Corporation were recently invited to include representatives of that body in a deputation to the Chancellor of the Exchequer from the New Mutual Telephone Co., who are endeavouring to obtain permission to establish a telephone service in Manchester in opposition to the National Company. We have previously referred to the coolness which has arisen between the New Mutual Telephone Co. and the Manchester Corporation, and the final blow has now been given. The special Telephone Committee considers it is not desirable to have the Corporation represented in the deputation.

Ventnor.—It is expected that the electricity works will be in working order by Easter.

Wimbledon.—A charge of 4d. per unit is to be made for current to places of public worship. For public lighting by means of 16 c.p. incandescents a charge of £3 per lamp per annum has been decided upon. The Electric Lighting committee have orders in hand for the supply of about 5,000 8 c.p. lamps for private lighting.

Electro Harmonic Society.—A smoking concert will be held at the St. James's Hall Restaurant (Banquet Room), Regent-street, W., this (Friday) evening at 8 o'clock.

COMPANIES' MEETINGS AND REPORTS.

Direct Spanish Telegraph Co. (Limited).

The forty-seventh ordinary general meeting of this Company was held at the offices, Winchester House, Old Broad-street, on the 17th inst., under the presidency of the Most Hon. the Marquis of TWEEDDALE, K.T.

The MANAGER (Mr. Ch. Gerhardi, M.I.E.E.) read the notice convening the meeting and the minutes of the last meeting.

The CHAIRMAN then said: Gentlemen, it is now my duty to invite your approval of the report and accounts, which I presume you will take as read; and in doing so I propose to supplement the report, which is already very full of information, with a few remarks on our proceedings during the past year. The traffic receipts show an increase of £3,812, owing almost entirely to the exceptional state of things which prevailed in the Spanish colonies during the past year. This condition no longer exists, and the traffic has now fallen back to its normal state; and I may mention with respect to this that the decline is somewhat considerable, amounting up to date to about £891, although, in fact, the number of telegrams is very much greater, showing that we are dealing with normal traffic. During the time of the Spanish war we had long official messages and very long press messages, which went to swell our receipts very much. Of course, this has all come to an end, and we shall now have to look forward to somewhat reduced receipts. The ordinary expenses exhibit an increase of £349, which is explained by the increased traffic, the items composing it—such as a larger staff, more instruments, &c.—being such as are dependent on the maintenance of the traffic and the work performed. On the other hand, there is a considerable decrease, amounting to £153, on the London office and London station expenses, as well as a small decrease of £33 under the head of travelling expenses. The extraordinary expenditure is higher by £3,082 than it was in 1897, and this is due to the cost of the two repairs to the Bilbao cable, amounting to £2,117, and to that of the extension and alteration of the London station, amounting to £961—making, together, £3,078. With respect to this latter item, I am sure that the shareholders will have noted with satisfaction that excellent accommodation has now beeen provided by the acquisition, upon a long lease, of 75, Gracechurch-street. This will enable the Company to carry on its business with greater advantage both to the public as well as to the staff. The terms on which the parts of the building not required by the Company have been let by the Company to desirable tenants will render the rent to us extremely reasonable. There is also an item of £326 which requires explanation. That is for the cost of renewing the two submarine cables across the Helford river, which form part of the duplicate underground line between Falmouth and Kennack, where the Bilbao cable lands, and which, after working for 17 years, failed entirely during last year. The item in the extraordinary expenses which shows the largest increase, £498, is explained by the necessity of renewing the underground lines at Bilbao. The Company's station in the town of Bilbao is connected with Arrigunaga, the landing place of the cable to England, by underground cables. These were laid in 1882, and in many places had become very defective, owing to the nature of the soil and other causes. It was therefore decided to replace the worst sections, before the cables failed entirely, by pipe lines. This important connection is now in fairly good order, although it is not at all improbable that before very long we may have to renew further sections of these underground cables. Another item is £11 for the supply and fitting of Hughes' instruments at our Bilbao station. The Spanish Telegraph Administration urged the adoption of the Hughes' instrument in working the special wire between Bilbao and Madrid, and as it was found to be to our interests to accede to their wish, the necessary instruments were purchased. The communication between Bilbao and Madrid has been considerably improved by their use. The Morse instruments can however, be resorted to at any time on the Madrid-Bilbao wire when through communication between Madrid and London is required. Paragraph 4 of the report refers to a fault which was discovered on May 21 last in the Bilbao cable about 13 miles from Bilbao. This fault was not serious enough to interrupt communication, but it rendered duplex working difficult, and as there happened to be a repairing ship of the Eastern Telegraph Co. on her way from Lisbon to England, the opportunity was taken advantage of to remove the fault. Two months afterwards the Bilbao cable gave way altogether, at 199 knots from Falmouth, owing to the cable lying upon uneven ground. This repair was effected, and after soundings had been taken, the position of the cable was altered, and it is hoped and believed that we shall not experience any recurrence of such an accident. The repair of this cable is remarkable for the promptitude with which it was effected. The break occurred on July 8, and although the steamship "Mirror," commanded by Capt. Pattison, was then in the Thames, the repair was effected within six days. That reflects considerable credit on Capt. Pattison, who is a most expert cable engineer. The net result of the year's operations is that, after providing for the debenture interest and redemption, and placing £5,000 to the reserve fund, the Directors are able to recommend the payment of the usual dividend of 10 per cent. on the Preference shares, and of a dividend at the rate of 4 per cent. on the Ordinary shares, half of which has already been distributed. The reserve fund now amounts to a little over £50,000—a substantial sum, no doubt, but still, in our opinion, not adequate as a provision for future contingencies. The only criticism that has reached us with reference to the report is that our dividend is not quite as large as might have been expected. I think, however, what I have said about the falling off in the traffic receipts this year, and their return to a normal condition, affords very good reason for not increasing our present dividend of 4 per cent. If we thought it was probable that we should be able to maintain a dividend of 5 per cent., if we were to pay it, I think that we should have no hesitation whatever in recommending a somewhat larger dividend; but in view of the reduction in the receipts and the improbability, therefore, of our being able to maintain a dividend of 5 per cent., supposing we were to pay it now, we feel that it will be better to strengthen our finances by adding to the reserve and contingency funds, and continue to pay the not at all small dividend of 4 per cent. With these observations I beg to move—

"*That the Report and accounts now presented be and are hereby received and adopted.*"

Mr. J. DENISON-PENDER seconded the motion, which was carried unanimously.

The CHAIRMAN: I have now to propose—

"*That the dividend at the rate of 10 per cent. per annum, less income tax, on the Preference shares, and a dividend of 4 per cent. per annum, free of income tax, on the Ordinary shares, both for the half-year ended Dec. 31, 1898, be and are hereby declared.*"

Mr. PENDER seconded the resolution, which was unanimously adopted.

On the motion of the CHAIRMAN, seconded by Mr. F. ALEXANDER JOHNSTON, Mr. J. Denison-Pender was re-elected a Director of the Company.

The auditors, Messrs. Deloitte, Dever, Griffiths and Co., were afterwards re-elected to their position for the present year.

A vote of thanks to the Chairman and Directors was then passed, and the proceedings terminated.

British Electric Traction Co. (Limited).

The third ordinary general meeting of this company was held on Saturday last, Sir CHARLES RIVERS WILSON, G.C.M.G., C.B., presiding.

The SECRETARY (Mr. George Stevens) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, when I last addressed you I predicted that the balance-sheet which we should present to you on the present occasion would show the Company to be in a very strong position. That expectation has, as you will agree, been realised. Our year has been one of very considerable labour, accompanied by certain anxieties, and we have had to encounter great obstacles; but we have accomplished a good deal, and I think we may consider that we have prepared the ground for a series of large and, I trust, very successful operations for the future. The report and accounts, I presume, we may take as read. I think it will be satisfactory to you that at the end of the second year of our operations we are able to show a substantial net profit of £67,778; and you will bear in mind that, although this includes £9,804 brought forward, it does not include premiums received on new issues of capital. With reference to the proposed appropriation of this net profit of £67,778, the Directors propose to write off the remaining portion of the preliminary expenses, £5,879. It is not generally the case that a company is able to wipe out the whole of its preliminary expenses within the first two years of its existence, but I think it is admitted that, whenever it is possible, it is a good thing to get this item without delay. The goodwill account stood last year at £15,000 and we propose to write off £5,000, leaving it at £10,000. You will remember how the goodwill account of £15,000 arose. At the inception of the Company £5,000 was paid as profit to the Pioneer shareholders and the other £10,000 for the promotion of the Company. They were not excessive figures, having regard to the very valuable business which has been built up upon the foundations thus provided. As a matter of fact it was really absurd, for the goodwill of a company like this to be put at so low a figure as either £10,000 or £15,000, and instead of the goodwill account being required to be written down, it would be really more correct to write it up; for if the goodwill of the business was worth £15,000 at the time of the formation of the Company, I have no hesitation whatever in saying that it is immensely more valuable than what is represented by that figure. Nevertheless it is the desire of the board to eliminate from the balance-sheet all items that are not immediately realisable, and as there is no object in

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debiting the goodwill account with £15,000 when, as a matter of fact, it is represented by a very much higher figure, the Directors propose gradually to wipe it out of the balance-sheet. In speaking of the goodwill, the shareholders will realise that an enormous amount of work has been done which is not represented in the accounts at all. The Company has not only made a satisfactory profit, but it has built up a great organisation, which will serve the purpose of creating and carrying on a large business in the future, and has laid the foundation for many profitable transactions. Although the business has been established only so short a time, we have collected around us a staff of competent officers, and machinery for carrying out a large amount of engineering and other work, all of which is worth a considerable price, but which is not in any way brought into the accounts. The whole expense of developing the business has either been charged to revenue account or has in part been added to the cost of undertakings in hand, all of which will come back to us with a profit. We have, of course, to provide for the dividend on the Preference shares for the year. £1,195 was paid as interim dividend on Aug. 15th last, and £2,252 is the proportion of the Preference dividend calculated up to the end of the year. This leaves £53,451 to deal with. As the proposed dividend of 6 per cent. on the Ordinary shares for the year would absorb only £18,000, leaving £35,451 to be carried forward, some shareholders may think that we have erred on the side of prudence, and that we ought to distribute a larger dividend, but I will say at once that the board have given this matter their most anxious consideration; and while they are quite satisfied that the profits have been fully earned and that if we could be quite sure of the future there would be no objection whatever to a somewhat larger distribution, yet, in view of the fact that we are developing a very large business, and one which is not altogether free from uncertainties, we think it would be wiser for us to make it our first object to put the Company in a thoroughly sound and impregnable financial position. We are working largely for the future. The full development of this business requires large increases of capital, and the stronger our position is, the better will be the terms upon which we can raise this capital, and the higher will be the dividends that we hope to be able to distribute on the Ordinary shares. You will see by the accounts that the charge for dividends in respect of the past year was only £21,448, whereas in the current year, upon the capital actually issued, without taking into consideration the charge which may arise in respect of future issues, will be £46,000. I refer to this in further explanation of the reason why we think it well to carry forward the balance of £35,450. We also think it very desirable that we should at least equalise our dividends in the future, irrespective of any increase. Turning to the capital account, you will gather from the report that the whole of our share capital and £200,000 debenture stock, making £800,000 in all, have been issued up to date. At the end of the year only £500,000 had been issued, and the net amount of premiums received was £29,135, which we have invested in consols. Since the close of the year a further £300,000 of capital, part of the total of £800,000, has been issued, and these additional issues have produced premiums of about £45,000. We have, therefore, at the present moment a reserve fund of something like £75,000, and it is the intention of the Board to invest this reserve fund in consols and first-class securities. Now that the whole of our share capital has been subscribed and is profitably employed in the business of the Company, the Directors consider it advisable that the shareholders should give them the necessary power to make further issues as and when they may deem advisable. The proposal is to double the present share capital, which will give the Directors power to double also the present issue of debenture stock. It would be impossible for me to explain in detail all the large number of undertakings we are engaged upon. The list embraces undertakings from Devonport, Poole and Brighton in the south, to Greenock in the north; and there is scarcely a division of the British Isles in which the Company is not carrying on its operations. Some of these are of considerable magnitude. To take the Potteries Electric Traction Co. as a sample, it has a subscribed capital of £400,000 and is carrying out electrical tramways and light railways extending over a distance of 34 miles. This is certainly the largest electric traction undertaking in the country. Then we have the Swansea undertaking, which has a subscribed share and debenture capital of close upon £200,000, and is at present working authorised tramways and has also obtained statutory powers for converting these tramways to electrical working. Quite lately an arrangement has been made to take over the Swansea Mumbles Railway, which will also be electrically equipped, and passengers will be enabled to travel from any part of Swansea right to the Mumbles by electric car without changing. I may also take the Dudley-Stourbridge Company which is part of the large scheme of electrical tramways we are endeavouring to provide for the whole of South Staffordshire, and that part known as the "Black Country," a combination similar to that which we are carrying out in the Potteries district. The Dudley-Stourbridge Company has a subscribed capital of over £60,000, and this will shortly be increased. These are examples of the work we are doing. With regard to the Company's investments, by far the largest part of our capital is invested in debentures and shares in associated and other companies, and it is important that you should feel satisfied that these investments are sound and remunerative; and when I tell you that they cover a list of no fewer than 40 companies, you have no cause to fear that we have put all our eggs into one basket. Every one of our investments is a satisfactory source of profit. It is, however, not so much at present for the sake of investment that we put our money into these companies, but rather with a view to develop electric traction and the business of our Company. One of the difficulties this Company has to overcome is the antipathy of shareholders in the existing tramway companies to sanction the conversion of their line to electric traction. We have, first of all, to teach the existing tramway companies that it is in their interests to adopt electric traction, and when we have succeeded in doing this we have to approach the local authorities and persuade them to allow electric traction to be adopted. In each case we are met with some misgiving and suspicion, and, in the case of the local authorities, we are brought face to face with the difficulty presented by the present tendency of municipalities to undertake trading operations. They have not the enterprise or the initiative to propose electric tramways, but directly we approach them with a proposal to improve the service of the tramways in their towns, or with a proposal to provide additional tramway facilities, it at once occurs to them that we, being a commercial body, would not make these proposals if they were not likely to be profitable; and then they want to know why, if profit is to be made, they, the municipalities, should not make it themselves. But they do not know how to go about the business, and they do not hesitate to negotiate with us (to "pick our brains," so to speak), and then, when we have told them all we can tell them, they frequently decide in favour of a policy of what is generally called municipalisation, and they do so on the ground that it is in the interests of the ratepayers; but the curious thing about this cry of municipalisation for the benefit of the ratepayers is that in most cases where corporations have thus municipalised commercial undertakings, the rates do not go down, but, on the contrary, are steadily increasing. On a former occasion I pointed out the difficulties which corporations have in municipalising tramways and light railways when worked by electricity, because they require to be carried beyond municipal boundaries; and our further experience of these difficulties has convinced us that, if the development of this enterprise in this country is to be in the hands of local authorities, we shall never have the tramway and light railway facilities which other countries possess. I may add, *apropos* of this important question, that we do not propose to confine our operations entirely to England, Scotland and Ireland; but we are looking outside these islands, and hope to obtain some position in connection with profitable undertakings in foreign countries, or, still more probably, in some of our colonies. There is no reason why we should not undertake that work if profitable; but I insist on it, in connection with the question of the opposition we encounter from local authorities, as a sort of object-lesson showing how the policy of those bodies has a tendency to drive British enterprise and capital out of this country. Reverting to the question of investments, all our investments stand in the books at cost price, and in the case of the shares mentioned in the auditor's certificate, which cost us £10, they are now saleable in the market at £16, and others are at even a higher premium. We propose in the future to make up the accounts to the end of March in each year. This will enable us to include in our profit and loss account the results of the year's working by the various associated companies, and we shall be able to embody in our report, the reports of the various associated companies in which you are interested. The next account will, therefore, be for a period of fifteen months, and the next ordinary general meeting will probably be held some time in May next year. I now move the adoption of the report and accounts, and of the recommendations as to dividends and otherwise.

Mr. EMILE GARCKE seconded the motion.

Mr. TUCKETT thought the statement the chairman had made showed the position of the Company to be eminently satisfactory. Of the £200,000 capital issued last year £100,000 was in Preference shares and £100,000 in Debenture stock. On those amounts £41,000 gross was received in premiums, and £29,000 net. That was £11,000 went for expenses of issue, or rather more than 5 per cent. He did not suggest that that was an improper or an unnecessary expense, but the Company now stood in such a sound position, and the shareholders believed in its prospects so thoroughly, that they would now be glad themselves to take the issues of capital that might be made.

Mr. MAKINS asked if they could have half-yearly meetings or, at any rate, an interim report from the Directors. The Company had no traffic receipts to publish, like the great railway companies, and he thought what he had suggested might be done.

The CHAIRMAN: There are reasons which I think will commend themselves to all which would rather conflict with the too frequent publication of the results of our operations. There is very strong competition in the matter of electric traction, and I think it is unnecessay to take the entire public—and particularly that portion of the public which may be in competition with us—into our confidence regarding our transactions. If at any time any shareholder desires information the offices are open, and the best attention of the officials shall be given to them.

Mr. CORK wished to know in what way their Company took a part in the administration of the companies with which they were associated.

The CHAIRMAN: The way in which we exercise control over those companies is by obtaining a majority on the Board, and sometimes the whole control is in our hands—by our being represented by our own Directors or officers. We, therefore, have the complete control, if not the entire management of those undertakings; and I would also mention this—that on appointing our officers and Directors to act as administrators in these companies, we do not allow them to receive any fees or remuneration for their services. Whatever fees are received are paid into the treasury of this Company.

The resolution for the adoption of the report and accounts was then adopted.

Lord Rathmore and Mr. J. S. Raworth were re-elected Directors, and Mr. F. W. Smith was re-appointed auditor; after which an extraordinary meeting was held, at which

The CHAIRMAN said: You will understand the necessity of our obtaining further capital shortly, and the amount we ask you to give us the discretion to issue is 60,000 shares—that is to say, 30,000 Ordinary and 30,000 Preference shares.

A resolution, approving the issue of the additional capital, was proposed.

Mr. MAKINS proposed an amendment that all new shares should be offered to the shareholders in proportion to their holdings.

The CHAIRMAN said: It would be quite impossible for the board to accept such a resolution as a binding instruction. To impose upon the

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board a standing obligation under all circumstances, without any reservation of their discretion, is a matter which would certainly not be advisable in the best interests of the Company. Our financial friends have done much for us up to the present time. I am not at all hostile to the practice which Mr. Makins has indicated, but I consider that its application as an obligation on us is at the present time premature, and would be most improper and most harmful. It might place us in the greatest possible difficulty. A question has been asked as to whether it was the case that one of the Directors was connected with the board of the Electric and General Investment Co. It is perfectly true that one of our members—the most distinguished member of our board I may call him, and to whom you owe almost exclusively our extremely successful results—is a Director of that Company. For a long time before Mr. Garcke joined this Company he was a member of the board of that Company, and the very fact that he is a member of that board has been of the utmost advantage to your interests. I wish to speak within bounds, but I felt indignant that such an observation should have been made, implying distrust, and something more, of Mr. Garcke, whose labour in your interest I have no words to describe. I assure the gentleman who made that inquiry that he would not have done so had he known what Mr. Garcke is and what Mr. Garcke has done for this Company, which is, in a sense, his sole creation. The benefit which has accrued to you from the enhanced value of our securities you owe, in a large measure, to Mr. Garcke.

Mr. MAKINS said he desired to state that he had not cast any imputation on Mr. Garcke. He knew that gentleman's ability, and estimated it as highly as anyone could. The only point he had raised was that the outside public had been employed to take an issue of Preference shares, which the shareholders in the Company would themselves have been delighted to take up. He himself applied for 500 shares and received only 100. He desired to withdraw his proposal.

This course having been allowed, and the notion of the issue of additional capital unanimously approved, a vote of thanks to the Chairman and Directors terminated the proceedings.

South London Electric Supply Corporation (Limited).

The ordinary general meeting of shareholders in this Company was held at Winchester House, Old Broad-street, on Tuesday, Mr. GEORGE ELLIS, J.P., presiding.

The SECRETARY (Mr. Sidney H. Webster) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, in greeting you at this second annual meeting, I do so with the utmost confidence, as I feel that our financial policy has proved to have been based on thoroughly sound and business principles, and has consequently been of immense advantage to the Company. In fact, had we not seized the opportunity which presented itself of placing the balance of the share capital when we did, we could not have carried out the contracts in their entirety, or have built a station and erected plant of sufficient capacity to enable us to satisfactorily supply the very extended area over which we have powers. Now that we have had time to realise the magnitude of the work we have undertaken, and the possibilities of the demand for electric energy in the parish of Lambeth, entailing, as it does, miles and miles of mains, and the great outlay necessary for the erection and equipment of so large a combined generating station and dust destructor as we are building—the largest, I believe, in the United Kingdom—I think we have reason to congratulate ourselves upon our strong financial position. It is very satisfactory to feel that after meeting all the charges incumbent on us for this very large station we shall have ample trading capital, and be able to start business on a thoroughly sound financial basis. I will now briefly explain to you the progress we have made, and the condition, as it stands to-day, of each department of our work; that is to say: (1) the buildings and the work generally upon the site; (2) the mains, transformers and house connections; and (3) the plant and machinery. First as to the buildings and the work upon the site. You will recollect that owing to difficulties and negotiations in connection with the acquisition of the site, it was not until Michaelmas of 1897 that we were in actual possession of the land, so that, what with the time taken up in getting building materials on it, and organising the labour, it was not until November in 1897 that the contractors were able to commence the actual construction of the buildings. During the spring and summer months of 1898, the weather was most favourable for building operations, but this was succeeded by several months of broken and wet weather during which the builders were much impeded, being only able to work about two-thirds of the time. Lately, again we have had very favourable weather and the work has been carried on with great speed. The position to-day is, that the chimney shaft, 180ft. in height, is quite complete and ready for use. The main building, consisting of the destructor house, boiler house, engine and dynamo house, is finished and roofed in, and the various rooms adjoining the main building, consisting of coal and other stores, outbuildings, &c., are also finished. The offices are ready for occupation, being quite complete with interior fittings and furniture, so that in a few days—in fact, on the 25th inst.—we shall remove our clerical and engineering staff into them, and by thus having all the officers under one roof much labour and inconvenience, and consequently expenditure, will be saved. The whole of the boilers have been delivered and erected, and four of the boilers and eight of the destructor cells are finished and ready for use; whilst the progress being made on the remainder makes it certain that the whole of the work within the destructor and boiler house will be finished by the early summer. The artesian well alluded to in the report is finished and is 390 feet in depth, and in this connection I should like to say that the Board are extremely gratified, as I feel sure you are, at the success which has attended this venture, for I must call it so. We took a considerable time in deciding as to whether we should spend the necessary amount—roughly £1,000—for the experts whom we consulted on this point were not unanimous in their opinion as to whether we should obtain an abundant and, what is more important, a permanent supply. However, the water we have struck has proved to be flowing from a true fissure vein in the chalk, and will be ample for all our requirements. Secondly, as to the mains, transformers and house connections, the map before you will enable you to judge of and to realise the amount of work done, and you will, I feel sure, admit that good use has been made in this branch of the time we have had at our disposal. The progress made by the British Insulated Wire Co. in the laying of mains during the past year has been most satisfactory. Mains have now been laid in a total of over 22 miles of streets. Earthenware conduits to carry high tension cables have been laid for sufficient length to carry over 44 miles of high tension cable. Twenty-four miles of low tension distribution cable have been laid on the solid filling-in system and brought into use, and over 13 miles of high-tension feeders have also been drawn in the before-mentioned ducts and brought into use. The above work has involved the excavation and making good of 25 miles of streets. From these mains 220 connections to consumers' houses have already been run, and, of course, meters erected and connected up in each case. Thirdly, as regards the plant and machinery, I am sorry I cannot report to you quite so favourably with reference to these items; but, as many of you are, doubtless, aware, the late strike in the engineering trade has caused quite a congestion in this field of work. English manufacturing firms are so far quite unable to make up the time lost owing to that unfortunate strike. To such an extent is this the case that even some of our largest railways have reluctantly been compelled to place their orders for locomotives abroad—for the most part in the United States of America. As you are aware, we have been taking on consumers and supplying them with energy by means of connecting our mains to those of a company who have a generating station in a district adjoining ours. Of course, this has not been done without incurring some additional expense, but we consider that we are amply compensated for the cost involved, for we have by this means been enabled to take on consumers with a total number of 15,870 8 c.p. lamps already, which will enable us to employ our machines directly they are ready, and thus avoid the great loss which generally occurs after the opening of an electric light station, while waiting for customers to get their premises wired. This should be most satisfactory to our shareholders, as if such a large number of consumers can be obtained before the works are opened, there must be every prospect of a large and lucrative business in store for us. We have not made any great effort in procuring customers so far, for there have been difficulties and troubles in supplying them under these conditions, which we trust will not occur when we are in a position to supply direct from our own station, and moreover we have not been able to deliver current, except to a limited area of our district. I do not know that I have any other point on which you may wish to be informed, but if any shareholder wishes to ask any question I shall be happy to reply. I now move the adoption of the report and accounts.

Mr. W. W. PHIPPS seconded the motion.

Mr. BARRETT asked what was the earliest date at which they expected to have their central station completed and be giving the supply from their own machinery? He thought that it would also be very interesting if the shareholders could hear whether they expected to have a load of 50,000 lamps by the autumn, and if so, whether they thought that that number would justify the Board in paying a reasonable dividend—say at the end of the financial year? Also was arc lighting likely to be adopted by the Vestry; was there likelihood of a day load from the supply of current for power purposes; and was it certain the Company had a monopoly of electric supply in their district?

Mr. A. TOOTH asked when the next call was likely to be made, and whether the houses they supplied were few and far between or close to the station.

The CHAIRMAN, in reply, said: In reply to Mr. Barrett, I may say that we anticipate that our station will be ready to supply current at the end of May, or at the beginning of June. That does not mean that we shall then have sufficient available from our own machines for the winter, but we shall get some engines in the summer, and others will follow about July or August; and we quite expect to have an abundance of plant for our requirements next winter. Mr. Barrett has also asked me one rather difficult question—namely, whether we can pay a dividend on a load of 50,000 lamps? In answer to that I can only judge from my experience in another place. I found that the supply in the second year came to 100 per cent. more, or double the quantity we had in the first year, and that in the three years which have since elapsed we have had an increase of 25 per cent. every year. You asked, I think, when the prospect of a dividend will arise. If I tell you what has happened with some of the chief companies in London you will be able to form your own opinion. The Westminster Company paid at the end of 2¾ years; the House-to House Company not for 10 years; the Pall Mall and St. James's Co. in 2¾ years; the Kensington and Knightsbridge in 3¾ years and the Notting Hill Company in 5 years. I hope that we shall not have to wait as long as the longest of those dates, but I do not think that we shall quite come up to the earliest. You have mentioned the question of arc lamps. That is a very important point, because I know by long experience that wherever you put the arc lamp the public will have the incandescent. They follow each other directly; the arc lamp seems to act as a magnet in attracting the incandescent. We, however, have no power in this matter unless we get an order from the Vestry. I have myself been several times to the Vestry about it, but I have not been able to induce them to adopt the arc light. We, have, however, one thing in our favour which may induce them more than anything else to adopt the arc lamp, that is, that the boundary of the parish of Newington is in the middle of a street in our area of supply, this boundary dividing the two parishes. The parish of Newington has decided on adopting the arc lamp, and part of the street in question

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which is in that parish will be lighted up in the course of a few months; and I feel certain that if the parishioners of Lambeth see one side of the street lighted by the electric light and the other side by gas, they will very soon demand the electric light. If not, I can only say that they are very different from the people in the south of England. I do not know if we shall be able to get a day load. On the other side of the river, I know that there is a considerable day load, but I have seen but little as yet to lead me to expect the same thing in the south of London, With regard to the question, as to when the next call will be made. I may say that we have sufficient money in hand to carry us up to the middle of May; and, therefore, the next call will be about the middle of May or the beginning of June. I think the same gentleman asked whether the lights were very much scattered. Ours is a very large area, and in that way our supply may be said to be scattered, but the consumers are in clusters. We generally find when we get a customer for the light that his next-door neighbour also wants it. I think that we supply more private houses than shops at the present time. As to our having a monopoly, that must be so, because this Order was granted by the Vestry. They cannot get another Order themselves, and no one else would get one, as in that case they would also have to purchase our undertaking at the end of the term. I therefore think that you may consider that ours is an absolute monopoly.

Mr. PEARSON inquired what powers the Vestry had as to taking over the Company's undertaking.

The CHAIRMAN: They can re-purchase it at the end of 21 years, but in that case they must pay us a profit of 25 per cent. over the capital expended. They can obtain it at par at the end of 31 years.

The motion was carried unanimously.

Mr. Phipps and Mr. Algernon Turnor, C.B., were re-elected Directors, and Messrs. Price, Waterhouse and Co., were re-appointed as auditors.

Mr. PEARSON afterwards proposed a vote of thanks to the Chairman and Directors for their services. He had been in the City for 35 years, and had never before seen a balance-sheet of a company showing a profit before its works were opened. He would like to include in the vote their courteous Secretary.

Mr. BARRETT seconded the motion, which was carried unanimously.

The CHAIRMAN acknowledged the vote, and the proceedings terminated.

Willans and Robinson (Limited).

The tenth half-yearly report of the directors of this company, covering the period to Dec. 31 last, states that, after writing off as depreciation £5,013. 3s. 4d., and paying interest upon Debenture stock, the balance to credit of profit and loss account (including £2,441. 6s. 11d. brought forward) is £25,069. 14s. 3d. The directors propose that dividends be paid at the rate of 6 per cent. per annum upon the Preference shares, and at 10 per cent. per annum upon the Ordinary shares, together amounting to £12,000. The amount payable to the original directors is £3,863. 10s. 2d., leaving £9,206. 4s. 1d. The directors propose to carry £2,000 to Debenture redemption sinking fund, and £3,500 to reserve, leaving £3,706. 4s. 1d. to be carried forward. The balance of £11,124. 14s. 6d., standing in last accounts to credit of the share premium suspense account, has been disposed of by writing off £163. 12s. 7d. removal expenses, £3,368. 6s. 8d. off value of freehold works at Thames Ditton, and £1,606. 7s. 10d. off sundry items of plant at Thames Ditton. £986. 7s. 5d. is kept in hand in a removal suspense account, and £5,000 has been carried to reserve.

As the period of the accounts now presented corresponds with the conclusion of the fifth year of the company's working, it may be pointed out that the sums reserved out of profits in the five years, viz., £25,146. 9s. 11d. reserve fund, £10,000 debenture redemption fund, and £3,706. 4s. 1d. now carried forward, amount together to £38,852. 14s., and that this sum exceeds the amount paid for the goodwill of the business.

The last year, and more particularly the last half-year, have been marked by a great increase in the demand for the special class of machinery which the company manufactures. There has also been a rapid increase in the size of the engines. Twelve months ago it was announced that an engine was on order to develop as much as 1,500 H.P.—a notable advance upon the sizes previously made by the company. Six months later the number of such engines on order had increased to four; the number now on order is 16, and there is reason to expect that much larger sizes will be called for.

The directors believe that the increased demand for engines, and especially for large engines, is due to permanent causes, and that it will continue to increase to an extent far exceeding the present producing powers of the company's plant. They also believe that if the company becomes unable to accept the orders offered to it, they will pass into the hands of foreign competitors, with permanent injury to the reputation of the company and to the interests of the shareholders. The directors are, therefore, of opinion that the plant should be increased, and that larger and more powerful tools should be provided. The directors also consider that the manufacture of the Niclausse boiler should be taken up on a larger scale than has hitherto been contemplated, or than is possible at Rugby. Under these circumstances the directors propose to take the existing boiler shop at Rugby as an additional machine shop, and to make some other additions, adding in all about 60 per cent. to the space now available for machine tools; they also propose to double the size of the foundry. They propose to erect separate boiler works upon a site which has been secured near Chester, upon the river Dee, with the advantages of cheap sea carriage for materials, and easy railway communication with Rugby and other important centres. The scheme will render necessary an increase of capital, and resolutions will be submitted to the forthcoming meeting authorising the creation of 40,000 new shares of £5 each, for one-half of which the directors propose to invite subscriptions in the course of the ensuing month. Subject to the concurrence of the existing Preference shareholders, it is proposed to take power to issue half the new shares as Preference and half as Ordinary.

County of London and Brush Provincial Electric Lighting Co. (Limited).

The report of the directors of the above Company for the year ended December 31st is as follows:—

Capital.—The capital expenditure in respect of the Company's London districts amounted to £148,767. 16s. 2d., making the total £562,587. 6s. 2d. This expenditure was met mainly by the balance of instalments falling due on the 10,000 Ordinary shares.

Revenue.—The net revenue, including balance from last account, and after payment of proportion of rents, rates, taxes, interest, and general establishment charges, is £17,375. 18s. 6d. Out of this an interim dividend on the 6 per cent. Preference shares for the half-year ended June 30th has been paid, and the dividend balance for the half-year just ended is recommended. This will leave £5,775. 18s. 6d., which it is proposed to carry forward. Nothing is included for the considerable increase in value that has taken place in the Company's investments, which stand in the balance sheet at cost. The Company is promoting a Bill in Parliament to enable the Company to obtain compulsory powers for acquiring lands and securing rights of way for the purpose of connecting its various London districts, as authorised by the special resolution approved by the shareholders.

The Directors have appointed Mr. Joseph Shaw to a seat on the Board to fill the vacancy created by the retirement, in 1896, of Mr. W. C. Braithwaite.

The following particulars relating to the Company's London stations accompany the report:—

St. Luke and Clerkenwell and Eastern Holborn.—The net revenue for the twelve months to December 31st last amounted to £2,158. 13s. 2d. In these districts the total applications to December 31st, including power, represented the eqivalent of 43,599 8 c.p. lamps, of which 36,303 were then connected. The applications for the year represented an increase of 18,769, and the connections 12,456. At the same date 35 users of motors aggregating 128 H.P. were supplied from the mains, and further applications have since been received raising the total to 60 representing 273 H.P. To meet the growing demand for power, special plant for the generation of continuous current, capable of supplying 1,500 H.P., is in course of erection, which will make, with the power plant already at work, an available total of 2,000 H.P.

Western Holborn and St. Giles.—The laying of mains in this district has been commenced, and a supply of energy, both for lighting and power purposes, will be available at an early date. The Company also holds orders for Mile End Old Town, St. George's-in-the-East, and the district of the Limehouse District Board of Works, all of which it is intended to supply from the City-road station.

Wandsworth District.—The net revenue for the year to December 31st amounted to £4,958. 18s. 11d. Applications for the equivalent of 32,636 8 c.p. lamps had been received at December 31st last, of which number 28,914 were then connected. The increase in lamps applied for during the year was 15,802, and in lamps connected 15,007.

Camberwell.—The street work in this district has been unavoidably delayed, but it is expected that supply will be available by June, a right of way through Lambeth having been obtained. The equivalent of 3,041 8 c.p. lamps were applied for at December 31st.

St. George-the-Martyr.—The work of laying mains in the compulsory streets in this district is in progress, and supply of current will be commenced at the same time as in Camberwell.

St. Olave.—The works in this district will be commenced forthwith.

[The Company's interests in (1) the Bournemouth and Poole Electricity Supply Co., (2) the Dover Electricity Supply Co., and (3) the Richmond (Surrey) Electric Light and Power Co. have been recently reported fully in *The Electrician*.]

NEW COMPANIES, STATUTORY RETURNS, &c.

DAVIS AND TIMMINS (LIMITED).—This company was registered on March 17, with a capital of £110,000, in £1 shares (60,000 £6 per cent. cumulative Preference), to acquire and take over as a going concern the business now carried on by Davis and Timmins (Limited), and to carry on the business of engineers, screw manufacturers, metal turners, &c. The first directors are:—Sir Henry C. Mance, C.I.E., H. Benbow, E. Davis. A. Le Neve Foster and G. E. Davis.

FRESHWATER AND TOTLAND (I. W.) ELECTRICITY SUPPLY CO. (LIMITED).—This company was registered on March 11, with a capital of £15,000, in £1 shares, to form centres at Freshwater and Totland, Isle of Wight, or elsewhere, for the generation of electric light and power, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, and manufacturers of and dealers in electrical apparatus, generators, accumulators, lightning conductors, lamps, fittings, &c. The first subscribers, with one share each, are: W. S. Nicholson, J.P., Lieut.-Col. R. G. Temple-Cotton, A. Bayliffe, A. Hollins, M.D., C. H. Hands, M.B., J. Dover and W. J. Waterhouse. The first Directors are: William S. Nicholson, Lieut.-Col. R. G. Temple-Cotton, and A. Bayliffe.

INTERNATIONAL TELEPHONE MANUFACTURING CO. (LIMITED).—This company was registered on March 1, with a capital of £200,000, in £1 shares, to manufacture telephones and telephone appliances, to establish, work, manage and regulate telephone exchanges and electric lighting works, and to carry on the business of a telephone, telegraph, and electric light, heat and power supply company, and of electricians, electrical and

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mechanical engineers, electrical apparatus manufacturers, &c. The first subscribers are: C. Cowley, A. E. Cowley, H. D. J. Claxton, C. E. Craig, J. D. Haddock, J. H. Todd and W. H. Sinclair.

AMAZON TELEGRAPH CO. (LIMITED.)—The annual return to Feb. 10 gives the capital as £250,000 in £10 shares, the whole of which has been taken up and paid for in full.

CAMBRIDGE ELECTRIC SUPPLY CO. (LIMITED).—According to the annual return to Feb. 17, the nominal capital is £100,000, in £10 shares, of which 9,423 have been taken up; £8 per share has been called on 4,970, and £2 per share on 4,453.

EASTERN TELEGRAPH CO. (LIMITED.)—The annual return to Feb. 2 has been filed. The capital is £6,000,000 stock, divided into £4,000,000 Ordinary and £2,000,000 Preference. £5,795,263 has been taken up and paid for in full.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LIMITED).—The 1899 return of this company has been filed. The capital is £350,000 divided into 50,000 Ordinary, 10,000 First Preference, and 10,000 Second Preference shares of £5 each. 15,000 Ordinary, 10,000 First Preference, and 6,687 Second Preference shares have been taken up, and 5,000 Ordinary shares have been issued as fully paid. The full amount has been called on the others.

NATIONAL ELECTRIC SUPPLY CO. (LIMITED.)—The annual return to Feb. 22 has been filed. The capital is £84,943. 15s., divided into 9,050 Preference shares of £5 each, 10,850 Ordinary shares of £3. 12s. 6d., and 100 Founders' shares of £3. 12s. 6d. each. 1,000 Preference and all the others have been taken up, and the full amount has been called.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING CO. (LIMITED).—According to the annual return to Feb. 28, the capital is £100,000, in £10 shares, of which 9,918 have been taken up; £8 per share has been called on 5,000 and £5 per share on the remainder.

NORTHAMPTON ELECTRIC LIGHT AND POWER CO. (LIMITED).—The annual return to March 9 has been filed. The capital is £50,000, divided into 10 "A" and 49,990 "B" shares of £1 each. 10 "A," 17,288 "B" Ordinary and 7,000 Preference shares have been taken up. £1 per share has been called on 10 "A," 15,000 "B" Ordinary, and 7,000 Preference, and 10s. per share has been called on 2,288 Ordinary.

PACIFIC AND EUROPEAN TELEGRAPH CO. (LIMITED).—The annual return to Dec. 21 has been filed. The nominal capital is £100,000, in £10 shares, all of which have been taken up. £4 per share has been called.

PORTABLE ELECTRIC LAMP CO. (LIMITED).—The annual return to Jan. 2 states that the capital is £50,000, in £1 shares, of which 40,157 shares have been taken up; 40,000 shares have been issued as fully paid, and the remainder have been paid up.

POTTERIES ELECTRIC TRACTION CO. (LIMITED).—The statutory return to Nov. 17 gives the capital as £400,000, in £10 shares, of which seven have been taken up, but no calls have been made.

RYDE ELECTRIC LIGHT AND POWER CO. (LIMITED).—The annual return to Jan. 13 has been filed. Seven shares have been taken up out of the capital of £10,000, in £5 shares, but no calls have been made.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT CO. (LIMITED).—The annual return to Feb. 21 has been filed. The capital is £300,100, in 40,000 Ordinary and 20,000 Preference shares of £5 each, and 100 Founders' shares of £1 each. 31,980 Ordinary, 20,000 Preference and 100 Founders' shares have been taken up, and the full amount called.

SCARBOROUGH ELECTRIC SUPPLY CO. (LIMITED).—The annual return to March 2 has been filed. The nominal capital is £50,000, in £10 shares, of which 4,500 have been taken up; £9 per share has been called on 4,000, and £4 per share on 500.

TELEGRAPH IMPROVEMENT CO. (LIMITED).—The annual return to Jan. 12 has been filed. 15,006 shares have been taken up out of a capital of £100,000 in £1 shares, of which 15,000 have been issued as fully paid, while £6 has been paid on the others.

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LIMITED).—The annual return to March 1 has been filed. The whole nominal capital of £399,500 in £5 shares has been taken up, and paid for in full.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 2, 1899). Price of silver 27 7/16d. per oz. (March 23). Consols (2¾ per cent.) 110⅝—110⅞ for money, 110¾—111 for account; 2½ per cent. 103⅜—103⅝ (March 23), Stock Exchange Settling Days: Consols, April 6; Stocks and Shares Continuation Days, March 27 and April 11; Ticket Days, March 28 and April 12; Pay Days, March 29 and April 13; Mining Share Carry over Days, March 25 and April 10.

ANGLO-AMERICAN TELEGRAPH CO. (LIMITED).—After placing £6,000 to credit of renewal fund, an interim dividend has been declared for the quarter ending 31st inst. of 15s. per cent. on the Ordinary stock, and £1. 10s. per cent. on the Preferred stock (less tax), payable on May 1.

BLACKHEATH AND GREENWICH DISTRICT ELECTRIC LIGHT CO. (LIMITED).—Capt. E. I. Bax, director of the South London Electric Supply Corporation, and manager of the Westminster Electric Supply Corporation, and Mr. Henry St. John Winkworth have joined the board of this company.

BRITISH CONTINENTAL ELECTRICITY CO. (LIMITED).—An interim dividend is declared on the Preference shares, at the rate of 5½ per cent. per annum for the half-year to Oct. 31, 1898.

BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS CO. (LIMITED).—At the annual meeting on Wednesday, the chairman (Mr. John Morris) said that they had been operating under great disadvantages, inasmuch as the section of new line which was being worked electrically was only a fragmentary one until within a month or five weeks ago. For the first four weeks the traffics on the new section had been at the rate of something like £45,000 a year, and he saw no reason why that satisfactory return should not continue. They had always looked with satisfaction to the adoption of the electric system, but they had been somewhat startled by finding in the first four weeks of its introduction such a great jump as was shown in the traffic up to the point to which it had been carried. He would not indulge in any prophecy as to what the result would be as they extended towards Belgrano, and when the new system went to Belgrano itself, but the result so far had gone considerably ahead of their expectations. They were going on with the work on the new line up to Belgrano, and hoped to get it finished in a few weeks. Their intention was to go on applying electricity, from Belgrano right up to Centro America; there they would stop for a time until they could get further facilities for proceeding into the centre of the city. They already possessed the right to go there.

COMMERCIAL CABLE COMPANY.—The accounts for 1898 show that, after setting aside $100,000 as reserve for insurance of stations, apparatus, and repair steamer, and $350,000 to reserve, there was a balance profit for the year of $1,908,758, inclusive of $477,019 brought forward. Interest on the Four per cent. Bonds and Debenture stock absorbed $704,296, and the dividends declared during the year on the share capital (8 per cent.) $800,000, leaving $404,462 to be carried forward.

DAVIS AND TIMMINS (LIMITED).—This old-established firm of manufacturers of screws and terminals, engineers and metal merchants, has joined the list of joint-stock undertakings. The capital of the Company is £110,000 in 60,000 6 per cent. Cumulative Preference and 50,000 Ordinary shares of £1 each. The whole of this capital has been offered for subscription at par this week, and the applications closed yesterday (Thursday). Sir Henry C. Mance is chairman of the Company. The original business was established in 1676, in Charles-street, Hatton Garden, London, where the business was conducted until 1892, when factory premises were taken at King's Cross. The purchase price for the business is £87,000—£40,000 in cash and £47,000 either wholly or partly in cash or Ordinary shares, at the option of the directors, two of whom, Mr. Emile Davis and Mr. A. Le Neve Foster, are the vendors. The purchase price, from the somewhat meagre particulars given on the prospectus, seems a heavy one, as the average annual profits for the three years and 5 months from July 31, 1895, to Dec. 31, 1898, are certified at only £9,523, "without charging interest, directors' fees and management remuneration." The Company's business is, however, a progressive one, and in view of the great extension of the electrical industries and the large number of leading firms on the Company's books as customers, the Preference shares should be a reasonably safe investment.

EASTBOURNE ELECTRIC LIGHT CO. (LIMITED).—The directors' report for the year 1898 states that the gross profit, after paying working expenses, amounted to £4,574. 5s. 6d., against £3,619. 7s. 11d. in 1897. After allowing for debenture and preference interest, adding £400 to depreciation and paying an interim dividend for the half-year ended 30th June last, there remains £3,069. 13s. 10d., and the directors propose a dividend of 20 per cent. for the half-year (making 12½ per cent. for the year), free of tax, on the Ordinary share capital, leaving £1,120 to be carried over. It is not proposed to place any part of the surplus to reserve, but, on account of the exceptional circumstances in which the Company is placed, to keep it as a floating balance for any purposes required. Depreciation now stands at £3,391. 5s. 3d., while reserve remains at £3,250. The equivalent of 8 c.p. lamps in circuit was 23,028 at the close of 1898, against 19,288 in 1897. The report refers to the negotiations with the Corporation for the sale of the Company's undertaking, and to the offer of the former to give £20 for every £10 share. On examination it was found that, owing to the deductions claimed by the Council, the price named would provide only about £18 per share. The shareholders, therefore, unanimously rejected the offer. They consented, however, to name two shareholders to meet two members of the Council's committee to discuss the subject and to arrange terms if possible. As a result of the meeting the Council had withdrawn their demand for the deductions previously claimed, and had amended their former offer, so that the price should really provide twice the amount of the share capital subscribed and paid-up as a net sum to the shareholders without deduction. The whole subject is to be fully discussed at the forthcoming meeting.

EVERED AND CO. (LIMITED).—The directors of this Company, after providing for debenture interest amounting to £2,416, show a net profit of £25,698 for 1898, making with £6,361 brought forward £32,060.

EXPLORATION CO. (LIMITED.)—At the annual meeting on Wednesday, the Chairman said that there had been no alteration in their holding in the shares of the Central London Railway, the opening of which had been delayed owing to unforeseen difficulties. They were satisfied that when the line was opened it would meet a real want, and benefit the shareholders in proportion to its utility. Their holding in the Electric Traction Co. had been slightly increased. The position of the Compagnie Générale de Traction, the Ordinary and Founders' shares of which were largely held by them, had still further improved since the issue of the report, inasmuch as the concessions for electric tramway lines "de Pénétration" for Paris, asked for by the Compagnie, and approved of by the Conseil Général de la Seine, had received the sanction of the Conseil d'Etat, and it was expected that the official decree enabling work to commence would issue immediately. Through the enterprise of the Compagnie they were confident that Paris and its suburbs would at no distant date be covered with a network of electric tramways of over 200 kilometres of new lines. Such lines as were of importance to the exhibition of 1900 would be in working order at the time of opening.

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GUILDFORD ELECTRICITY SUPPLY CO. (LIMITED).—The directors' report for the year 1898 states, that the balance profit on revenue account, after allowing £150 for depreciation, amounts to £149. 2s. 8d. The directors have also written off £77. 14s. 6d. for preliminary expenses. Since the last meeting, mains have been laid in several additional thoroughfares, and this extension has necessitated further expenditure in machinery and plant. There are now 79 customers, against 52 in March last year. During the year the price of current for lighting has been reduced from 8d. per unit (with varying discounts) to 6d. net. It will be necessary to expend further sums on mains, machinery and plant, and further capital is required. The directors are applying for an extension of their area of supply, and hope to obtain an order during the present session, adding to the company's present area the rural parishes adjoining the borough of Guildford within a radius of three or four miles.

HAMPSTEAD ELECTRIC SUPPLY CO. (LIMITED).—The *Financial Times* again calls attention to offers being made by a firm of outside brokers to unload shares in the above company, and warning its readers against having anything to do with the said shares.

PONTYPOOL ELECTRIC LIGHT AND POWER CO. (LIMITED).—The annual meeting was recently held at Pontypool. The directors' report stated that during the past year the further sum of £518. 6s. 10d. was expended in "free" wiring, and the additional customers brought in had put the company on a profit-earning basis. The directors, however, notified that they will discontinue the free-wiring system at the end of 1898, in order that they might consider their position. During the year, the station building had been extended, and a new boiler and steam dynamo had been erected, approximately doubling the capacity of the station. Certain extensions of the mains were also carried out, and in order to meet the capital expenditure entailed by these extensions, the directors made a fresh issue of £5,000 4 per cent. Debentures, out of which the previous issues (amounting to £2,000) were paid. The running of the station for the year ended December 31st (after carrying £100 to renewal) resulted in a net profit, which, with the balance from last year, amounted to £475. 5s. 2d.; and the directors recommended that £50 be carried to reserve, £150 to an account to be formed for redemption of Debentures, a dividend of 5 per cent. be paid upon the paid-up capital, and the balance (£13. 4s. 2d.) be carried forward. The report and accounts were adopted.

ROBEY AND CO. (LIMITED).—After putting £10,000 to reserve and carrying £352 forward, the Directors have declared a dividend of 10s. per share for the year 1898. It has been decided to pay off during 1899 the whole of the second issue of debentures, amounting to £46,305.

ROYAL ELECTRIC COMPANY OF MONTREAL.—Particulars are given in an advertisement elsewhere of the numbers of 77 4½ per cent. debentures, amounting to £7,700 which have been drawn for payment at £105 by the Bank of Montreal, 22, Abchurch-lane, London, E.C., on April 1. The coupons, due April 1, on the balance of these debentures, will be paid by the Bank of Montreal.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has appointed Tuesday, 28th inst., a special settling day in the further issue of 2,500 £10 fully paid Ordinary shares (nos. 12,501 to 15,000) of *W. T. Henley's Telegraph Works Co. (Ltd.)* The shares, as well as the further issue of 40,000 4½ per cent. debenture stock of the *Chelsea Electricity Supply Co. (Ltd.)*, have been ordered to be quoted in the official list. Application has also been made to appoint a special settling day in and to grant a quotation to 37,500 ordinary £10 shares of the *City and South London Railway Co.*, and to appoint a special settling day in 233,334 5 per cent. cumulative £1 preference shares of *Doulton and Co. (Ltd.)*

UNION ELEKTRICITATS GESELLSCHAFT.—A dividend of 12 per cent. for the year 1898 has been declared.

WEST INDIA AND PANAMA TELEGRAPH CO. (LIMITED).—The estimated amount of the traffic receipts of this company for the half-month ended March 15 is £2,667, against £1,890 in the corresponding period of 1898.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	AGGREGATE. Amount.	AGGREGATE. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Mar. 18	3,851	+ 372	10	41,395	+ 3,285
Blackpool Corporation...	...	...	...	...	...	...
Blackpool and Fleetwood	„ 18	236	...	11	1,912	...
Bradford Corporation ...	...	...	...	...	...	...
*Bristol Trams & Carriage	„ 17	2,710	+ 206	11	27,510	+ 1,608
City & South London Ry.	„ 19	1,089	+ 69	12	13,278	+ 452
Dover Corporation	„ 18	141	+ 30	50	8,770	...
Dublin United (Southern)	...	...	...	...	...	...
*Glasgow Corporation ...	„ 18	8,520	+1,384	...	...	...
Liverpool Corporation						
Dingle Route	„ 11	477	...	17	8,920	...
Prince's Park Route...	„ 11	334	...	8	2,415	...
Liverpool Overhead Rly.	„ 19	1,369	+ 53	12	15,642	- 493
*Sheffield Tramways....	„ 19	1,161	+ 230	11	13,193	+ 2,781
*South Staffs. Trams.....	„ 17	616	+ 63	11	6,550	+ 208

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price March 15.		Price Wednesday, March 22.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Week Ending March 22.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	103	104	103	104	3 16 11	January and July	..	..
25,000	10	..	Amazon Telegraph	3	4	3	4	..	..	..	..
£125,000	100	5%	Do. 5 per Cent. Debenture	87	92	87	92	5 6 5	..	..	..
£905,560	Stock	24/0	Anglo-American	65	68	65	68	5 2 0	Feb., May, Aug., Nov.	..	..
3,047,220	Stock	80/0	Do. Preferred	116½	117½	116½	117½	5 2 7	„ „	117⅞	116⅝
3,047,220	Stock	18/0	Do. Deferred	13¾	14¼	13⅞	14¼	6 6 4	„ „	14⅜	14
2[illegible]1	10	3/0	Brazilian Submarine	16	16½	16	16½	4 4 10	Mar., June, Oct., Dec.	16⅛	16⅛
£375,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	110	114	110	114	4 7 9	June and December	..	..
10,000,000	$100	$2½	Commercial Cable Capital Stock	190	200	190	200	4 0 0	Jan., Apr., July, Oct.	..	..
£1,332,523	Stock	4%	* Do. 4 per Cent. Debenture Stock	105	107	105	107	3 15 2	„ „	108⅛	108⅛
16,000	10	8/0	Cuba Submarine Ordinary (Deferred)	9½	10½	9	10	7 0 0	February and August	9¾	..
6,000	10	10/0	Do. Preference 10 per Cent.	17½	18½	17½	18½	5 8 1	„ „	17½	..
12,931	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October	..	..
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	„ „	..	..
£30,000	50	4½%	Do. 4½ per Cent. Debentures	104⅞	107⅞	106⅞	109⅞	4 3 4	January and July	..	..
60,710	20	3/0	Direct United States Cable	12⅞	12¾	12½	12⅝	5 2 0	Jan., Apr., July, Oct.	12⅞	1 ½
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	103	106	103	106	4 5 6	..	..	..
£400,000	Stock	5%	Eastern Ordinary	180	185	180	185	3 16 1	Jan., Apr., July, Oct.	181½	180
£1,795,000	Stock	3½%	Do. 3½ per Cent. Pref. Stock	104	107	103	106	3 6 6	„ „	105½	103
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	125	129	125	129	3 2 9	May and November	127	125½
£89,900	100	5%	* Do. 5 per Cent. Debentures, 1899	99	102	99	102	4 18 0	February & August	..	..
250,000	10	2/6	Eastern Extension	18	18½	18	13½	3 15 8	Jan., Apr., July, Oct.	18⅛	18
£520,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	129	125	129	3 2 3	February & August	1[illegible]6	..
£16,200	100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Deb. 190[illegible] (reg.)	99	103	99	103	4 17 1	January and July	..	..
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	„ „	..	..
£35,100	100	5%	*Eastern and S. African 5 p.c. Mor. Deb., 190[illegible] (reg.)	99	103	99	103	4 17 1	„ „	..	..
£46,500	100	5%	Do, (Bearer)	100	103	100	103	4 17 1	„ „	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102	105	102	105	3 17 8	February & August	..	..
£200,000	25	4%	Do. 4% Mauritius Sub. Debs. (red.)	104⅞	107	104⅞	107	3 15 2	May and November	..	..
130,227	10	1/9	Globe Telegraph and Trust	12⅝	13½	12⅝	13½	3 17 4	Jan., Apr., July, Oct.	13½	12⅞
180,042	10	6%	Do. 6 per Cent. Preference	16⅝	17½	16⅝	17½	3 9 7	„ „	17⅞	16[illegible]
150,000	10	5/0	Great Northern of Copenhagen	30	31	30	31	3 4 6	January, April, July	30	..
£97,800	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red)	100	103	100	103	4 8 0	June and December	..	..
17,000	25	12/6	Indo-European	57	60	57	60	4 3 4	May and November	..	..
£100,000	100	6%	*London Platino-Brazilian 6 per Cent. Debs., 190[illegible]	108	111	108	111	5 8 1	March & September	..	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red)	105	108	105	108	3 14 5	June and December	..	..
11,889	8	4/0	Reuter's	6½	7½	6½	7½	5 6 8	April and October	..	..
3,881	£100 Cert.	6%	Submarine Cables Trust	140	145	140	145	4 4 3	„ „	..	..
15,609	10	..	West African Telegraph	2½	3½	2½	3½	..	..	..	..
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	4 18 0	March & September	..	..
80,008	2½	..	West Coast of America	½	1	½	1	..	..	..	..
£150,000	100	4%	* Do. 4 per Cent. Debentures	103	106	103	106	3 15 9	June and December	1[illegible]4	..
88,321	10	1/6	West India and Panama	1⅞	2⅛	1⅞	2⅛	..	May and November	2	1⅛
24,563	10	6/0	Do. 6 per Cent. 1st Preference	10½	11	10½	11	5 9 1	„ „	1[illegible]8	..
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	„ „	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures	105	108	105	108	4 13 3	January and July	..	..
64,269	15	5/0	Western and Brazilian Ordinary	12½	13	12⅝	13½	4 9 3	May and November	..	..
33,129	7½	3/9	Do. 5 per Cent. Preferred Ordinary	8¼	8¾	8½	9	4 3 4	„ „	..	..
33,129	7½	1/3	Do. Deferred Ordinary	4	4½	4¼	4⅝	..	„ „	..	..
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	107	110	106	109	3 14 1	June and December	1.7	..
£158,100	100	6%	Western Union 6 per Cent. Sterling Bonds (red.)	100	105	105	105	5 14 3	March & September	..	..

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price March 15.	Price Wednesday, March 22.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending March 22. Highest	Lowest
			TELEPHONES.			£ s. d.			
£4,000	£5	4/0	Chili Telephone (fully paid)	2⅝ 2¾	2½ 3	6 14 4	August	–	–
£74,850	£1 10s.	1½d	Consolidated Telephone Const. & Manufacturing	⅛ ⅛	⅛ ⅛	6 7 0	July	–	–
£8,000	5	4/0	Monte Video Telephone 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	October	–	–
£90,000	5	2/0	National	4½ 5½	4½ 6	6 0 0	February & August	4¾	4½
£5,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	12 14	12 14	4 5 0	" "	12½	..
£5,000	10	6/0	Do. 6% Cumulative 2nd Pref.	12 14	12 14	4 5 0	" "	13½	..
£50,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	4¾ 5½	4¾ 5½	4 15 2	" "	5	4¾
£1,°19,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	99 101	99 101	3 9 9	June and December	100½	99
£1,504	1	0/4	Oriental	¾ ¾	¾ 1	5 0 0	April and October	¾	¾
£9,000	5	6/0	United River Plate	4½ 5½	4½ 5½	5 14 3	July	–	–
£151,723	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	104 107	104 107	4 13 1	June and December	–	–
			ELECTRICITY SUPPLY COMPANIES.						
100,000	1	–	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (10s pd.)	⅜ ½	⅜ ½	–	–	–	–
6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	13½ 14	13½ 14	–	–	..	..
6,000	10	4.6	Do. 4½ per Cent. Cumulative Pref.	10½ 11½	10½ 11½	4 4 0	–	11	–
30,000	5	5/0	Charing Cross & Strand Electricity Supply Corp xd	11½ 12½	11½ 12½	3 4 0	February & August	13	..
20,000	5	2/3	Do. 4½ per Cent. Preference xd	6 6½	6 6½	3 9 3	" "	–	..
£34,000	5	3 6	Chelsea Electricity Supply Ordinary xd	8 9	8 9	3 6 8	March	8½	–
£100,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	114 116	114 116	3 18 1	June and December	..	..
£1,200,000	£1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red) xd	101 105	101 105	4 17 7	April and October	–	..
50,000	10	7/0	City of London Elec. Lighting Ord. 40,001 to 90,000 xd	18 19	18 19	3 3 2	February & August	13½	18
10,000	10	6/4	Do. Ordinary 90,001 to 100,000 xd	18 19	18 19	..	–	–	–
40,000	10	6%	Do. 6% Cumulative Pref. xd	16 16	16 16	3 15 0	January and July	16½	–
£40,000	Stock	5%	* Do. 5% Debenture Stock (red.)	124 129	124 129	3 17 10	June and December	..	..
40,000	10	..	County of London & Brush Prov. Ord. (1 to 30,000)	11½ 12½	11 12	–	–	11⅜	0½
30,000	10	6/0	Do. 6% Cumulative Preference	14½ 15½	14 15	4 0 0	March & September	14⅛	..
19,661	5	3/6	House-to-House Electric Lighting Supply Ord. xd	8½ 9½	8½ 9½	3 13 8	–	..	–
12,000	5	3/6	Do. 7 per Cent. Preference xd	9 10	9 10	3 10 0	March & September	9¾	..
15,000	5	10%	Kensington and Knightsbridge Ord.	13 14	13 14	3 18 7	–	–	–
10,000	5	6%	Do. 6% 1st Pref.	7¾ 8½	7¾ 8½	3 14 9	January and July	–	–
110,000	3	–	London Electric Supply Ordinary	3½ 4	2½ 4	–	–	–	–
8,050	5	3/0	Do. Preference xd	6½ 7	6½ 7	4 5 9	–	6⅝	..
£100,000	Stock	..	Do. 4% 1st Mort. Deb.	105 107	105 107	3 14 9	Mch., June, Sept., Dec.	1 6½	–
62 500	10	5/0	Metropolitan Electric Supply Ordinary	13 17	16 17	3 10 9	April and October	13½	16⅛
22,500	10	–	Do. (£7 paid)	12 13	12 13	..	–	–	–
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117 120	117 120	3 15 9	June and December	117¾	117
6,452	10	6/0	Notting Hill Electric Ordinary xd	16½ 17½	16½ 17½	3 8 7	March	..	–
10,000	5	–	Oxford Electric Ordinary	6¾ 7½	6¾ 7½	–	–	–	..
275,000	1	–	Rand Electric	¾ 1½	¾ 1½	–	..	–	–
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'c'n, Ltd., 5% 1st Mor. Deb.	85 93	83 93	5 8 1	–	–	–
150,000	$100	$2	Royal Electric Company of Montreal Shares	170 90	170 190	4 5 1	–	–	–
130,900	100	4½%	* Do. 4½% 1st Mort. Debs.	107 109	107 109	4 3 9	April and October	–	–
31,988	5	9/6	St. James and Pall Mall Electric Ordinary	16½ 17½	17 17½	3 2 9	February & August	17½	17
20,000	5	3/6	Do. 7 per Cent. Preference	9 10	9 10	3 10 0	" "	..	..
65,000	5	..	South London Electric Supply Ordinary (£3 paid)	3½ 3¾	3½ 3⅝	..	–	3¾	3½
79,900	5	7/0	Westminster Electric Supply Ordinary	15½ 16	15½ 16	3 15 0	March & September	15¾	15⅛
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
90,000	2	1/2½	Brush Electrical Engineering	2 2½	1¾ 2½	2 13 5	–	2⅜	2⅛
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2½ 2¾	2½ 2¾	5 1 1	–	2⅞	–
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	110 114	110 114	3 19 2	February & August	–	..
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	101 104	102 105	4 6 7	June and December	..	..
£20,000	5	5/0	Callender's Cable Construction	13½ 15½	12 18	5 0 0	" "	13½	18
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	114 117	114 117	3 17 5	November and May	..	..
300,000	1	9½d.	Castner-Kellner Alkali Co. (fully paid)	1⅛ 1⅜	1⅛ 1⅜	5 16 5	–	..	..
50,000	1	–	Chadburn's Ship Telegraph Ordinary	1⅛ 1⅛	1⅛ –	–	–	1⅜	–
50,000	1	7½d	Do. 6 per Cent. Cumulative Pref.	1⅛ 1⅜	1⅛ 1⅜	4 7 3	–	–	–
22,098	3	1/6	Crompton and Co. (Nos. 1 to 32,098)	3½ 3⅞	3½ 3⅞	4 0 0	–	3⅞	..
£100,000	100	5%	* Do. 5% First Mort. Deb. (red.)	98 101	93 101	4 19 8	January and July	–	..
99,261	5	1.9½	Edison and Swan United ("A" Shares) (£3 paid)	2½ 2¾	2½ 2¾	7 1 8	February & August	2¾	–
17,139	5	2/6½	Do. (£5 paid)	4 5	4 5	6 11 0	" "	–	–
£344,022	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	97 99	97 99	4 1 8	June and December	99	97½
17,400	5	5%	Edmundson's Electric Corporation Ord (fully pd)	5½ 5¾	5½ 5¾	4 6 11	Half-yearly	–	–
112,100	2	1/3½	Electric Construction Co. (Limited)	3¾ 3¾	3¾ 3¾	4 12 0	January & July	3⅞	–
25 000	2	2/9½	Do. 7 per Cent. Cumulative Pref.	3 3¼	3 3½	4 0 0	July	..	–
£140,300	Stock	4%	Do. 4% First Mortgage Deb. (red.)	103 106	103 103	3 15 10	January and July	–	..
91,196	1	–	Elmore's Patent Copper Depositing	⅜ ⅝	⅜ ⅝	..	–	–	–
12,500	10	£0/0	Henley's Telegraph Works Ordinary	23 27	26 27	5 3 8	February & August	2⅞	26
8,000	10	7/0	Do. 7 per Cent. Preference	18½ 19½	18½ 19½	3 11 10	" "	..	–
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	112 115	112 115	3 19 10	" "	..	..
80,000	10	15/0	India Rubber, Gutta Percha, &c., Works	21 23	21½ 22½	4 8 11	" "	22½	22
£00,000	100	4%	Do. 4% First Mortgage Debentures (red.)	102 106	102 106	3 15 6	March & September	..	..
£7,250	13	24/0	Telegraph Construction and Maintenance	38 42	38 42	4 5 9	March and July	39½	33½
£118,000	100	..	Do. 4 per Cent. Deb. Bond's, 1900	104 107	104 107	3 15 4	..	10⅜	–
£19,400	5	..	Do. Manufacturing Ordinary	10 10½	9¾ 10½	–	–	10½	10⅛
13,490	5	..	Do. 5% Cum. Pref.	6⅜ 6½	5½ 6½	4 0 0	–	–	–
£20,000	5	4/0	Williams and Robinson Ordinary	7½ 9	9½ 9½	4 2 1	April and October	9⅛	–
£30,000	5	3/0	Do. 6% Cumulative Preference	7½ 7¾	7½ 7¾	3 17 5	" "	–	–
£160,000	Stock	4½%	Do. 4½% First Mort. Debs	106 103	106 103	3 18 8	May and November	–	–
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	8/0	Blackpool and Fleetwood Tramways	24½ 25	24½ 25½	3 2 6	–	–	–
50,000	10	7½	Bristol Tramways and Carriage	23½ 24½	23½ 24½	2 14 1	–	–	–
£90,410	Stock	4%	Do. 4% Debenture	120 124	120 124	3 6 2	–	..	..
80,000	10	..	British Electric Traction Ordinary	21 22	19½ 20	..	–	20½	19½
10,000	10	6/0	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm. pd.)	13½ 14½	13½ 14½	4 4 10	–	14⅛	13½
£100,000	Stock	6/2·8	Do. 5% Perp. Deb.	123 129	123 129	3 17 6	–	123	127
40,000	5	..	Buenos Ayres & Belgrano 6% Cum. Pref. (£3 paid)	3½ 4	3½ 3¾	..	..	3¾	3½
27,500	5	..	Do. do. do. (fully paid	4½ 5	4¾ 4¾	..	..	4¾	4⅝
£260,000	Stock	5%	Do. do. 5% Deb.	108 111	108 110	4 10 11	..	–	..
£35,250	10	3/0	Central London Ordinary	9½ 10½	9½ 10½	2 18 6	June and December	10	–
178,308	10	1/9½	Do. (£8 paid)	7½ 8	7½ 8½	2 13 2	" "	–	..
£230,000	Stock	3%	City and South London Railway Con. Ordy.	68 70	68 70	3 0 9	January and July	69	–
22,500	10	..	Do. Ordinary (£5 paid)	4½ 4¾	4¾ 5½	..	..	..	..
9,251	10	5%	Do. 5% Perpetual Preference	14½ 15½	14½ 16½	3 5 7	January and July	–	–
£137,701	Stock	4%	Do. 4% Perpetual Debenture	131 135	133 135	2 19 7	May and November	134	..
20,000	10	7½%	Imperial Tramways Ordinary xd	24½ 25	24¾ 25½	2 13 6	March & September	25½	24½
10,000	10	6%	Do. 6% Preference xd	16¾ 16½	16 16½	3 12 9	" "	13½	13
£70,000	Stock	4½%	Do. 4½% Debenture	119 120	118½ 119½	3 15 4	" "	119½	1 5½
67,500	10	4½	Liverpool Overhead Railway Ordinary	10 10½	10 10½	3 9 2	February & August	–	
10,000	10	5%	Do. 5% Preference	14½ 14½	14½ 14½	3 7 8	" "	–	–
113 880	Stock	4%	Do. 4% Debentures	106 108	106 108	3 14 1	January and July	..	
80,000	5	3.5½	New General Traction 6% Cumulative Pref	5 5½	5 5½	5 9 1	–	5½	..
£549,000	Stock	3%	Waterloo and City Ordinary	109 112	109 112	2 13 7	June and December	110½	–

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

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CONTENTS OF THE CURRENT NUMBER.

NOTES	783	Electricity Works Accounts	795
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe. Illustrated	787	RAPID TRANSIT	798
		Obituary	799
		Reviews	800
Magnetic Leakage in the Alternating Current Transformer. By A. Russell, M.A. Continued	788	The Induction Motor. By E. Wilson. Continued	801
		The Crowdus Storage Battery. Illustrated	802
Carbons for Electric Lighting and Other Purposes. By F. Jehl. Illustrated. Continued	789	Electric Lighting Schemes for the City of London	803
		Parliamentary Intelligence	804
		Legal Intelligence	805
The Hissing of the Electric Arc. By Mrs. Ayrton. Illustrated	791	Trade Notes and Notices	806
Electric Traction and its Application to Suburban and Metropolitan Railways. By Philip Dawson. Concluded	794	Companies' Meetings and Reports	810
		New Companies, &c.	815
		City Notes	816
		Companies' Share List	818

NOTES.

SMOKE has once again been a source of anxiety to one of the metropolitan electric supply companies, the Charing Cross and Strand Company having, on Monday last, been summoned before Sir JAMES VAUGHAN for disobeying an order to prevent black smoke from being emitted from their chimney so as to cause a nuisance. It appears that, notwithstanding the use of fuel consisting of a mixture of coke with the best Welsh coal, the fumes emitted from the chimney were not above suspicion. On the one hand, residents in the neighbourhood are said to complain that they dare not open their windows; on the other hand, the Company protested that they have done the best they could to prevent smoke, and, consequently, claimed exemption from further proceedings. Sir JAMES VAUGHAN adjourned the summons *sine die*, in order that an expert, to be nominated by the President of the Institution of Civil Engineers, might examine the boiler plant, &c. In thus acting he has adopted a course which might well be followed whenever similar difficulties arise in future.

WITH the assiduity of a SHERLOCK HOLMES, Mr. A. P. TROTTER has been following up a series of clues as to electrical earth currents in the vicinity of Cape Town. In his garden at Wynberg, he arranged an automatic recording current meter, the records of which, taken over a lengthy period, revealed three distinct sources of electric current in the ground. The chief effect was undoubtedly due to the tramways; a second appeared to be traceable to sun-spot phenomena; while the third, absent on moonlight nights and always ceasing with clockwork regularity at midnight, was clearly caused by leakage from the public lighting mains. At Cape Town, as in many other places, the street lamps are not switched on when the moon shines nearly full.

OTHER matters are also dealt with in the report wherein Mr. TROTTER embodies these observations. The wanderings of the earth currents have been mapped out, and their tendency to do electrolytic and other mischief scrutinised Currents have been traced some distance out to sea, while at one part of the beach it is possible to light a glow lamp from electrodes stuck in the sand. Another feature of electric traction, as practised at Cape Town, elicits from Mr. TROTTER a sly dig at the rough-and-ready style of American practice, as shown by the noise which the car gears persistently make. In a country, he says, where unusual industrial activity is quaintly described as "making things hum" it is quite possible that a noise of this kind, so far from being a nuisance, may be regarded as an indication of progressive enterprise. Our readers will probably, however, sympathise with Mr. TROTTER'S English taste for silent gears, and will prefer that our home tramways should be equipped with home-made gears having nothing of the American propensity to "hum."

A BRISTOL firm of wiring contractors has, at the request of Mr. FARADAY PROCTOR, the Corporation engineer, sent us some photographs of joints and wires taken out of a house wired, they believe, by an amateur some two years ago. The wires were, we are told, run through holes in the walls and under the floors, without pipes or casing, and the joints, with two poor exceptions, were unsoldered. Two of the unsoldered joints were insulated with a piece of old lace curtain. In one place a mouse had eaten away the insulation of the wires and caused a short circuit, the electrocuted mouse having been found at the spot. Such examples of wiring as this point two ways: first, to the false economy in cheap and nasty wiring, as the installation has had to be remade in two years; and secondly, to the needlessness of strict fire office rules, for in spite of unsoldered joints, in some cases blackened by heating and lace insulation, no fire occurred during the two years the work held together.

THERE has been, during the last few months, an epidemic of international technical dictionaries, but, notwithstanding this, we appear to be as far as ever from having a thoroughly useful and up-to-date reference book of this kind. A

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technical dictionary is wanting that does not confine itself merely to one branch of technics, but which covers the whole ground, supplying completely those words and phrases which are of necessity omitted from general dictionaries. The various applications of science and engineering are so intimately connected that they permit of no sharp boundary line, and a list of scientific and technical terms used in one branch alone is not found sufficient by the majority of readers of foreign technical literature. Although such a book is urgently needed, it is evident, from commercial considerations, that its realisation is hardly to be expected at present. A really good work of the kind would entail not only the services of an able cosmopolitan editor prepared to devote years to its compilation, but would also require a large staff of collaborators representing almost the product of the number of languages with the number of technical subjects dealt with. Even if one man could be found who would be sufficiently self-sacrificing to devote himself to the task of editor with but a faint prospect of pecuniary recompense, it would be extremely difficult to obtain this army of disinterested helpers. Or, if the payment were to be adequate, what publisher would be prepared to guarantee this and take the risks of publication?

The *rôle* of publisher of such an international technical dictionary appears to us, however, to be one eminently suited to a representative scientific or engineering society or to several of such societies in conjunction. Recently one such body has resolved to prepare a general international scientific index, and others have been devoting a great deal of attention to the question of publishing abstracts of articles on scientific and engineering subjects which have appeared in foreign papers and periodicals. However excellent such productions may be, they can contain in most cases little more than bare summaries of articles, and it must always be left to independent technical journals to publish translations or fuller abstracts, and to guide their readers by comment and criticism. Exigencies of space naturally compel these journals to omit much that is not unimportant and to deal only with those matters likely to interest a fair proportion of their readers. Those, therefore, wishing to study in detail articles of which full abstracts have not been published, must have recourse to the originals, and, even with a fair knowledge of foreign languages, this is often a hard task, owing to the multitude of words not to be found in the ordinary dictionaries. The whole question is worthy of consideration by the Royal Society and the Institution of Civil Engineers and allied technical societies.

Our contemporary *l'Industrie Electrique* publishes in its issue of March 10th its annual table of electric traction statistics for all European countries. Germany still leads the way in the number and length of lines in power-house capacity, and in the number of cars running, France coming next with 56 lines of an aggregate length of 303 miles, a power-house capacity of 18,718 kilowatts, and 759 motor cars. Great Britain and Ireland, of course, come next, but we note that some lines have been omitted, for the total number should be 84 instead of 81, and the total mileage 240 instead of 145. We notice also that the Bessbrook-Newry line is entered both in England and Ireland, and that in the former country its maximum gradient is 2 per cent., and in the latter 1 per cent. On the other hand, the Giant's Causeway railway appears only in England. The *French* Thomson-Houston Company are said to have built the Dublin tramways, and Cork is among the towns omitted. Altogether Ireland is badly treated. We notice that the German lines have not been quite fully reported either, the totals being considerably less than those published by the *Elektrotechnische Zeitschrift* last January, and referred to in our issue of January 27. The number of electric tramways and railways in Switzerland has increased considerably since last year. There are now 32 lines, all worked on the overhead system, the aggregate length being 125 miles, the plant capacity 6,665 kilowatts, and the number of motor cars and locomotives 325. In France 42 out of the 56 lines are on the overhead system, two underground conduit, one central rail, six simple accumulator system, four "mixed" trolley and accumulators and one trolley and conduit.

Correspondence.—Pressure on our space compels us to hold over several letters until next week.

Cable Interruptions.	Date of Interruption.
Paramaribo—Cayenne	Feb. 10, 1899
Cayenne—Pinheiro	Mar. 10, 1899

Opening of Blackburn Tramways.—The Corporation electric tramways, described in our issue of the 24th inst., were formally opened on Wednesday last.

Royal Institution.—Among the lecture arrangements for after Easter are the two Tyndal lectures by Prof. Silvanus P. Thompson on "Electric Eddy Currents." The Friday evening meetings will be resumed on April 14th, when a discourse on "Earth Currents and Electric Traction" will be delivered by Prof. A. W. Rücker.

Uninsulated Middle Wire.—An electricity supply station has been built at Bonn (Germany), on the 2 × 220 volt three-wire system, with a bare middle wire. The station has only recently started a regular supply, and has at present a lamp-connection equivalent to 24,000 8 c.p. lamps. The plant includes two 250 H.P. steam dynamos and an accumulator battery, and a third steam-dynamo of 650 H.P. is on order.

Röntgen Ray Burns.—Interest has been aroused in medical circles in Paris, says the correspondent of the *Daily Chronicle*, by legal proceedings which are about to be taken owing to alleged dangerous burns caused by the examination of a woman's thigh under Röntgen rays. The burns are said to have developed symptoms of gangrene after three exposures to the rays. Damages to the amount of 5,000f. are claimed.

Papers on Electric Arcs.—Mrs. Ayrton's Paper on "The Hissing of the Electric Arc," read at the Institution of Electrical Engineers last week, together with the unread Paper on "Experiments on Alternate Current Arcs by Aid of Oscillographs," by W. Duddell and E. W. Marchant, which appears in Part 138 of the *Journal*, will conjointly form the subject of a discussion to take place at the next meeting of the Institution on April 13th.

Effect of the Copper "Boom" on the Price of Old Trolley Wire.—According to the *Electrical World* of New York, the Brooklyn Heights Railroad Co. is having an anomalous experience in replacing its worn out trolley wire. A company had executed a contract last year providing for the delivery throughout 1899 of new wire at prices in accordance with the then market value, and since then the price of copper has gone up so much, that the company is obtaining more for its old wire than it is paying for the new material.

The Use of Electricity on American Warships.—The authorities at Washington have decided that electricity shall

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not be employed to operate the auxiliaries on the five new battleships now in course of construction. This seems the more remarkable as a short time ago the officers of the cruiser "Brooklyn," in a report sent in to the Navy Department, referred in the highest terms to the advantages of electricity over steam for operating the auxiliary machinery on men-of-war, referring particularly to the experience gained in the war with Spain.

Personal.—It is officially announced that the Postmaster-General has been pleased to appoint Mr. W. H. Preece, C.B., to be consulting engineer to the Post Office.

In the report in our last issue of the dinner to Mr. Charles Gerhardi, it should have been stated that he has been 46, and not 42, years in the telegraphic service, of which he is now the *doyen* in active work.

We are glad to learn that Sir Eyre Massey Shaw, K.C.B., chairman of the Metropolitan Electric Supply Co., is quite restored to health.

Accident Returns of an Electric Tramway System.—The following record of the disturbances to traffic on the Hamburg electric tramways during 1898 is of interest:—Caused by motor cars, 311; by derails and collisions, 127; by trailers, 14; by overhead wire, 7; and by an occurrence in the power station, 1. The figures are not large when it is considered that over 10 million car-miles were traversed during the year. Of the seven faults on the overhead wire, one affected the traffic for $3\frac{3}{4}$ hours, two for 30min. each, and the remaining four from 6min. to 10min.

First Wireless International Press Message.—The following is the first Press message transmitted by wireless telegraphy across the Channel. It was despatched on Tuesday last by a correspondent of *The Times*:—

Communication between England and the Continent was set up yesterday morning by the Marconi system of wireless telegraphy. The points between which the experiments are being conducted are South Foreland and Wimreux, a village on the French coast, two miles north of Boulogne, where a vertical standard wire, 150ft. high, has been set up. The distance is 32 miles. The experiments are being carried on in the Morse code. Signor Marconi is here conducting the trials, and is very well satisfied with the results obtained.

Thawing Water-Pipes by Electricity.—In the United States, where water-pipes freeze more often than in this country, it has been discovered that a good means of thawing them is to pass an electric current from one end to another of the frozen portion. This electric heating, if not carried too far, is found to break up the ice without damaging the pipe in any way. A disadvantage to the method was recently found in a town in Indiana, however, where the leakage current through the earth caused all the telephone indicators of subscribers in the district to drop, the telephone lines being on the earthed return system.

An Electric Crane for Kiao-Chow.—The *Elektrotechnischer Anzeiger* states that a 150-ton electric crane is shortly to be erected in Kiao-Chow harbour. It will be fitted with two winding gears of 75-ton capacity, which can be used singly or coupled, and a smaller winding gear of $2\frac{1}{2}$ tons capacity. It will be driven by two 100 H.P. motors, and the swinging extension of the gib will be capable of bearing 70 tons in its lower and 150 tons in its upper position. Two additional 100 H.P. motors are employed to actuate the gib extension, and a 20 H.P. motor to turn the crane. Needless to say, the order for the crane was placed with a German firm.

Cable Specifications.—Six of the leading cable manufacturers in Austria and Hungary have, at the suggestion of the Austrian Electrical Society, decided on certain standard sizes and denominations for various classes of insulated wire and cable used for electric light installations. They give notice that from July 1 next they will deliver according to these standards only. Fourteen conductor sections have been chosen, from 1 to 150 sq. mm., four different specifications for cotton and rubber-covered single wire and cable, three types of multiple wire and three varieties of lead covering and armouring.

Damages for Electrolysis.—The City of Chicago has sued the Chicago North Shore Street Railway Co. for $500 damages, which is claimed for injury done to the city water mains by electrolysis. The claim is based upon the assertion that a large portion of the return current from the company's trolley line passes through the water main, and at a point opposite the power house, where it leaves the main, very serious disintegration of the iron pipe has taken place. The *Railway and Engineering Review* (Chicago) states that this suit has been brought as a test case to determine whether a street railway is liable for damage of this kind.

An Electrically-Heated Surgical Operating Table.—Dr. H. Lewis Jones, of St. Bartholomew's Hospital, is now working out, in conjunction with Messrs. Arnold and Sons, the details of an electrically-heated operating table in which incandescent lamps supply the heat. The body of the table has the form of an air chamber of metal, which may be divided into separate sections for convenience. Six or eight 16 c.p. lamps enclosed in this chamber will rapidly raise an operating table to the required temperature, and half that number will then maintain the temperature at a proper level when the rest have been switched off. Wherever electric light circuits exist, this mode of warming an operating table, says Dr. Jones, would present decided advantages.

The Albert Medal.—The Council of the Society of Arts will proceed to consider the award of the Albert Medal for 1899 early in May next, and they invite members of the Society to forward to the Secretary, before April 8, the names of men of high distinction who they think are worthy of this honour. The medal was struck to reward "distinguished merit" in promoting arts, manufactures or commerce, and is bestowed annually. It was first awarded in 1864 to Sir Rowland Hill, and among other recipients are: H.I.M. Napoleon III., Michael Faraday, Sir W. F. Cooke, Prof. Charles Wheatstone, Sir Joseph Whitworth, Viscount F. de Lesseps, Sir Henry Bessemer, Sir George B. Airy, Lord Armstrong, Lord Kelvin, James Prescott Joule, Thomas Alva Edison, Prof. David E. Hughes and Prof. R. W. Bunsen. The last-mentioned received the medal in 1898.

A 95-Volt Arc.—Mr. Alton D. Adams, in the *Electrical Engineer* of New York, describes a method he employs to obtain a steady arc with so much greater length than is customary, that it takes a pressure of 95 volts and yet burns steadily. He shunts an induction coil to the series coils of the usual series-coil arc lamp, and does away with the usual dead resistance. Some of these lamps are in use in Boston, and are said to burn well. The following tests show the gain in efficiency which is claimed:—

	Long arc.		Short arc.
Volts at main	110·0	...	110·0
Volts at arc	95·3	...	78·1
Amperes	4·19	...	4·12
Watts to lamp	461·0	...	452·0
Watts to arc	398·0	...	322·0
Mean spherical c.p.	128·0	...	91·3
Watts per spherical c.p, lamp	3·59	...	4·96
Watts per spherical c.p. arc	3·11	...	3·50
Gain in efficiency in lamp	27 per cent.		
Gain in efficiency in arc	11 per cent.		

One watt taken by lamp will give 35 per cent. more light. Clear inner and opal outer used.

The Electric Railway and Tramway Carriage Works.—The new works of the Electric Railway and Tramway Carriage Works (Limited) were opened at Preston on the 23rd inst. These works have been built with a view to supply the British and foreign markets with electrically equipped tramways and rolling stock, and we understand that in their present state of development, they are capable of turning out as many as three cars a day. Two hundred men are at present employed, but it is expected that this number will shortly be increased to 600 or 700. The buildings include a number of spacious shops for car building and erecting on the trucks, &c., together with an engine house and boiler house for generating electric power. In the boiler house there are erected two Galloway boilers rated at 225 H.P., while in the adjoining machinery house there is a horizontal compound steam engine direct-coupled to a Mather and Platt multi-polar dynamo. This generating set is rated at 325 H.P., running at 150 revolutions under a steam pressure of 120lbs. A storage battery set has been erected, consisting of 170 chloride cells, with which it is intended to light the buildings during the night or to supply,

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occasionally, power during the day. The whole of the machine tools throughout the works are operated by electric motors, the larger tools being driven by separate motors and the smaller ones grouped on line shafts. There are now some 25 electric motors of from 10 H.P. to 45 H.P. distributed throughout the works.

Temperature Coefficients of Copper.—The majority of wire and cable manufacturers have been content to use Matthiessens' temperature correction when measuring the resistance of copper wire, and in submarine cable work the same coefficients have also always been considered sufficiently reliable, although they were obtained before copper of such a degree of purity as at present was on the market. Matthiessen found that the temperature coefficient increased with the conductivity, and he gave a law by which the temperature coefficient of the commercial metal could be calculated from that of the pure metal when the conductivity of the former was known. Messrs. Clark, Ford and Taylor have found that, although until the last few years the mean temperature of a laid cable could be calculated from a "compound interest" formula, so as to agree actually with thermometer observations, in a recent case, where the thermometric survey of the cable route had been carried out with unusual completeness, a large discrepancy was apparent. They have, therefore, carried out a series of tests on six samples of copper wire supplied to the Telegraph Construction and Maintenance Co. by five of the largest wire manufacturers. The tests were carried out by the potentiometer method, using a standard resistance of manganin wire, the potentiometer being divided into 20,000 equal parts. The thermometers had been verified at Kew, and their zero points recently checked; they were divided to 0·1 and 0·2°C. It was found that the temperature coefficients of the wires were almost identical, but that they differed to some extent from Matthiessen's standard, the formula obtained being $R_t/R_{32} = 1 + 0{\cdot}0023708\ (t-32) + 0{\cdot}0000003458\ (t-32)^2$, for the Fahrenheit scale. This formula, when employed for calculating from the conductor resistance the mean temperature of the cable referred to above, gave results agreeing to within 0·3°F. with the thermometric observations, while with Matthiessen's coefficient the difference amounted to 3·3°F. Messrs. Clark, Ford and Taylor have published a neatly-arranged, leather-bound booklet recording their observations, giving a curve of their results alongside one drawn from Matthiessen's formula, and including three tables. The first of these gives resistances at different temperatures when R = 1 at 32°F., the second when R = 1 at 75°F., and the third contains logarithmic coefficients for calculating the resistance at 75°F. from observed resistances.

New French Wiring Rules.—The Chambre Syndicale des Industries Electriques has issued a revised code of wiring rules, the previous set having remained unaltered since 1892. On the whole they are much less strict than the rules enforced in England. The following are some of the main points of difference:—Cables and wires are to have a conductivity of at least 90 per cent.; 100 per cent. conductivity being defined as that corresponding to a resistivity of 1·80 microhm centimetre at 20°C. The maximum drop of voltage to the farthest lamp is fixed at 3 per cent., but the section of wire is to be such that when carrying double its normal current, the rise in temperature is less than 40°C. For this the following current densities are given: 3 amperes per sq. mm. for sections of from 1 to 5 sq. mm., 2 amperes per sq. mm. for sections of from 5 to 50 sq. mm., and 1 ampere per sq. mm. for larger cables. The smallest conductor which may be employed is a single wire of 0·9 millimetre diameter. Bare wires are forbidden "*en principe*," but allowed in special cases. Practically no specification for the insulation of conductors is given. In distinction to the other easy regulations it is laid down that metal covers are not allowed on switches or fuse-holders. Fuses are to be marked with the number of amperes of the circuit which they protect, and are to fuse at three times that current. The rule as to the undesirability of an intermediate position between "on" and "off" in switches, which is generally adopted in this country, applies only to "when the break may cause an electric arc, for instance above 2 amperes at 100 volts." Fuses are to be placed on every circuit and at every branch down to 5 amperes. Fittings, such as electroliers, must be insulated at their point of attachment. Combination gas and electric fittings are allowed, but they must be insulated from the gas pipes by half a megohm. The lamp holders must be insulated from the fitting, and the wires on them must be efficiently insulated and protected, and be of such a nature that the heat of the gas does not harm them. The insulation resistance, either to earth or from wire to wire expressed in ohms, must not be numerically less than five times the square of that number of volts working pressure for each section of the conductor which can be separated from the remainder by turning a switch or taking out a fuse. While considerably increasing the labour of testing, this last rule will not necessarily bring the insulation resistance of the whole installation up to a very high standard.

150-Ton American Electric Crane.—The Newport News Shipbuilding and Dry Dock, in Virginia, although well provided with appliances for handling material, was found to be in need of apparatus more powerful and more convenient than the 100-ton sheer legs which had been used for handling the heavier weights. Careful consideration led to the adoption of a 150-ton revolving derrick, electrically operated and controlled, mounted on a steel tower supported in turn by pile foundations. The derrick jib is capable of having its outer end raised or lowered, thus giving to the hoisting blocks, which depend vertically from this end, a movement not only of rotation about the centre of the derrick, but also of translation in or out from this centre. With the outer end of the jib in its lowest position the hoisting blocks will, on rotation of the derrick, describe the circumference of a circle 207ft. diameter; with the jib in its highest position these blocks, on rotation, describe the circumference of another concentric circle 88ft. in diameter. Weights up to 70 tons may be handled throughout the entire range. The derrick is revolved by duplicate sets of machinery, each consisting of one G. E. 800 railway motor, capable of developing 20 H.P., and driving, by means of a double threaded worm and wheel, a pinion which, engaging a horizontal circular rack on the outside of the tower, gives the required rotation. The motors are series wound and controlled from a series parallel controller, giving high efficiency under starting conditions as well as at normal speed. The turning motion is very smooth and perfectly noiseless, and requires very little power. The racking movement of the jib is effected as follows:—At the inner and upper apex of the jib is a 10in. steel pin carrying 22 cast-steel sheaves, each sheave of 5ft. pitch diameter. At the upper apex of the housing is another 10in. steel pin carrying 24 similar sheaves. Leading over these two sets of sheaves and sustaining the weight of the jib and load, are two 1¼in steel wire ropes, each rope being wound on alternate sheaves, and each end of each rope brought down to separate drums, located below in the housing, this arrangement ensuring freedom from side twisting on the sheaves and also requiring each rope to take its share of the weight. The four drums, on which these ropes are wound, are arranged in pairs, each one of a pair taking opposite ends of the same rope and each pair driven by a G. E. 2,000 series motor of 100 H.P., the power from the motor being transmitted to each drum through a separate train of gears. The drums are of cast-iron, 5ft. pitch diameter, carried by 7in. steel shafts. The main hoists are each of 12 parts, 1¼in. steel wire rope, leading over six sheaves, 5ft. pitch diameter, carried on a 10in. steel pin at the outer end of the jib. The lead from these sheaves to the operating drum is carried down the jib on wooden roller runners. These drums, one for each hoist, are of cast-iron, 8½ft. pitch diameter, carried on 7in. steel shafts, and each driven through a train of gears, by a 100 H.P. G. E. motor, series wound. These hoists may be coupled together and operated as one hoist of 150 tons capacity. The 20-ton whip is of three parts, 1¼in. steel wire rope, carrying a single block and leading over two sheaves, carried, as are those for the main hoist, at the outer end of jib. The lead from these sheaves passes down the jib, over a single guide sheave, to a cast-iron drum, 8½ft. pitch diameter, driven through a train of gears by a 100 H.P. series wound motor.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

"Continuous" Discharges.—Using the most sensitive wave detectors at his command, Hertz found that when batteries of sufficiently small resistance were used, their discharge through a vacuum tube was apparently continuous. As in the case of spectrum analysis or of astronomical nebulæ, this may mean that there is real continuity, or that our instruments are not sufficiently sensitive to discover any discontinuity. M. Cantor has, therefore, tested the matter with the aid of that supremely sensitive modern device, the coherer. He placed a battery of 1,000 accumulators in the cellar, and connected it by thick copper wires with the laboratory on the second floor. On joining the cathode of the vacuum tube with the leaves of an electroscope, and through a liquid resistance with its metallic case, the form of discharge described by Hertz was found to be apparently continuous, since the electroscope showed no divergence. But, under the same circumstances, a coherer filled with small iron screws showed the presence of waves distinctly. A number of controlling experiments, undertaken to eliminate sources of error, led to the same result. It remains now to find whether any portion of the discharge is continuous, or whether there is altogether no such thing as a continuous discharge in vacuum tubes.

[Cantor, *Wied. Ann.*, No. 2, 1899.]

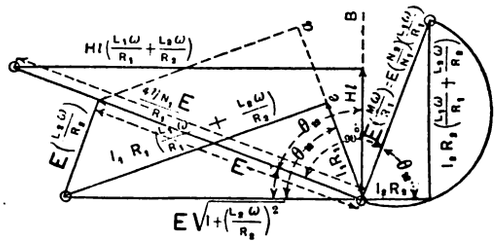
Propagation of Waves Along Wires.—The problem of the propagation of Hertzian waves along a wire is of such fundamental importance that an exact mathematical treatment on the basis of Maxwell's theory would be very desirable. The chief difficulty encountered lies in the exact discussion of a transcendental equation whose root gives the rate of propagation and the damping in the interior of the wire. Hitherto the calculations attempted have been of an unpractical nature, on account of the assumption of an infinite thinness of the wire (Hertz); or another assumption, that the lines of force are normal to the surface of the wire (Poincaré), which they could only be if the propagation took place with the velocity of light. A. Sommerfeld discards these assumptions, and proceeds further on the lines already indicated by J. J. Thomson, treating the case of a single straight infinite wire. He shows that when the frequency is high and the wire thick, the propagation is very nearly at the rate of the velocity of light; but when that is not the case, as, for instance, when there is a platinum wire of 0·004mm. diameter, and the frequency is only 3×10^8 per second, the rate is only three-quarters of that of light. As far as the wire is concerned, all the occurrences take place in a layer not more than 0·01mm. thick.

[Sommerfeld, *Wied. Ann.*, No. 2, 1899.]

Nature of Cathode, Lenard and Röntgen Rays.—In a synthesis of existing theories, W. Sutherland attempts to frame a more or less complete theory of the relations between cathode and Lenard rays on the one hand and Röntgen rays on the other. Briefly, he regards the cathode and Lenard rays as streams, not of ions, but of free negative electrons. The Röntgen rays, on the other hand, are caused by the internal vibrations of the free electrons. To the electrons he assigns inertia and size, and, therefore, also shape; but a general conception of shape involves also the notion of deformability, which, therefore, we must consider as a possible property of the electron. The electron is, therefore, to be supposed capable of emitting vibrations due to the relative motion of its parts. These vibrations are transmitted by the luminiferous ether, but they and light itself need have nothing else in common. The author identifies Röntgen rays with these vibrations. Appreciable Röntgen radiation is only to be looked for when free electrons are thrown into vigorous internal vibrations, as happens when cathode electrons impinge upon the walls of the vacuum tube. Swinton's observation that two colliding cathode streams do not give rise to Röntgen rays is explained by the smallness of the electrons and their distance apart.

[Sutherland, *Phil. Mag.*, March, 1899.]

New Transformer Diagram.—F. G. Baum expresses the instantaneous values of the three varying quantities—primary current, secondary current, and magnetic flux—with their angular relations, in terms of the inductance and resistance of the two coils and the impressed E.M.F. The resulting diagram is simple, and applies to every case, and the method of obtaining it is straightforward. The algebraic process upon which the diagram is based is such that it is no more difficult to solve analytically any transformer problem than it is to solve any problem in the simple alternating-current series circuit, the solution of any transformer problem being, in fact, reduced to the latter. In the annexed diagram, which applies to the case of a non-inductive secondary and no



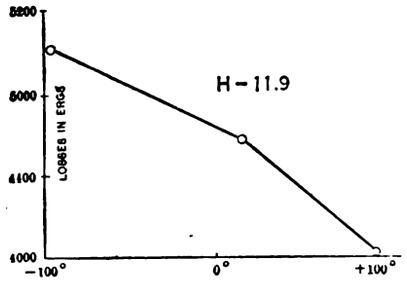
hysteresis, the letters H_1, R_1, R_2, L_1, L_2, ω have the usual signification; l is the length of the magnetic circuit, N_1 N_2 are the turns on the primary and secondary respectively. E is the maximum impressed E.M.F. on the primary. The apparent E.M.F. on the primary is

$$E\sqrt{1+\left(\frac{L_2\omega}{R_2}\right)^2},$$

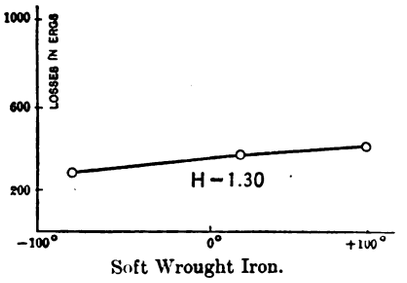
the phase being in advance of the real E.M.F. by an angle whose tangent is $\frac{L_2\omega}{R_2}$.

[Baum, *Phys. Rev.*, Feb., 1899.]

Hysteresis at Low Temperatures.—A. H. Thiessen has compared the hysteresis of iron and steel at ordinary temperatures with their hysteresis at the temperature of solid carbon dioxide, and has obtained results different from those of Fleming and Dewar, who found no difference in the hysteresis loss per cycle at ordinary temperatures and the temperature of liquid air. As the accompanying diagrams show, the loss changes



Soft Wrought Iron.



Soft Wrought Iron.

considerably with the temperature, being greater in the cold when the field is strong, and somewhat less when it is weak. The apparent discrepancy may either be due to the fact that there is a maximum or minimum somewhere between the temperature of solid carbonic acid (−80°C) and liquid air (−185°C), or, as the author prefers to suppose, by the fact that Fleming and Dewar's method is subject to errors due to Foucault currents or time lag. The author used the ballistic method.

[Thiessen, *Phys. Rev.*, February, 1899.]

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Resistance as Influenced by the Surrounding Dielectric.—Since it is now almost universally believed that the energy of a current is propagated, not through the wire, but through the surrounding dielectric, it is natural to suppose that the nature of the dielectric has some influence upon the rate at which this energy is dissipated, in other words, upon the resistance of the wire. Such an influence was suspected in 1892 by Sanford, and announced as necessitating a modification of Ohm's law. J. F. Merrill has since repeated Sanford's experiments with copper wire, using elaborate precautions against changes of temperature and other sources of error. He claims to have proved that if kerosene, absolute alcohol and its vapour, and the vapours of ether, gasoline, benzine, and chloroform have any modifying influence upon the wire which they surround, the resistance of the latter does not change in any case more than by about 0·01 per cent., which is within the limits of experimental error.

[MERRILL, *Phys. Rev.*, February, 1899.]

Canal Rays.—It is quite possible that cathode rays will soon cease to be the chief object of interest in vacuum phenomena, and that their place will be taken by the positive rays, anode rays, or canal rays, as they are variously termed. For there can be little doubt but that these rays consist of projected metallic particles or ions, and it is just these metallic ions which play the most important part in the vast majority of electrical phenomena. We have recently seen Broca prove the disintegration of an anode emitting positive rays. Now we have A. Wehnelt investigating how a mica cross introduced into the dark cathode space casts a shadow, not upon the anode, but upon the cathode itself. This fact, first observed by Schuster, is supplemented by the important observation that the size of the shadow is independent of the distance between cross and cathode, provided the cross always remains within the dark cathode space. Within the region covered by the shadow, no canal rays appear on the other side of the perforated cathode, which confirms the view that canal rays are simple anode rays which are not intercepted by the cathode. The author further makes it extremely probable that no cathode rays are given off except where anode rays impinge, thus making them the primary phenomenon. He obtains a permanent silhouette of the cross by oxidation of the copper cathode where the anode rays impinge upon it.

[WEHNELT, *Wied. Ann.*, No. 2, 1899.]

MAGNETIC LEAKAGE IN THE ALTERNATING CURRENT TRANSFORMER.

BY ALEXANDER RUSSELL, M.A.

(Continued from page 604.)

Calculation of ϕ_1, A_1, W_1, V_2. W_2 *and* η *for given Secondary Currents from Initial Data.*—In calculating the following table, the following data only are assumed:—1. $W_0 = 34{\cdot}5$. 2. $A_0 = 1{\cdot}462$. 3. $Q = 0{\cdot}40$. 4. $E_2 = 117{\cdot}5$. 5. $\alpha = 6{\cdot}5$ deg. when the secondary current is three amperes.

No. of experiment.	A_2	ϕ_1	A_1	W_1	V_2	W_2	η
1	0	66·9	1·462	34·5	117·5	0	0
2	0·302	49·2	1·786	70·0	117·0	35·3	0·505
3	0·511	40·9	2·084	94·5	116·7	59·6	0·631
4	1·004	29·2	2·912	163·0	115·9	116·0	0·763
5	1·427	24·0	3·683	202·0	115·3	165·0	0·815
6	1·817	21·1	4·428	248·0	114·4	208·0	0·838
7	2·344	18·7	5·439	309·0	113·5	266·0	0·861
8	2·972	17·5	6·673	382·0	112·3	334·0	0·874
9	3·365	17·0	7·446	427·0	111·5	375·0	0·878
10	3·992	16·9	8·714	500·0	110·1	440·0	0·880
11	4·512	17·2	9·946	570·0	108·9	491·0	0·862

In this table the column headed A_2 is taken from the preceding table. The column headed ϕ_1 is calculated by the formula

$$\tan \phi_1 = \frac{A_0 \sin \phi_0 + n A_2 \sin \alpha}{A_0 \cos \phi_0 + n A_2 \cos \alpha}.$$

It is interesting to note that ϕ_1 attains its minimum value before full load and is beginning to increase.

The column headed A_1 is calculated by the formula

$$A_1 = A_0 \frac{\sin (\phi_0 - \alpha)}{\sin (\phi_1 - \alpha)} \quad . \quad . \quad . \quad . \quad . \quad (20)$$

W_1 is then got by evaluating $V_1 A_1 \cos \phi_1$.

V_2 is calculated by

$$V_2 = 117{\cdot}5 \cos \alpha - 1{\cdot}5 A_2.$$

W_2 equals $V_2 A_2$, and the last column is simply

$$\eta = \frac{W_2}{W_1}.$$

This method of calculating the efficiency is not to be commended as it is affected by errors in calculating A_1, ϕ_1 and V_2. A much simpler and more accurate method is given below.

Experiment with Wechsler Machine (rounded curves).—Frequency 41. Induction density in iron core about 11,700. The same notation and formulæ used as above.

Dr. Roessler's Observations.

No. of experiment.	V_1	A_1	W_1	ϕ_1	V_2	A_2	W_2	η
1	60	2·1	53·0	65·1		0	0	0
2	60	2·405	88·9	52·0	117·4	0·301	35·4	0·398
3	60	2·7	115·4	44·6	117·4	0·522	61·4	0·532
4	60	3·457	171·0	34·5	116·2	0·998	116·0	0·677
5	60	4·221	223·9	27·9	115·4	1·431	165·0	0·737
6	60	5·009	274·1	24·2	115·5	1·846	213·2	0·777
7	60	5·960	334·7	20·6	114·6	2·352	269·6	0·806
8	60	7·203	411·4	17·8	113·5	3·005	339·8	0·829
9	60	7·986	457·5	17·3	112·6	3·393	382·1	0·835
10	60	9·223	532·3	15·8	111·5	4·021	448·3	0·842
11	60		602·6		110·2	4·644	511·8	0·849

Calculation of Angle of Lag due to Leakage.

No. of experiment.	2	3	4	5	6	7	8	9	10	11
α by (5)	0·0	0·0	1·6	1·6	2·3	2·4	2·9	4·0	4·4	...
α by (7)	0·0	0·0	1·5	1·4	2·3	2·3	2·8	4·0	4·3	...
Probable α	0·3	0·6	1·1	1·6	2·0	2·6	3·3	3·8	4·4	5·2

Formula (6) again fails to give us α.

Calculation of A_1, ϕ_1, W_1, V_2, W_2 *and* η *for Assumed Secondary Currents.*—The following data were used:—

1. $W_0 = 53$. 2. $A_0 = 2{\cdot}1$. 3. $Q = 0{\cdot}40$. 4. $E_2 = 117{\cdot}5$. 5. $\alpha = 1{\cdot}1$ deg. per ampere of secondary current.

No. of experiment.	A_2	ϕ_1	A_1	W_1	V_2	W_2	η
1	0	65·1	2·1	53·0	117·5	0	0
2	0·301	52·1	2·401	88·5	117·0	35·2	0·398
3	0·522	45·0	2·683	114·0	116·7	60·9	0·535
4	0·998	34·2	3·432	170·0	116·0	116·0	0·680
5	1·431	28·1	4·178	221·0	115·3	165·0	0·746
6	1·846	24·3	4·937	270·0	114·6	212·0	0·784
7	2·352	20·9	5·875	329·0	113·3	266·0	0·809
8	3·005	17·9	7·106	406·0	112·8	339·0	0·835
9	3·393	17·2	7·875	451·0	112·2	381·0	0·843
10	4·021	15·8	9·080	524·0	111·2	447·0	0·853
11	4·644	15·3	10·30	596·0	110·1	511·0	0·858

Direct Calculation of the Efficiency of the Transformer (1) *when used with the Ganz Machine and* (2) *when used with the Wechsler machine.*—(1) The only data assumed are that $Q = 0{\cdot}40$ and $W_0 = 34{\cdot}5$.

$$\eta = \left(1 - \frac{34{\cdot}5}{W_1}\right)\left(1 - \frac{0{\cdot}4 W_1}{3600}\right).$$

The above formula is equivalent to the graphical construction given in *The Electrician* for March 25, 1898.

No. of experiment	2	3	4	5	6	7	8	9	10	11
Obs. efficiency ...	0·494	0·607	0·747	0·800	0·822	0·841	0·856	0·864	0·864	0·863
Calc. efficiency ...	0·514	0·645	0·767	0·812	0·839	0·860	0·872	0·876	0·880	0·880

These calculated results do not agree very closely with the observed results. They agree, however, with the efficiencies calculated from the observed readings in the secondary circuit (see below). In such a small transformer, if we want a three-figure accuracy, we cannot neglect the last term in formula (12). In this case it equals +0·002 at full load, hence this ought to be added to the last eight of the calculated efficiencies above.

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(2) With the Wechsler machine,

$$\eta = \left(1 - \frac{53}{W_1}\right)\left(1 - \frac{0{\cdot}4W_1}{3600}\right).$$

No. of experiment	2	3	4	5	6	7	8	9	10	11
Observed e	0·398	0·532	0·677	0·737	0·777	0·806	0·829	0·835	0·842	0·849
Calculated e	0·400	0·534	0·677	0·744	0·782	0·806	0·831	0·839	0·847	0·851

By equation (12) we see that we ought to add on to all except the first two +0·003.

Calculation of the Efficiency from the Readings in the Secondary Circuit.—The formulæ used are

$$\frac{1}{\eta_1} = \frac{E_2}{V_2} + \frac{W_o}{W_2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

and correcting for leakage

$$\frac{1}{\eta} = \frac{E_2}{V_2}\cos\alpha + \frac{W_o}{W_2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

(1) With the pointed curves

No. of experiment	2	3	4	5	6	7	8	9	10	11
Observed η.....	0·494	0·607	0·747	0·800	0·822	0·841	0·856	0·864	0·864	0·863
,, η_1	0·506	0·625	0·768	0·801	0·837	0·863	0·873	0·872	0·875	0·870
,, η.....	0·511	0·627	0·770	0·806	0·841	0·868	0·879	0·880	0·884	0.877

(2) With the rounded curves

No. of experiment	2	3	4	5	6	7	8	9	10	11
Observed η.....	0·398	0·532	0·677	0·737	0·777	0·806	0·829	0·835	0·842	0·849
,, η_1	0·403	0·539	0·642	0·747	0·790	0·821	0·839	0·846	0·853	0·855
,, η.....	0·403	0·539	0·642	0·747	0·790	0 821	0·840	0·848	0·855	0·858

In the above calculations no attempt has been made to take into account the differences in the core loss and the copper resistances at no load and full load. In practice it is not difficult to take these into account, and so determine the efficiency with great accuracy. In the above transformer the core loss is considerably less at full load than at no load. The back E.M.F. in the primary circuit at full load (B C in Fig. 1) is $V_1 - RA_1 \cos\phi_1$ nearly, and this equals 60 – 2, *i.e.*, 58 volts. Hence the induction density at full load is 3·3 per cent. less than at no load, and, therefore, the hysteresis loss is 5·3 per cent. less. The eddy current loss will be 6·6 per cent. less due to the diminished value of the effective E.M.F. caused by the driving flux besides a further diminution due to the increase in the specific resistance of the iron with rise of temperature. How the copper resistances (of any particular transformer) vary with the load is a matter to be determined by experiment. Dr. Roessler has given us the limits between which these resistances vary in the transformer he experimented on, and the above figures show that no great error is introduced in the calculations in which they occur by assuming them to be constant.

Mathematical Example.—The height of the centre of gravity of the E.M.F. wave produced by an alternator A is twice as great as that produced by an alternator B, the effective value of the volts in each case being 2,500. A 10-kilowatt transformer tested with the former alternator gave a core loss of 100 watts on open circuit, and a tenth of this loss was due to eddy currents. If Q equals 10 ohms find the efficiency of this transformer at one-twentieth, one-tenth, one-half and at full load : (1) when tested with A ; (2) when tested with B.

Since the height of the centre of gravity of the wave produced by B is only one-half the height of that of A, the maximum induction density in the core is twice as great when tested on B. Hence, by Steinmetz's law, the core loss when tested on B will be

$$2^{1{\cdot}6}(100 - 10) + 10 \; ; \; i.e., \; 282{\cdot}8 \text{ watts.}$$

Using the formulæ

$$\eta_A = \left(1 - \frac{100}{W_1}\right)\left(1 - \frac{10W_1}{2{,}500^2}\right)$$

and

$$\eta_B = \left(1 - \frac{283}{W_1}\right)\left(1 - \frac{10W_1}{2{,}500^2}\right)$$

we get

Load.	$\frac{1}{20}$th.	$\frac{1}{10}$th.	$\frac{1}{2}$	Full load.
Efficiency with A	80·0	89·9	97·2	97·4
,, ,, B	43·4	71·5	93·5	95·6

The above example illustrates the necessity of makers stating the alternator used in the test and the height of the centre of gravity of the wave produced by it at the given effective voltage. They ought to know some simple method of doing this ; otherwise, their tests are of very little value to consulting engineers.

Analysis of Dr. Fleming's Test on a 6-Kilowatt Hedgehog Transformer.—This test was chosen, as it illustrates that the formulæ given above apply to open iron circuit transformers. Also, as there is considerable magnetic leakage, the calculations were made first by neglecting leakage altogether, and then taking it into account. The comparison of the two sets of calculations is instructive, as it shows that we may neglect leakage in the efficiency formula, but that large errors are introduced by neglecting in it the others.

* Swinburne "Hedghog" Transformer. No. 601. Power, 6,000 watts. Current used in test supplied by the London Electric Supply Corporation at a frequency of 83. The average height of the centre of gravity of the E.M.F. wave when the effective voltage is 2,400 is about 1,350, hence it is not unlike the rounded curve produced by the Wechsler machine used by Dr. Roessler.

Primary volts 2,400.

Primary circuit resistance = 7·93 ohms (measured hot).

Secondary circuit resistance = 0·0151 ohm (measured hot).

$$n = \frac{E_2}{V_1 - RA_0\cos\phi_0} = \frac{1}{23{\cdot}53} \; ; \; Q = R + \frac{S}{n^2} = 16{\cdot}3.$$

No. of experiment.	V_1.	A_1.	W_1.	ϕ_1.	V_2.	A_2.	W_2.	η.
1	2,400	1·194	151	87·0	102·0	0	0	0
3	2,400	1·214	469	80·8	102·0	3·06	312	0·665
7	2,400	1·442	1,804	58·6	101·7	16·03	1,630	0·903
9	2,400	1·661	2,583	49·4	101·4	23 87	2,420	0·937
12	2,400	2·030	3,632	42·0	100·8	34·35	3,462	0·954
14	2,400	2·392	4,571	37·2	100·1	43·86	4,390	0·960
16	2,400	2·692	5,297	34·9	99·7	51·38	5,123	0·969

(To be concluded).

CARBONS FOR ELECTRIC LIGHTING AND OTHER PURPOSES.†

BY FRANCIS JEHL.

(Continued from page 649).

The manner in which a waggon is placed in the tunnel without interrupting the draught is best understood from the diagram shown in Fig. 49. Here T_1 represents that part of the tunnel that contains the waggons in which the goods have already been carbonised, and, as seen, its end is open so as to permit the air to enter that is fed to the fire in the furnace F. T_2 is the part of the tunnel that contains the unfinished carbons or electrodes, and the arrow shows the direction in which the waggons move. The rails are indicated by r, and the turn tables are placed at t. G shows the positions of the generators, and C that of the chimney. At d there is a sort of damper or sliding door made of sheet iron, which, when slid into the tunnel, covers its whole cross-section, and at e there is a ordinary tight-fitting door, also of sheet iron.

At P there is an apparatus which may either be a sort of large, long screw or a suitable hydraulic machine that can be used from time to time to push the train of waggons that are in the tunnel. When the contents of a waggon have been carbonised in the furnace F, the apparatus P is so actuated that the waggons in the tunnel are moved one space further, which act delivers a finished waggon at the end T_1, while at the other end room is made for a waggon to be added. A waggon that has been newly packed with fresh goods is then pushed from the packing department on to the turn table at the T_2 end of the tunnel, and at the same time the sliding door d is pushed in so that it cuts off the part c. The door e is then

* "Experimental Researches on Alternate-Current Transformers." By Dr. J. A. Fleming, F.R.S. *Journal* of the Institution of Electrical Engineers, Vol. XXI., p. 649.

† From a forthcoming book to be published by *The Electrician* Printing and Publishing Company (Limited). All rights reserved.

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opened and the waggon is pushed in, after which *e* is closed again and the sliding door drawn back. By this simple means it will be seen that waggons can be moved into the tunnel without interrupting the draught, &c.

The advantages the writer claims for his furnace system for the carbon industry are the following:—

There is a large economy in fuel while the greatest possible effect is obtained. The heat contained in the finished articles is taken up by the air used for combustion, which cools them gradually. The heated gases as they leave the furnace heat up a regenerator with a large surface, and after leaving the latter the hot gases slowly and gradually heat up the fresh carbons.

There is a decided advantage in not having a large network of passages and flues, as is necessary in the chamber system, &c., and thus the gas from the generator arrives in the furnace very hot, whereas in those systems where it has to travel long distances it cools down considerably, which means less economy in fuel. In fact the absence of networks of passages, complicated systems of chambers, &c., lessens the cost of the building and maintenance of the writer's system. In the tunnel system there is only one set of valves and dampers while in the chamber or ring system there is a set for every chamber or division, so that the chances of gas escaping is reduced to a minimum in the writer's system, while the handling gives less work than in other systems. Also there being but one chamber in which combustion takes place it can always be maintained at a high temperature; in the other systems the chambers must first get heated up.

The advantage, in a continuous system, of having a regenerator like that shown in Fig. 46, gives us a means with which the fire can be kept up for any length of time and always at a high intensity, while the direction can be reversed from time to time so that the action of the flames and heat

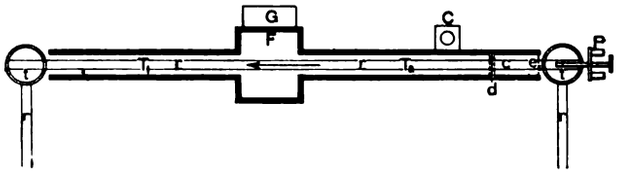

Fig. 49.—Diagram of Jehl's Tunnel System of Furnace.

will produce an even and well-distributed effect on both sides of the retorts and cases that contain the carbons. This cannot be produced in the other systems. This method of changing the direction of the fire from time to time always furnishes us with a well-heated regenerator, and is much used in steel manufacture where only a very high intensity of heat can be used; so that in adapting the same for carbonising carbons and electrodes the more ideal requirements can be obtained. Large electrodes need a very high intensity of heat for a considerable length of time, so that the heat can penetrate into the interior of the carbon mass. This takes time, as carbon is a very bad conductor.

The advantages in handling the carbons, &c., in the writer's system save time and labour, as the carbons and electrodes can be packed in the packing department on the waggons direct, and the finished goods can be delivered into the receiving department. In the other systems the carbons must be packed, and then brought to the furnace, placed in the chambers; the entrances of the latter must always be sealed up with fire-bricks, which are removed again when the chamber is emptied. All this extra work is not necessary in the system described in Figs. 46 to 49. Of course, in this system we have the expenses of the waggons, but their cost is more than balanced by the less cost in building a simple tunnel—one furnace with hardly any length of passages.

A convenient and cheap method of packing electrodes, &c., on the waggons can be effected by means of pieces made of the best fire-clay (chamotte), as shown in Fig. 50. Here pieces similar to *a* serve for the ends, and pieces like *b* are placed between the ends of a trough that is constructed on the waggon. In the waggon W_2 (Figs. 47 to 48) this method of packing is shown. Here *x* indicates fire-bricks that are laid at even lengths, so as to support the trough, while at the same time passages are formed through which the flames and heat can pass. On these fire-bricks pieces similar to those shown in Fig. 50 are laid, their sides being smeared up smooth with fire-clay in order to keep the contents of the trough so formed from burning. In the trough a few fire-bricks are also placed to support the cover, which consists simply of fire-clay slabs. A good bed of carbon dust is placed in the trough, on which the electrodes, &c., are laid, and they are then covered up again with carbon dust, on which the slabs are then placed. In a similar manner four or five such troughs are laid on a waggon, so that there are many passages, as shown in the Figs. 46 to 48, through which the flames and heat can play, and the electrodes are evenly carbonised. It will be seen that such a method of making large troughs is much cheaper than employing troughs made of one piece, for when such a trough breaks it is of no value; while, when a piece as shown in Fig. 50 breaks, it can be replaced at little cost. It is also possible to have such pieces made thinner than can safely be made when whole troughs are made.

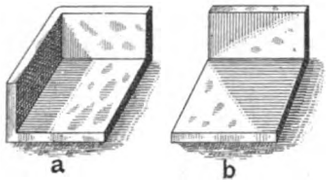

Fig. 50.—Forms made of Fire-clay for packing Carbons and Electrodes.

In Fig. 51 we have a view of a trough made in one piece, as is sometimes used in carbon factories, and to which a cover is provided. These troughs often break, and especially at or near the bottom, as the bottom is generally made much thicker than the sides.

The writer proposes to have such troughs made without bottoms, which will cost much less, while at the same time they will stand the action of the fire better than those with bottoms. The first one is then laid in the waggon and filled with sand; on the top of this another bottomless trough is placed and packed with electrodes; then another, and so on, as shown in Figs. 47 and 48, at waggon, w_1. This method affords also ample passages for the heat and flames. Instead

Fig. 51.—Fire-clay Trough.

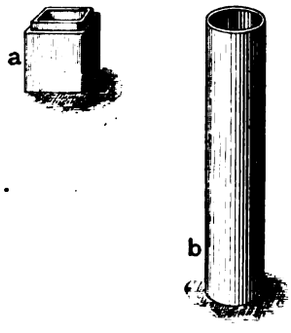

Fig. 52.—Fire-clay Box and Retort.

of using such a form for the lower row, fire bricks can be laid on which a slab rests, on which slab the troughs can be placed, while the top one is, of course, also covered with fire-clay slabs. It will be seen that many good ways can be found by which the carbons can be easily packed on the waggons. In Fig. 52, *a* represents another fire-clay box used sometimes for brushes, &c. These boxes can also be made bottomless, so that they can be placed to fit one upon another, so as to make a long retort. Instead of square forms, round ones are also often used; *b* represents the retorts mostly used by carbon manufacturers for electric light carbons, and it will be seen that if such retorts are constructed from two or three pieces they will be cheaper than when made in one piece. These large retorts often break, and their cost is a considerable item in the expenses of a carbon factory.

(To be continued.)

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THE HISSING OF THE ELECTRIC ARC.*

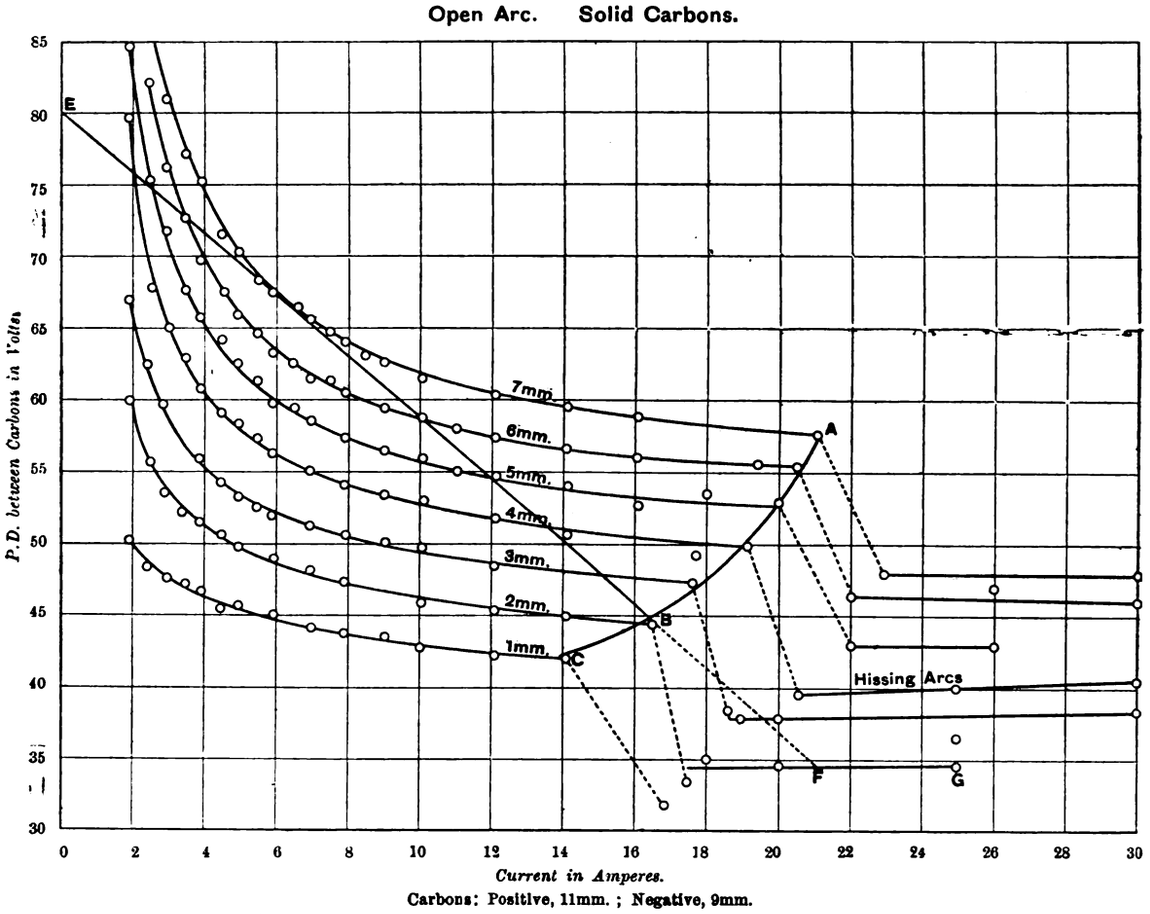
BY MRS. AYRTON.

There are three ways in which any change that takes place in the electric arc may manifest itself: (1) by giving out sounds of various kinds or by becoming silent; (2) by changes in its electrical measurements; and (3) by an alteration in the appearance of the crater, the arc and the carbons. Only two of the many and varied sounds given out by the *direct current open* arc seem to possess much significance—the hum and the hiss—and the causes of these are evidently connected with one another, for the hum never occurs except when the arc is on the point of hissing, or has just been hissing, although it is quite possible to make an arc hiss and become silent again without any hum being heard either before or after. It is proposed, in the present Paper, to discuss the arc as it passes from silence to humming, and from humming to hissing, but, as the changes that occur when the silent arc begins to hum make themselves perceptible to eye and ear only, and do not sensibly affect the electrical measurements, silent and humming arcs will be included under one head in the portion of the Paper dealing with those measurements. It is, however, to the comparatively unexplored region of the direct-current *hissing* arc that I desire to particularly direct your attention this evening.

Some of the electrical measurements of the arc burning between two *solid* carbons 11mm. and 9mm. in diameter are shown in Fig. 1, in which the curves connect the P.D. between the carbons with the length of the arc for several constant lengths of arc, both silent and hissing. It is important to bear in mind that before each observation was made the current and length of arc were kept *rigorously* constant for a sufficient length of time for the carbons to take their characteristic shape for that particular current and length of arc, and long enough, therefore, for the P.D. to have become constant also. Such an arc I propose to call a *normal* arc, as contrasted with one arrived at in a haphazard fashion by suddenly giving the current some particular value and the arc some particular length, and making observations without giving the carbons time to acquire their proper forms. All the lines to the left of the curve A B C represent silent arcs, while immediately to the right of this curve are dotted lines denoting a period when the arc is in the unstable condition that always divides the silent from the hissing arc; and still further to the right are the lines representing the hissing arc. As we are only dealing with hissing and humming arcs, and with the silent arcs that are near hissing or humming, we need only discuss that part of Fig. 1 that is to the right of the line representing, say, 12 amperes, for that part includes all such arcs for each of the constant lengths.

An examination of these curves shows that with the carbons used, and with what I have called the *normal* arc, the following results are met with:—(1) When the length of the arc is constant and the arc is silent, it may be made to hiss by increasing the current sufficiently. (2) The largest current that will maintain a *silent* arc is greater the longer the arc. (3) When the arc begins to hiss, the P.D. suddenly falls about 10 volts and the current suddenly rises 2 or 3 amperes. (4) When the current is constant and the arc is silent, *shortening* the arc will make it hiss. (5) For the hissing arc, the P.D. is constant for a given length of arc, whatever the current.

It was Niaudet* who, in 1881, first observed the fall of about 10 volts in the P.D. between the carbons at the moment that hissing began, and, although, perhaps, there is even yet a lingering notion that it is only when an arc is short that it can hiss,



Carbons: Positive, 11mm.; Negative, 9mm.

FIG. 1.—Curves connecting P.D. and Current for Constant Length of Arc.

I find that as far back as 1889, Luggin† showed that, however long an arc might be, it would still hiss were the current increased sufficiently. At the Congress at Chicago, in 1893, Prof. Ayrton‡ first drew attention to the region of instability, or rather, the region of blankness (notice the dotted portion of Figs. 1 and 2), corresponding with the impossibility of maintaining any *normal* arc with a particular range of current for each length. At the same time he pointed out in Fig. 2, shown at Chicago, that whether the P.D. was descending as the current increased for, say, a 4mm. *silent* arc, or was ascending for, say, a 0·5mm. *silent* arc, it became quite constant for wide variations of current with a *hissing* arc. And, lastly, by a comparison of Fig. 2 with Fig. 3 he brought out the fact that the largest current that would flow silently with any given length of arc was increased by using thicker carbons. For the carbons in Fig. 3 have about twice the diameter of those in Fig. 2, and, while the largest silent current for, say, the 2mm. arc in Fig. 2 is 15·5 amperes, that for the same length of arc in Fig. 3 is about 49 amperes, or more than three times as great.

* Paper read before the Institution of Electrical Engineers, March 23rd.

* *La Lumière Electrique*, 1881, Vol. III., p. 287.

† *Wien Sitzungsberichte*, 1889, Vol. XCVIII., p. 1,192.

‡ *The Electrician*, 1895, Vol. XXXIV., pp. 336-7.

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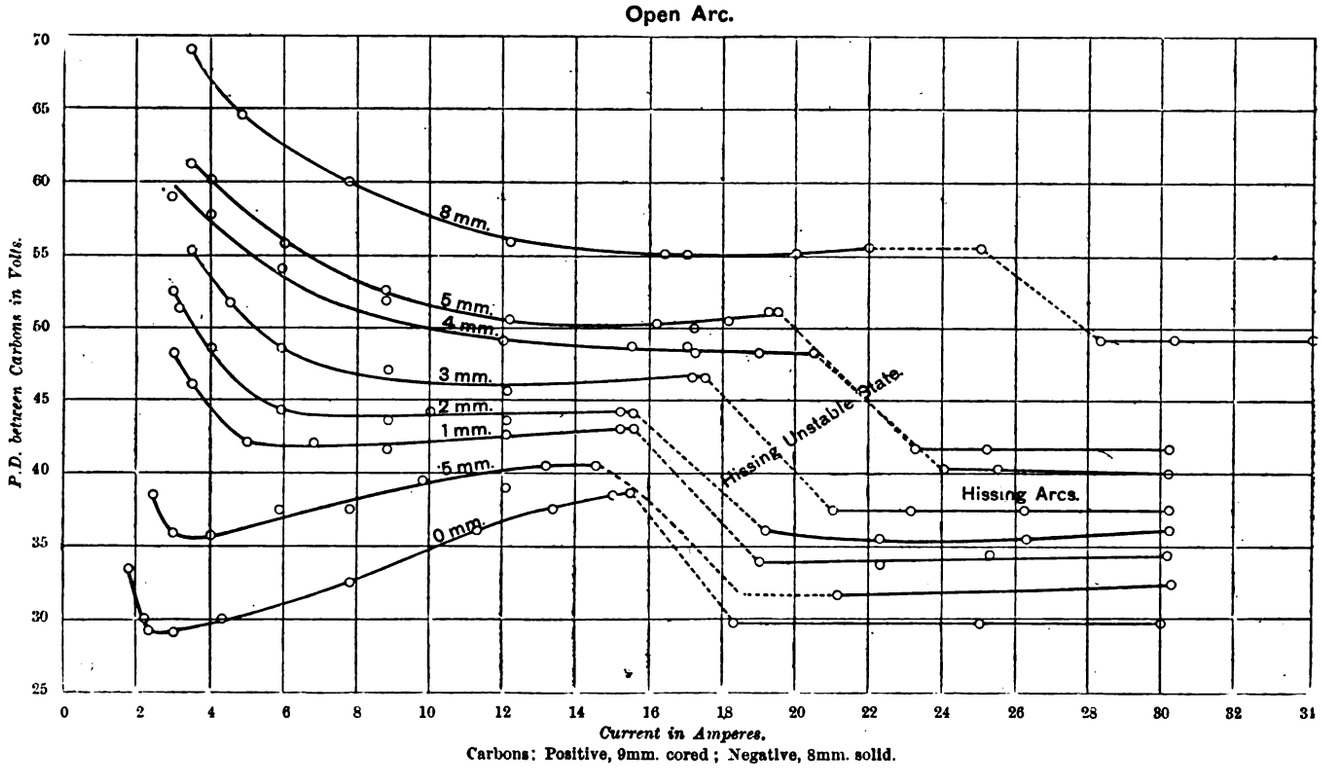
Returning now to the subject of the dotted lines in Figs. 1, 2, and 3, it is plain that these divide the curves into two perfectly separate parts, governed by different laws. For to the left of the dotted part the lines are all curved, and curved differently according as solid or cored positive carbons are used, showing that with silent arcs the P.D. varies as the current varies, and



Carbons: Positive, 9mm. cored; Negative, 8mm. solid.

FIG. 2.—Curves connecting P.D. and Current for Constant Lengths of Arc.

that the law of variation is different with solid and cored carbons. To the right, on the other hand, the lines are all straight, and more or less parallel to the axis of current, whether the positive carbon is solid or cored, showing that with *hissing* arcs the P.D. is the same for a given length of arc and a given pair of carbons, *whatever* current is flowing, and that this law is true whether the carbons be cored or solid. In fact, some complete and sudden break-down appears to occur when hissing begins, upsetting all the

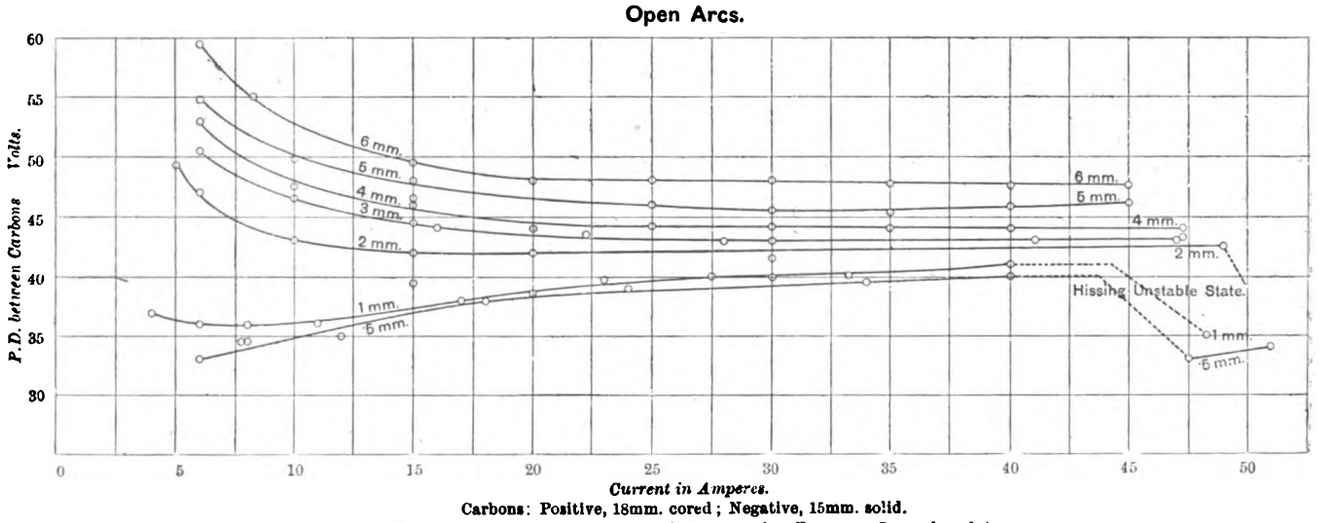
therefore, the arc is really hissing. On examination of Fig. 1, the points of which were obtained experimentally with much care, it is seen that the hissing points lie well on the curve A B C, the equation to which I have shown elsewhere* to be

$$V = 40{\cdot}05 + \frac{2{\cdot}91 - A29{\cdot}02}{10{\cdot}54 - 0{\cdot}416A} \quad \ldots\ldots \quad (1)$$

where V is the P.D. between the carbons in volts, and A is the largest silent current in amperes. Or, expressing the P.D. in terms of l, the length of the arc in millimetres, instead of in terms of the current at the hissing points, we have

$$V \quad 40{\cdot}05 + 2{\cdot}49l \quad \ldots \quad (2)$$

which shows that at the hissing points any given increase in the length of the arc causes an increase in the P.D. between



Carbons: Positive, 18mm. cored; Negative, 15mm. solid.

FIG. 3.—Curves connecting P.D. and Current for Constant Lengths of Arc.

laws that have governed the arc while it was silent, and bringing the behaviour of cored and solid carbons into accord.

Thus, our subject divides itself quite naturally into two distinct portions, the one dealing with the arc when the breakdown is imminent, but before it has actually occurred—dealing, that is to say, with the points at which the current is the largest that will flow silently—the *hissing points*, as I shall call them; and the other dealing with the arc after the breakdown has occurred, and when,

the carbons that is simply proportional to the increase of length. That is to say, for every millimetre that is added to the length of the arc, 2·49 volts is added to the P.D. between the carbons at the hissing point. From the above two equations I deduced the third, viz.:—

$$l = \frac{1{\cdot}17A - 11{\cdot}66}{10{\cdot}54 - 0{\cdot}416A} \quad \ldots\ldots \quad (3)$$

* *The Electrician*, 1896, Vol. XXXVI., p. 541.

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nd pointed out that, since l was infinite when $10{\cdot}54-0{\cdot}416A=0$, r when $A=25{\cdot}3$ amperes, no current greater than 25·3 amperes ould maintain a normal *silent* arc, however long it might be made with the particular carbons used. Hence we may gather that *for each pair of carbons the current that will sustain a normal silent arc has a maximum value, and that any current greater than this will make the arc hiss, however long it may be.*

To turn, now, to the arc when hissing has actually begun. It has already been shown that *when the arc is hissing, the P.D. between the carbons is constant for any given length of arc, and is, therefore, independent of the current*; but no law has yet been given connecting the P.D. between the carbons with the length of the arc when hissing. This can now be found from Fig. 1, by plotting the mean P.D. between the carbons for each length of arc when it was hissing, with the corresponding lengths of arc. In this way we get a straight line, the equation to which is

$$V=29{\cdot}25+2{\cdot}75l \quad . \quad . \quad . \quad . \quad . \qquad (4)$$

How far equation (4) really sums up the facts may be seen from Table I., which gives the mean value of the observed P.D. between the carbons for each length of hissing arc, the P.D. calculated from equation (4), and the difference between the two.

Table I.—*Hissing Arcs. Mean P.D. between Carbons for Different Lengths of Arc compared with same P.D. calculated from Equation (4).*

Carbons: Positive, 11mm. solid; Negative, 9mm. solid.

Length of arc in millimetres.	Mean P.D. between carbons in volts.	P.D. calculated from equation (4)	Difference in volts.
1	32·0	32·0	0
2	34·4	34·75	−0·35
3	37·8	37·5	+0·3
4	40·0	40·25	−0·25
5	43·0	43·0	0
6	46·5	45·75	+0·75
7	48·0	48·5	−0·5

Equation (4) shows that, *with the hissing as with the silent arc, a straight line law connects the P.D. between the carbons with the length of the arc.*

There is, however, this vast difference between the law for silent and that for hissing arcs—viz., that for silent arcs the law only holds for constant currents or for the currents at the hissing points, whereas for hissing arcs it holds *whatever the current may be.* Thus, while for silent arcs the constants which correspond with the terms 29·25 and 2·75 in equation (4) are constant only for each separate current, and change when the current changes, with *hissing* arcs they remain the same *whatever* the value of the current may be. For instance, the equation equivalent to equation (4) for a normal silent arc with a current of 4 amperes is $V=41{\cdot}79+4{\cdot}71l$, and with a current of 12 amperes it is $V=39{\cdot}85+2{\cdot}95l$; but with the hissing arc the equation is $V=29{\cdot}25+2{\cdot}75l$, whether the current be one of 20 amperes or of 50, *and whether the arc be normal or not.* This brings me to the reason for the great importance of distinguishing between arcs that are normal and those that are not. We have seen that, with normal arcs of any given length, hissing only starts when all the silent arcs have been used up, as it were; that is to say, when the current is *greater* than it can be with any silent arc of the same length. But with a *non*-normal arc of 2mm. I have been able to produce hissing with a current of 11 amperes, and to have a silent arc burning with a current of 28 amperes, the same carbons being used in each case. This apparent anomaly will be fully explained later, when we go into the causes that produce hissing.

We are now in a position to find the law connecting the length of the arc with the change that takes place in the P.D. between the carbons when hissing begins. For if we call V the P.D. between the carbons at the *hissing point* with any given length of arc l, and V′ the same P.D. when the same length of arc is hissing, then from equations (2) and (4) we get

$$V-V'=10{\cdot}8-0{\cdot}26l \quad . \quad . \quad . \quad . \qquad (5)$$

which shows that *the longer the arc the less does the P.D. between the carbons diminish when it changes from silence to hissing.*

In 1889, Luggin* found, by measuring the fall of potential between each carbon and the arc, that the principal part of the diminution of P.D. caused by hissing took place at the junction of the positive carbon and the arc. About three years ago, not then having come across any account of Luggin's experiments, I made some of the same sort myself, and obtained the same result. I used two solid Apostle carbons 11mm. and 9mm. in diameter, and the third carbon for placing in the arc was 3mm. in diameter. This last was somewhat thick, but it burnt well to a point in the arc, and thinner carbons burnt away too rapidly with the current I used—25 amperes—to give good measurements. The P.D. between the positive carbon and the arc was found by placing the third carbon in the arc as close as possible to the positive carbon, and measuring the P.D. between the two with a very high resistance voltmeter. This was easily done when the arc was hissing, but was impossible when the largest silent current was flowing, for then the mere insertion of the third carbon was sufficient to make the arc hiss. Accordingly, the P.D. between the positive carbon and the arc when the largest *silent* current was flowing has had to be calculated from the formula I gave at the meeting of the British Association† last year for calculating that P.D. with *any* silent current, viz., $V=31{\cdot}28+\frac{9+3{\cdot}1l}{A}$.

* *Wien Sitzungsberichte*, 1889, Vol. XCVIII., p. 1,192.

Table II.—*P.D. between Carbons, and P.D. between Positive Carbon and Arc with Largest Silent Current and with Hissing Current of 25 amperes.*

Carbons: Positive 11mm. solid; Negative, 9mm. solid.

Length of arc in millimetres.	Largest silent current.		Hissing current of 25 amperes.	
	P.D. between carbons in volts.	P.D. between positive carbon and arc in volts (calculated).	P.D. between carbons in volts.	P.D. between positive carbon and arc in volts.
1	42·2	32·1	32·1	24·4
2	44·5	32·2	34·6	25·2
3	47·5	32·3	37·0	25·7
4	49·4	32·4	40·5	25·7
5	53·0	32·5	43·9	27·9
6	55·5	32·6	45·9	27·2

Table III.—*Diminution of P.D. between Carbons due to Hissing compared with Corresponding Diminution of P.D. between Positive Carbon and Arc.*

Carbons: Positive, 11mm. solid; Negative, 9mm. solid.

Length of arc in millimetres.	Diminution of P.D. between carbons due to hissing.	Diminution of P.D. between positive carbon and arc due to hissing.
1	10·1	7·7
2	9·9	7·0
3	10·5	6·6
4	8·9	6·7
5	9·1	4·6
6	9·6	5·4

In Table II. two sets of currents are dealt with, viz., the largest silent current for various lengths of arc, and a hissing current of 25 amperes; and, for each of these sets of currents and lengths of arc, two P.D.'s are given, viz., the P.D. between the main carbons, and the P.D. between the positive carbon and the arc itself. Now, in order to compare the change in the P.D. between the main carbons caused by hissing, with the corresponding change in the P.D. between the positive carbon and the arc, we must subtract column 4 of Table II. from column 2, and column 5 from column 3, and compare the differences. These difference are given in Table III. Thus for the lengths of arc dealt with, hissing causes a mean fall of about 9·7 volts in the total P.D. between the main carbons, and a mean fall of about 6·3 volts in the P.D. between the positive carbon and the arc. Hence of the whole diminution of the P.D. between the carbons caused by hissing, about two-thirds takes place at the junction of the positive carbon and the arc.

Further, my experiments showed that very little of the remainder of the diminution, if any, was due to a fall of the P.D. between the arc and the negative carbon; therefore this remaining diminution must be attributed to a lowering of the resistance of the arc itself. We may sum up these results as follows:—*Of the total diminution of the P.D. between the carbons caused by hissing, about two-thirds takes place at the junction of the positive carbon and the arc, and the remaining third seems to be due to a lowering of the resistance of the arc itself.* From Fig. 1 it might be supposed that, given the length of the arc, the increase of current that abruptly occurs as the arc starts hissing was as definite for that length of arc as the diminution in the P.D. And this, for a long time, I imagined to be the case. But, while trying to find out what law connected the smallest hissing current with the length of the arc, I saw that the value of that current really depended on the circuit *outside* the arc. For, let E be the E.M.F. in volts of the generator, which we will assume to be constant and independent of the current; r, resistance in ohms of the whole circuit *outside* the arc; l, length of the arc in millimetres; A, largest silent current in amperes; V, corresponding P.D. between the carbons in volts; A′, smallest hissing current in amperes; V′, corresponding P.D. in volts, then $E=V+Ar$ and $E=V'+A'r$; therefore, $\frac{A'-A}{V-V'}=\frac{1}{r}$, that is, the sudden increase of current when hissing begins equals

† *Report of the British Association*, 1898, p. 805.

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the product of the sudden diminution of the P.D. into the conductance of the circuit outside the arc. Again, $\frac{A'}{A}=\frac{E-V'}{E-V}$ or $A'=\frac{E-V'}{E-V}A$. But for a given hissing point, for example, B (Fig. 1), V, V', and A are all constants; therefore, for such a point A' depends simply on E. In fact, for a fixed point B and a fixed line F G, the position of the point F merely depends on the slope we give to the line E B F; that is, on the point of the axis of P.D. we select for E. And a consideration of the figure shows that the distance between this point E and the axis of current measures E, and the E.M.F. of the dynamo. Consequently it now appears that the dotted lines in the unstable region constitute records of the particular E.M.F.'s the dynamo was made to give on the various days when the experiments were made with the different lengths of arc, several years ago. *Hence, when the largest silent current changes to the smallest hissing current for the same length of arc, the value of that smallest hissing current depends on the E.M.F. of the generator only.* Thus, it is possible, by choosing suitable E.M.F.'s, to make the sudden smallest hissing current have any value greater than that of the largest silent current for the same length of arc. It is evident from Fig. 1 that the smaller the E.M.F. of the generator, the larger will be the value of the smallest hissing current, for the lower down will E be on the axis of P.D., and therefore the farther will the point F be along the line F G. This explains a circumstance that puzzled me greatly when it happened, but which is now perfectly comprehensible. Some years ago I was using accumulators to maintain an arc, and employing as small a number of cells as possible. I was able to have quite a moderate current as long as the arc was silent, but as soon as it began to hiss, the current rushed up to some huge value which would inevitably have ruined the cells, if I had not had a cut-out arranged to break the circuit. Why the first hissing current should be so much greater than I was accustomed to find it with the dynamos I ordinarily used, I could not imagine, but the reason is now perfectly obvious. The hissing current was so great simply because the E.M.F. of the cells was so small, and had it been possible to maintain a silent arc without any resistance in the outside circuit except that of the cells, which is what I was trying to accomplish, I might, except for the cut-out coming into operation, have had practically an infinite current when the arc began to hiss.

(To be continued.)

ELECTRIC TRACTION AND ITS APPLICATION TO SUBURBAN AND METROPOLITAN RAILWAYS.*

BY PHILIP DAWSON.

(Concluded from page 765.)

Having tried to show the advantages which electric traction possesses, as regards the possibility of increasing the frequency of the trains without decreasing the factor of safety, namely, the distance between two trains, it may be advantageous to see how, from an economical standpoint of generating power, electricity is a cheaper method of operation than steam locomotives. An electrically-driven train only requires one man instead of two to drive it, and when the train is not running no power is consumed and no coal or water wasted. Steam locomotives, it is well known, use but very little less coal and water when they are standing still than when they are running, and are much less economical, consuming, as they do in America, from 5lb. to 6lb. of coal per indicated horse-power. On main line English roads it is stated that 3lb. to 4lb. are consumed, and, taking an average power of 400 H.P. per locomotive, and a train, plus engine, weighing 250 tons at a speed of 40 miles an hour, we get at the most economical rate about 0·65lb. of coal per ton mile, or, compared to the electric power required by electric traction, 1lb. of coal per Board of Trade unit required, which is enormous—under favourable conditions it would not take much over 3lb. of coal to give one Board of Trade unit at the switchboard. A properly designed electric station, with large units, would probably never consume more than 2lb. of coal per indicated horse-power hour, or 2·65lb. per kilowatt hour at the awitchboard, and engines of the size of 4,000 to 6,000 H.P. would be guaranteed to consume not more than 12lb. of steam per indicated horse-power hour. A large station would fully justify a comparatively large initial expense in coal handling and stoking machinery, and the location of the station could be chosen so as to be most advantageously situated as regards both coal and water, the coal without being handled being taken from either the ship's hold or the railway truck, conveyed automatically to the cold stores, and from thence automatically to the fires, the ashes being conveyed away automatically as well. In such a station but very few men would be required, and the cost of power could be reduced below one halfpenny per Board of Trade unit, including expenses of every kind.

* Paper read before the Society of Arts, March 22, 1899.

Comparing again the coal consumption per train mile on large English main line railways, which varies from 35lb. to 58lb. of coal per train mile, we get a coal consumption of from 0·146lb. to 2·32lb. per ton mile, corresponding to 28·12lb. to 46·4lb. per Board of Trade unit, required to be generated at the power-house. The following results actually obtained with slow-speed Corliss type engines and standard American railway generators may be of interest:—Total coal consumed, Brooklyn City Railway Co. per Board of Trade unit, 3lb. Total cost, everything included, of Board of Trade unit at switchboard, 0·5195 cents. (about one farthing). Cost of coal per unit, 0·2307 cents, about 0·166 of a penny; Union Traction Co., Philadelphia. Poorest coal, 3½lb. consumed per Board of Trade unit at switchboard. In another case cost of coal, 0·272 cents per Board of Trade unit at switchboard, about 0·186 pence. Total cost of unit, all included, 0·591 cents, about 0·296 pence. Coal consumption in another case with Corliss engine, average for one year, per indicated horse-power hour, 1·65lb. to 1·76lb. What good slow-speed Corliss engines, properly designed for railway work, compared to other engines, mean are shown by the fact that by such a change in a large American station the coal consumption was reduced from an average of 8·3lb. to 4·9lb. of coal per car mile.

From a series of figures obtained from the various Chicago electric overhead lines, from 0·116 to 0·135 Board of Trade units are required at the switchboard to drive the trains, the average speed of the trains being 13½ miles an hour, and the maximum speed obtained varying from 28 to 35 miles an hour. The coal and water consumption, per Board of Trade unit, could not help but be very low, the losses in the step-up and step-down transformers and in the transmission and rotary converters would not be very great, and it would be perfectly feasible to attain an efficiency of 60 per cent. at the motor terminals and of 50 per cent. on the power applied to the car axles. Large engines and large generators and converters are designed so as to take an overload of 25 per cent. for any period of time, and be capable of overloading 50 per cent. for a short time without injury, and by a selection of proper units a very large economy could be attained.

Metropolitan Elevated, Chicago.	
Length of street	36¼ miles.
Average distance between stations	1,600 feet.
Time interval between consecutive trains	2½ minutes.
Average speed in miles per hour	13 miles.
Maximum speed	28 miles.
Total rated power of generating station	5,000 kw.
South Side Elevated, Chicago.	
Length of street	18½ miles.
Average distance between stations	1,720 feet.
Time interval between consecutive trains	1½ minutes.
Average speed in miles per hour	14 miles.
Maximum speed in miles per hour	26 miles.
Total rated power (4 units 800 kw. each) of generating station	3,200 kw.
Lake-street Elevated, Chicago.	
Length of line	15 miles.
Power of station	3,000 kw.
North-Western Elevated, Chicago.	
Length of line	15 miles.
Rated power of station (3–1,500 kw.; 1–800 kw.)	5,300 kw.
Loop, Chicago.	
Length	4 miles.
Rated capacity of station (4 units 1,500 kw.)	6,000 kw.
Number of trains passing over line in 24 hours	3,000 trains.
Total rated power of Chicago elevated lines, approximately	22,500 kw.
Nantasket Beach.	
Length of line	20 miles.
Rated power of station	1,800 kw.
Average distance between stations	4,280 feet.
Maximum speed per hour	43 miles.
Average speed	25 miles.
Board of Trade units per ton mile, at switchboard	0·0808
Weight of two-car train	55 tons.

The elevated railroads of New York and Brooklyn have been losing business during the last few years so rapidly that the financial condition of the Brooklyn system is serious, and the return on investment of the New York system much reduced, and is still declining. The elevated railroads of Chicago have never been able to earn a satisfactory dividend. The general introduction of electricity in the Chicago system has greatly improved the Chicago situation, in spite of the competition of the surface trolley lines, which parallel the elevated lines in most cases. The elevated railroad problem is resolved into a discussion of speeds, station frequencies, and relative costs of service. Any railroad of this class which aims to maintain a high schedule must choose a motive power in which the possibilities of rapid acceleration are a maximum, and—all other conditions being equal—should choose that particular motive power which will bring about the quickest acceleration, consistent with due economy. The Manhattan system is a comparatively simple one, with four main through lines, without branches of importance,

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while the Brooklyn and Chicago systems are composed of trunk lines with branches, involving more or less complicated switching arrangements. Until about a year ago, the three Chicago companies, the Lake Street, the South Side, and the Metropolitan, had independent termini in the business heart of the city. Now, however, the newly constructed "Loop," encircling the business district, is used as a terminus for all three lines and for a fourth, the North Western, now under construction, and all the elevated trains of the city pass round this loop on each trip. The Brooklyn elevated system has lately secured a new terminus on the Manhattan Island side of the Brooklyn Bridge, and experiments are being made with a view to converting the entire Brooklyn system to electricity in the near future. The entire New York system, however, is at present operated by steam locomotives. The little locomotives in use on the New York system weigh 47,000lb., of which 31,500lb. are on the four 42in. driving wheels, and 15,500lb. are on the four 30in. truck wheels. The total wheel base is 193in., of which 60in. is rigid. The cylinders are 12in. in diameter, and have a 16in. stroke. The grate area is 16·5 sq. ft., and the total heating surface is 4,034 sq. ft. There are 154 flues 1½in. in diameter and 75in. long. The standard Manhattan car weighs 29,088lb., has seats for 48, and frequently carries 100 passengers. It is mounted on eight 30in. wheels. The total weight of a 5-car loaded Manhattan train is about 130 tons. The weight on the drivers is 12 per cent. of the total train weight, and, with 25 per cent. adhesion, the maximum drawbar pull possible for the locomotive to exert is 7,875lb.

The electric locomotive car of the Metropolitan Elevated Railway Company, of Chicago, weighs 53,200lb. complete with motors, or 40,000lb. exclusive of motors. It is a standard American passenger car with full seating capacity, about one-half of each platform being taken up with the cab and necessary controlling apparatus. The trail cars weigh 33,000lbs. The seating and standing capacity of both motor and trail cars is approximately 90 passengers. The average 4-car heavily-loaded train will weigh about 100 tons, of which 32·5 tons approximately are on the four wheels of the locomotive's motor truck, and 67·5 tons are in the trail cars. From 30 to 35 per cent. of the entire train weight is available for traction under these conditions, and the maximum drawbar pull possible to exert without slipping of wheels is about 16,250lb. The South Side Elevated Railway Co., of Chicago, is equipped with the Sprague multiple unit system, by means of which two or more cars in a train are equipped with motors and may be operated in unison by a single controller from any point in the train. The company is now operating four car trains, on each of which is a motor truck carrying two motors. The cars weigh about 20 tons each, without load, and about 60 per cent. of the train weight is available for traction.

There are, therefore, three distinct types of elevated railway equipment—the steam locomotive, using 10 to 15 per cent. of the train weight for traction under heavy traffic conditions; the electric locomotive, using 30 to 35 per cent.; and the multiple unit system, using any amount desired up to 60 per cent. of the train weight.

The transportation expenses of the South Side Elevated Railway in Chicago for July, August and September, 1897, when steam locomotives were employed, were 2·8 cents per car mile, while in the same months of 1898 they were 1·9 cents per car mile, or a saving of nearly 0·9 cents, or about 33 per cent.

Metropolitan District, London.

Average speed in miles per hour	13½.
Maximum " "	27.
Minimum time between consecutive trains	2 minutes.
Average time between consecutive trains	3½ to 4min.
Total weight of train	161 tons.
Average carrying capacity	450 passen.
Weight of locomotive	47 tons.
Average distance between stations	2,600ft.
Time required in seconds to reach 25 miles an hour starting from a standstill	30 seconds.

The figures in the above table show at once the great advantage to be gained by electric traction, by means of which speed of 25 miles an hour could be obtained in 10 seconds, and by simple calculation it is easy to ascertain that this would greatly increase the average speed and therefore decrease the time necessary to do the distance.

The characteristic difference between the acceleration curve of a train hauled by a steam locomotive and one driven electrically is that, whereas the acceleration where steam is used as motive power increases at first, slowly following a curve which is nearly tangent to the horizontal or time axis, the acceleration curve in the case of electric propulsion is represented by a straight line rising very rapidly, and forming a very small angle, with a vertical axis.

It may be interesting to mention a few details regarding the two large power stations which are now being equipped in New York, and which will operate the two large tramway systems of that city, namely, the Metropolitan and the Third Avenue. The Metropolitan station is now under construction, and will contain 11 direct connected sets each of 3,500 kilowatts, room for extension being allowed, and a capacity having been foreseen of nearly double that amount. The following gives the particulars of the General Electric Co.'s dynamos which will be used. The machine will have a frequency of 25 cycles per second, at 6,600 volts. It will have 40 poles, and will run a speed of 75 revolutions per minute. It will be of the stationary armature type, the core being built up of laminations 0·014in. thick. Each lamination has two dovetail projections, which fit in corresponding slots in a heavy cast-iron spider. Spaces are left between the laminations at intervals, through which currents of air are driven by the rotating field and circulating by intimate contact with core and windings. The armature winding consists of form-wound coils placed in slots in the core, and retained by wooden wedges, the edges of which fit into recesses in the teeth. The field frame consists of a cast-steel ring, supported upon a cast-iron spider; to this are bolted laminated cores of sheet iron, the pole-pieces of which project over and support the copper field windings. The field winding consists of copper strip wound on edge with paper insulation between turns. The insulation is such as to stand a test of 4,000 volts alternating between the winding and the core. The exciting E.M.F. is 125 volts. The collecting rings are of copper, and carbon brushes are used. The armature winding is tested to 12,000 volts alternating. The temperature rise of the machine after 10 hours' run at full load is well under 40°C. The efficiencies are as follows:—

1¼ load	90 per cent.	½ load	92·5 per cent.
Full load	95·5 "	¼ load	88 "
¾ load	95 "	Inherent regulation	9 "

The steam engines which drive these dynamos are cross compound Allis vertical engines, 46in. high and 86in. low pressure cylinders, and 60in. stroke. They will develop 4,900 I.H.P. at the rated economical load, and will be able to work continuously at 6,000 H P. if required, and for a short space of time they are to be able to work at 7,000 H.P. The crank shaft is of solid steel, bored and forged, with a hole 16in. diameter the entire length, and it is 37in. in diameter where the wheel and armature are located. The diameter of the shaft in the bearings is 34in., and the length of the bearings 60in. The fly wheel will have cast steel centres, and the rim will be built up of steel plates riveted together. The rim will weigh 225,000lb., and the engine itself, complete, about 600 tons, and it is believed that as good results as 12½lb. of steam per indicated horse-power will be easily obtained. There will be several sub-stations in which will be located step-down transformers of 300 kilowatts each, which will lower the voltage from 6,600 volts to 350 volts. At this pressure the current will enter rotary converters of 900 kilowatts each, and will be delivered in the shape of a continuous current of 500 volts to the tramway system. This company operates some 250 miles of tracks and carries approximately 250,000,000 passengers every year.

The Third Avenue Road is now engaged in equipping all existing horse and cable lines with electric traction, and for this purpose has just given out a contract for a power station which will eventually contain 16 3,000 kilowatt generators. The generators will be very similar to those described above, and are being built by the Westinghouse Company, who are the sole contractors for the whole work. The engines will be Marine type, vertical, and are being built by the Westinghouse Machine Company. Sub-stations with rotary transformers will be used, as in the case of the Metropolitan system.

To give an idea of what may be done as regards power transmission, the following few figures may be useful. The first attempts at this class of work were made during the Frankfort Exhibition of 1891, 300 H.P. being satisfactorily transmitted a distance of 106 miles with a pressure of 30,000 volts. Since that time electrical power transmission has largely increased, and the results obtained have been very satisfactory; 4,000 H.P. at the present moment are regularly transmitted a distance of 85 miles to the city of Sacramento, California, at a pressure of 30,000 volts, where they are transformed into low-pressure three-phase and continuous current for lighting, power and traction purposes. At Teluride, Utah, 1,000 H.P. are transmitted 55 miles, at a pressure of 40,000 volts; 4,500 H.P. are transmitted a distance of 40 miles to Salt Lake City, at a pressure of 15,000 volts; 1,400 H.P. are being transmitted 35 miles to Fresno, California, at a pressure of 11,000 volts; 2,000 H.P. are being transmitted 30 miles to West Kootenay, British Columbia, at a pressure of 20,000 volts; 10,000 H.P. are being transmitted from Niagara to Buffalo, a distance of 22 miles, at a pressure of 10,000 volts. All the plants are working and giving satisfaction, and have nothing experimental about them, and there are hundreds more such.

In the designing and carrying out of a large system there are three points which are frequently overlooked, and which may cause a disastrous failure. These are good and adequate bonding; thoroughly good insulation, both mechanically and electrically; and trucks suited for the work for which they are intended. As regards the bonding, the bonds used should be flexible, but, at the same time, should contain no solder or brazed joint, and they should be expanded against the side of holes drilled in the web or

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foot of the rail, and held in place by pins. Bonds of this description, when properly applied, can be absolutely relied upon, the contact resistance of the bond with the rail not being greater than the resistance of the solid bond. With regard to the third-rail insulators, very good results are obtained by using insulating bolts screwed into base plates which are fixed to the sleepers, cast-iron chairs being fixed to the head of the bolts to hold the rails.

ELECTRICITY WORKS ACCOUNTS.

Chelsea Electricity Supply Co. (Limited).

Our two analyses this week are of the accounts for 1898 of the Chelsea and House-to-House Companies. Both concerns commenced business in 1889, and have, therefore, been in operation over nine years.

Since 1897 the remaining portion of the authorised share capital of the Chelsea Company has been paid up, the total being £200,500. An additional £32,120 has been raised on Four and a-Half per Cent. Debenture stock, the total from this source being now £92,120. The capital expended has reached £332,291, or at the rate of about £147 per kilowatt of generating plant in the stations. During the year 226 additional consumers were secured, with the equivalent of 16,062 8 c.p. lamps, thus raising the lamp connection from 96,638 to 112,700—an increase of nearly 12 per cent. The output for the year was 1,220,198 units sold, or about 15 per cent. higher than the output of 1897. The revenue from supply has been kept practically steady at about 5·8d. per unit. The items in expenditure of wages and repairs and maintenance at the station show a decided increase, with the result that the works costs for 1898 are higher by 0·1d. than they were in 1897. This increase has, however, been more than compensated for by economies in management and property charges, so that the total costs and their ratio to the revenue have remained constant.

A working profit of £16,662 was turned, and has afforded an ordinary dividend of 6 per cent. after paying £2,786 as interest, £2,500 to the renewal and depreciation fund, and a 6 per cent. dividend on the Preference shares. The payment into the reserve fund of £12,780 was, as in 1897, made out of the premiums received on share issues. It should be stated that the renewals and depreciation fund account has been charged with £670 to "Renewals of Plant," and in our table the items opposite repairs and maintenance at the station and of the mains are exclusive of this £670. We append a table which is an interesting record of the progress of the undertaking:—

Year.	No. of consumers.	8 c.p. lamp connection.	Output units sold.	Rev.	Gross Profit.	Div.	Plant capacity kw.	Max. load kw.
1889	93	8,730	...	...	...	...	...	...
1890	252	19,580	...	£6,079	£543	...	£66	...
1891	...	27,500	290,458	10,173	1,750	...	449	...
1892	...	34,876	357,162	12,523	4,319	2¼%	...	...
1893	...	40,665	402,848	13,732	6,269	5%	885	...
1894	...	47,286	469,515	15,486	8,096	5%	885	476
1895	715	57,354	577,770	17,165	9,890	5%	1,205	638
1896	972	80,460	813,764	21,355	10,362	5%	1,310	980
1897	1,190	96,638	1,061,970	27,382	14,555	6%	1,860	1,350
1898	1,416	112,700	1,220,198	31,363	16,662	6%	2,260	1,390

House-to-House Electric Light Supply Co. (Limited).

The 1898 accounts of the House-to-House Company give evidence of very satisfactory progress. In the course of the year 861 additional consumers with the equivalent of 13,937 8 c.p. lamps were connected to the mains—an increase in the latter of 21 per cent. A similar and corresponding increase shows itself in the output which was 974,618 units sold as compared with 811,255 in 1897—a rise of slightly over 20 per cent. The average revenue for supply was practically the same as in the previous year, viz., 5¾d. There is a slight rise in the costs, but the fuel charges, in spite of the troubles in the coal trade last year, have dropped and generally there is a practical maintenance of the satisfactory working of 1897.

The tariff is at the rate of 6d. per unit subject to rebate on the following scale in 1898 provided that the consumer's maximum demand in kilowatts does not exceed 0·2 per cent. of the consumption in units during the year:—

On consumption per annum of or above	Discount.	Price charged.
3,000 units.	¼d.	5¾d.
4,000 ,,	⅜d.	5½d.
5,000 ,,	½d.	5¼d.
6,000 ,,	1d.	5d.
10,000 ,,	1¼d.	4¾d.
14,000 ,,	1½d.	4½d.
20,000 ,,	1⅝d.	4¼d.
30,000 ,,	2d.	4d.
50,000 ,,	2¼d.	3¾d.
75,000 ,,	2½d.	3½d.
100,000 ,,	2⅝d.	3¼d.
150,000 ,,	3d.	3d.
250,000 ,,	3¼d.	2⅝d.
500,000 ,,	3½d.	2½d.

We fear that under this scale few consumers will enjoy even a rebate of ¼d. per unit, for there cannot be very many who will each consume 8,000 units annually, equal to £75 per annum. In the last line of the table provision is made for a consumer to buy more than half the units sold during the whole of 1898.

The working profit made during 1898 amounted to £14,066, representing 8·39 per cent. of the mean capital. Out of this profit £4,000 has been carried to the depreciation fund and £1,507 paid in interest on loans. The balance has afforded the payment of a full dividend on the Seven per Cent. Cumulative Preference shares and a dividend on the Ordinary shares of 6 per cent. for the year.

Of the authorised capital of £249,500, £140,635 has been received from the issue of shares and £50,000 has been borrowed on Four and a-Half per Cent. Debenture stock. Up to December 31st last the expended capital amounted to £177,538, representing £122 per kilowatt of generating plant. The following table indicates the progress made since 1889:—

Year.	No. of consumers.	Equivalent lamp connection.	Output.	Plant capacity k.w.	Max. demand. k.w.	Revenue.	Working profit.
1889	78	4,520	...	...	...	...	...
1890	248	13,665	...	300	...	£5,010	£386
1891	373	19,388	247,861	300	250	8,328	2,250
1892	471	23,700	313,484	450	306	10,689	2,837
1893	599	28,429	358,506	550	354	12,064	4,231
1894	755	35,858	400,911	550	410	13,696	6,264
1895	932	44,162	476,714	930	520	15,395	6,841
1896	1,164	55,265	643,693	1,325	658	17,442	9,032
1897	1,416	66,364	811,255	1,410	809	20,811	12,033
1898	1,777	80,301	974,618	1,460	917	24,907	14,066

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	1899 Jan. 6	Kens'gton & Knightsbr' (Co.)	'99 Mar. 3
Ayr (Municipal)	1898 Nov. 11	Kingston-upon-Hull (Mun.)	1898 Aug. 19
Bedford (Municipal)	,, Mar. 4	Kingston-on-Thames (Mun.)	,, Mar. 25
Belfast (Municipal)	,, Sept. 23	Lancaster (Municipal)	,, Oct. 21
Birmingham (Company)	,, Dec. 16	Leeds (Company)	1899 Mar. 3
Blackpool (Municipal)	,, Oct. 7	Leicester (Municipal)	,, Jan. 20
Bournemouth (Company)	,, June 3	Leyton (Municipal)	1898 Sept. 23
Bolton (Municipal)	,, Dec. 9	Liverpool (Municipal)	,, Aug. 12
Bradford (Municipal)	,, May 20	Manchester (Municipal)	,, July 29
Brighton (Municipal)	,, May 6	Newcastle and District (Co.)	,, Dec. 2
Bristol (Municipal)	,, July 29	Newcastle-upon-Tyne (Co.)	,, April 29
Burnley (Municipal)	,, Sept. 16	Northampton (Company)	,, April 15
Burton-upon-Trent (Mun.)	,, April 15	Norwich (Company)	,, Dec. 2
Bury (Municipal)	,, Nov. 25	Notting Hill (Company)	1899 Mar. 17
Cambridge (Company)	1899 Mar. 10	Nottingham (Municipal)	1898 Oct. 28
Cardiff (Municipal)	,, Jan. 6	Oldham (Municipal)	,, Nov. 18
Charing Cross (Company)	,, Mar. 17	Oxford (Company)	,, April 1
Chelsea (Company)	1898 May 20	Portsmouth (Municipal)	,, Nov. 4
Cheltenham (Municipal)	,, Oct. 7	Preston (Company)	,, Oct. 28
Chester (Municipal)	,, Oct. 14	Reading (Company)	,, Sept. 16
Clerkenwell (Company)	,, Mar. 18	Richmond (Company)	,, Mar. 4
Derby (Municipal)	,, Dec. 9	Scarborough (Company)	,, April 1
Dewsbury (Municipal)	,, Nov. 25	St. James' & Pall Mall (Co.)	1899 Feb. 24
Dover (Company)	,, Mar. 11	St. Pancras (Vestry)	1898 May 13
Dundee (Municipal)	,, Nov. 4	Sheffield (Company)	,, Dec. 16
Eastbourne (Company)	,, July 22	Shoreditch (Vestry)	,, May 27
Edinburgh (Municipal)	,, Oct. 14	Southampton (Municipal)	,, June 3
Exeter (Municipal)	,, Aug. 5	Southport (Municipal)	,, Dec. 23
Glasgow (Municipal)	,, Aug. 12	Stafford (Municipal)	,, Oct. 21
Guildford (Company)	,, May 13	Sunderland (Municipal)	,, Aug. 19
Halifax (Municipal)	,, Nov. 18	Taunton (Municipal)	,, Aug. 5
Hammersmith (Vestry)	,, June 10	Tunbridge Wells (Mun.)	,, July 22
Hampstead (Municipal)	,, Sept. 9	Walsall (Municipal)	,, Nov. 11
Hanley (Municipal)	,, April 8	Wandsworth (Company)	,, Mar. 18
Harrogate (Municipal)	,, Dec. 30	Westminster (Company)	1899 Feb. 24
Harrow (Company)	,, Sept. 9	Whitehaven (Municipal)	1898 Dec. 23
Hast'gs & St. Leonard's (Co.)	,, April 29	Windsor (Company)	,, Dec. 30
House-to-House Co. (K'ns'gt'n)	,, Sept. 30	Wolverhampton (Municipal)	,, July 15
Hove (Company)	1899 Mar. 10	Woolwich (Company)	1899 Jan. 13
Huddersfield (Municipal)	1898 Mar. 25	Worcester (Municipal)	1898 May 13
Islington (Vestry)	,, June 24	Yarmouth (Municipal)	,, June 17

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	CHELSEA (LONDON).		CENTRAL KENSINGTON (LONDON).	
Undertaking Worked by	The Chelsea Electricity Supply Co. (Ltd.)		The House-to-House Electric Light Co. (Ltd.).	
Date of Commencement of Supply	September, 1889.		January, 1889.	
System of Supply	Continuous-current with dynamotor sub-[stations.		Alternate-current transformers feeding low-[pressure network.	
Chief Engineer	Percy Still.		H. W. Bowden.	
YEAR ENDED	DEC. 31, **1897.**	DEC. 31, **1898.**	DEC. 31, **1897.**	DEC. 31, **1898.**
QUANTITIES—				
Units generated	—	—	—	—
„ SOLD (TOTAL)	1,061,970	1,220,196	811,855	974,818
„ sold to consumers	1,061,970	1,220,196	—	—
„ sold for public lighting, &c.	nil	nil	nil	500
„ used on works	—	—	—	—
UNITS SOLD PER 8 C.P. LAMP CAPACITY	17·7	17·3	18·4	21·4
Maximum supply demanded	1,350 kilowatts	1,390 kilowatts	808·9 kilowatts	917 kilowatts
Number of public lamps	nil	nil	nil	2 arc [e]
Number of consumers	1,190	1,416	1,416	1,777
Connections to mains in 8-c.p. lamps	96,638	112,700	66,364	80,301
CAPACITY OF PLANT IN 8-C.P. LAMPS	60,000	70,650	44,100	45,600
CAPACITY OF PLANT IN KILOWATTS	1,860	2,260	1,410	1,460
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	— / —	— / —	£250,000 / £177	£249,500 / £171
Share	£200,500 / £108	£200,500 / £88·7	200,000 / 142	199,500 / 137
Loan (including Debenture charges)	—[a] / —	—[a] / —	50,000 / 35·5	50,000 / 34·2
RECEIVED (TOTAL)	241,740 / 130	292,620 / 129	158,805 / 113	190,635 / 131
Share	181,740 / 97·6	200,500 / 88·7	108,805 / 77·2	140,635 / 96·4
Loan (including Debenture charges)	60,000 / 32·2	92,120 / 40·8	50,000 / 35·5	50,000 / 34·2
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	18,760 / 10·1	— / —	91,195 / 64·7	58,865 / 40·3
Share (unissued)	nil / —	nil / —	91,195 / 64·7	58,865 / 40·3
Share (uncalled)	18,760 / 10·1	nil / —	— / —	— / —
Loan (including Debentures)	— / —	— / —	— / —	— / —
REPAID (TOTAL)	— / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	36,717 / 19·7	46,818 / 20·7	— / —	— / —
DEPRECIATION FUND	6,840 / 3·68	8,670 / 3·84	10,000 / 7·09	14,000 / 9·59
EXPENDED (TOTAL)	273,810 / 147	332,291 / 147	158,115 / 112	177,538 / 122
Lands and buildings	69,856[b] / 37·5	94,829[b] / 41·9	14,619 / 10·37	19,099 / 13·1
Plant	114,902[b] / 61·8	135,085[b] / 59·7	82,536 / 58·5	91,507[a] / 62·7
Mains	74,460[b] / 40·0	87,375[b] / 38·7	58,828 / 41·7	64,556 / 44·2
Miscellaneous	14,592 / 7·85	15,002 / 6·64	2,132 / 1·51	2,375 / 1·63
BALANCE OF CAPITAL ACCOUNT	−32,070[c] / −17·2	−39,671[c] / −17·6	+690 / +0·49	+13,097 / 8·97
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£27,382 / 6·190d.	£31,363 / 6·171d.	£20,811 / 6·160d.	£24,907 / 6·138d.
Revenue from supply	25,564 / 5·780d.	29,474 / 5·800d.	19,427 / 5·750d.	23,379 / 5·760d.
„ meters, &c.	1,047 / 0·237d.	1,215 / 0·239d.	1,297 / 0·384d.	1,480 / 0·365d.
„ public lighting	— / —	— / —	— / —	—[e] / —
„ sale of lamps, &c.	— / —	— / —	— / —	— / —
„ miscellaneous sources	771 / 0·174d.	674 / 0·133d.	87 / 0·026d.	47 / 0·012d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£12,828 / 2·896d.	£14,701 / 2·893d.	£8,777 / 2·600d.	£10,841 / 2·670d.
WORKS COSTS	8,121 / 1·840d.	9,860 / 1·940d.	5,382 / 1·590d.	6,510 / 1·603d.
Generation of electricity	*6,626* / *1·500d.*	*8,324*[h] / *1·638d.*	*5,097* / *1·510d.*	*6,222* / *1·532d.*
Fuel (including cartage, &c.)	3,870 / 0·875d.	4,495 / 0·884d.	2,483 / 0·735d.	2,784 / 0·686d.
Oil, waste, water, stores	633 / 0·143d.	661 / 0·130d.	283 / 0·084d.	439 / 0·108d.
Wages at station	1,318 / 0·298d.	1,752 / 0·345d.	2,065 / 0·612d.	2,398 / 0·591d.
Repairs and maintenance at station	805 / 0·182d.	1,218 / 0·240d.	266 / 0·069d.	601 / 0·148d.
Distribution of electricity	*1,495* / *0·338d.*	*1,536* / *0·302d.*	*285* / *0·084d.*	*288* / *0·071d.*
Wages, &c.	786 / 0·178d.	949 / 0·187d.	176 / 0·052d.	224 / 0·055d.
Repairs, renewals of mains, &c.	709 / 0·160d.	586 / 0·115d.	109 / 0·032d.	65 / 0·016d.
Public lighting	*nil* / —	— / —	— / —	— / —
Attendance	— / —	— / —	— / —	— / —
Renewals	— / —	— / —	— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	4,707 / 1·060d.	4,841 / 0·953d.	3,395 / 1·005d.	4,331 / 1·067d.
Royalties	*7* / *0·002d.*	*7* / *0·001d.*	— / —	— / —
Rent, rates, taxes	*1,840* / *0·416d.*	*1,859* / *0·366d.*	*1,134* / *0·336d.*	*1,367* / *0·337d.*
Management	*2,860* / *0·647d.*	*2,975* / *0·586d.*	*2,261* / *0·669d.*	*2,964* / *0·731d.*
Salaries	2,201[f] / 0·498d.	2,233[f] / 0·439d.	1,630 / 0·483d.	1,892 / 0·466d.
Stationery, &c.	110 / 0·025d.	145 / 0·029d.	99 / 0·029d.	149 / 0·037d.
Establishment charges	242 / 0·055d.	266 / 0·052d.	249 / 0·074d.	308 / 0·076d.
Law charges, &c.	307[d] / 0·069d.	332[g] / 0·065d.	283[b] / 0·084d.	615 / 0·151d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£14,555 / 5·96%	£16,662 / 5·50%	£12,033 / 8·24%	£14,066 / 8·39%
Sum carried to Depreciation Fund	2,000 / 0·82%	2,500 / 0·825%	3,000 / 2·055%	4,000 / 2·383%
Sum carried to Reserve or Sinking Fund	20,852[e] / 8·54%	12,780[e] / 4·22%	— / —	— / —
Net interest on loans (incl. Debenture charges)	2,780 / 1·14%	2,736 / 0·903%	2,073 / 1·42%	1,507 / 0·898%
BALANCE FROM LAST ACCOUNT	1,527 / 0·626%	1,652 / 0·545%	44 / 0·03%	226 / 0·135%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	11,344 / 4·64%	12,923 / 4·26%	5,613[c] / 3·84%	8,785 / 5·23%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	6% / —	6% / —	4% / —	6% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	46·8%	46·9%	42·2%	43·5%
Expenditure per kilowatt capacity	£6. 18s. 0d.	£6. 10s. 2d.	£6. 4s. 6d.	£7. 8s. 7d.
REVENUE PER KILOWATT CAPACITY	£14. 14s. 0d.	£13. 17s. 2d.	£14. 15s. 0d.	£17. 1s. 0d.
Expenditure per 8-c. lamp capacity	4s. 3½d.	4s. 2d.	3s. 11⅜d.	4s. 9d.
REVENUE PER 8-C.P. LAMP CAPACITY	9s. 1½d.	8s. 10½d.	9s. 5½d.	10s. 11d.
REVENUE PER 8-C.P. LAMP CONNECTED	5s. 8d.	5s. 6¾d.	6s. 3¾d.	6s. 2½d.
Price charged for lighting, per unit	6d.	6d.	6d.[d]	6d.[d]
Price charged for power, per unit	4d.	3d.	5d.	3d.
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RAPID TRANSIT.

A problem which the Americans have long since faced, and in their own fashion have solved, is now being recognised in our own country, viz., the problem of what in America is termed "rapid transit"—the systematic transportation of large crowds of passengers between city and suburbs, or between adjacent cities. There is observable a marked difference in the manner of attacking this problem in different countries, a difference partly arising from divergences in social and even engineering requirements, and partly having its cause in the peculiarities of national character. In America the problem has been solved in a systematic manner, the growth of large cities being attended by the prompt provision of adequately organised methods of transportation. This is seen in the way electric tramways, light interurban railways, and overhead railways in cities, have been developed and engineered. We refer not merely to the abundant existence of these facilities, as contrasted with their paucity in the United Kingdom; the evidence of a careful study of the problem is shown as much in the peculiarities of their engineering design as in the amount of their mileage. To make our meaning clear, let us sketch the main developments of English transportation and contrast these with the characteristics exhibited in American practice. We may preface our remarks by saying it is in no way our purpose to extol American electric traction at the expense of English electric traction; for in the comparatively few places where electric traction has been adopted in this country it compares most favourably with American practice. This, however, is by the way.

In England, it can scarcely be said that the development of transportation facilities has kept pace with the growth of crowded centres of population. Except for its main railway system, which stands *facile princeps* among the railway systems of the world, the United Kingdom, considered as a whole, is barely half civilised in the matter of transportation. The invariable amazement of the American on his first visit to this country is no affectation; it is equalled by the astonishment of the Briton at the converse state of affairs when he visits America. As regards street traffic, our British arrange-

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ments lack two qualities essential to the provision of good "rapid transit," viz., organisation and the means of attaining a high speed quickly. The omnibus necessarily implies disorganisation; while, wherever the horse is the source of power, neither rapid acceleration nor high speed is possible. Satisfactory organisation implies a frequent and a scheduled service of vehicles between pre-arranged stopping places; rapid transit implies the provision of mechanical motive power capable of producing a high-speed between stopping places not widely separated from one another. And, if all these requirements are lamentably absent from our usual omnibus and tramway systems, so are they far from being conspicuous in our heavier methods of transportation. Whether on the suburban railways or as exhibited on the underground railways of London, the ordinary steam railway train is but badly adapted to the requirements of rapid transit of the kind we are considering. The enormous mass to be set in motion by the locomotive renders it well nigh impossible, and always costly, to provide sufficient power to produce rapid acceleration. Consequently, on these railways the choice of necessity lies between infrequent stoppages and a low mean speed. In either case the service does not satisfy the requirements of the problem. What is needed everywhere, whether in the streets and roadways, or on the suburban and city railways—whether elevated or underground is not relevant to the question—is a frequent service of vehicles, each attaining a high velocity between a series of stopping places situated much nearer together than is usual on English suburban railways, or even on the Inner Circle. This is attainable, in our opinion, neither by vehicles that are not run on rails, nor by any species of mechanically-propelled vehicle the source of energy for which is contained in the vehicle itself. In other words, the only solution practicable, in the present state of engineering, is a system of cars continuously supplied with power from outside; for only in vehicles of this description does it seem possible to obtain that high ratio between the available power and the mass to be moved which the problem necessitates. Speaking of acceleration, by the way, we are not aware that any experiments have been made with a view to determine definitely the amount of acceleration which the human organism will safely or even comfortably stand. The precise circumstances, of course, would naturally affect the limiting value; but what is wanted in the present instance is the figure for the safe acceleration of an individual in a train or tramcar. This figure is much higher than ordinary traction practice, or even than ordinary brake practice. Emergency brake practice occasionally reveals what the human subject will patiently submit to. That a man can stand an acceleration equal to gravity is shown by the fact that mere falling does not injure him; it is abruptly ceasing to fall that does the mischief. In mining practice the cage is not infrequently allowed to fall freely down a considerable part of the shaft. But gravity does not act on a falling man merely as a whole mass; it acts simultaneously and proportionally on every atom of his composition. Railway acceleration acts differently; it starts the man's legs and the exterior part of his body first, leaving his internal economy to catch up afterwards. Hence the serious strain on the internal tissues produced by this form of acceleration when rapid, and the liability to severe—even fatal—injury if the acceleration be extremely large. Exact data, however, appear to be wanting. By acceleration, of course, is not meant only an increase in speed; our remarks apply equally also to a decrease in speed, or to a change of direction on a curve.

Coming to the main point, it is evident that electric traction provides the only method of satisfactorily solving the problem of rapid transit in and between adjacent cities. The precise conditions under which it has done so in America are discussed in the Paper on "Electric Traction and its Application to Suburban and Metropolitan Railways," read by Mr. Philip Dawson before the Society of Arts on the 22nd inst., the concluding portions of which we reprint this week. Inasmuch as the essence of the problem lies in high acceleration and a frequent service of vehicles, it is open to doubt whether, in the electric railways now being constructed in London, the train unit is not somewhat too heavy; also, whether the motor-car principle is not, on these very grounds, preferable to the locomotive-and-train principle. At any rate, one advantage of the motor-car principle is its greater flexibility, as it allows of either long or short trains or separate cars being run, at longer or shorter intervals, to suit the requirements of the hour—a very useful reserve of traffic management in times of emergency. The motor-car principle has proved successful on 90 miles of elevated electric railway at Chicago, and on the Liverpool Overhead Railway in this country. On the other hand, the City and South London Railway system, we believe, has not proved so successful, though the causes appear to be not sufficiently general to condemn the locomotive system. Doubtless, after the various underground electric railways that are being constructed under London have been running for a year or two, sufficiently reliable data will be forthcoming for a better and more certain judgment as to the relative merits of these two methods of electric railway traction.

OBITUARY.

GUSTAV HEINRICH WIEDEMANN.

Germany has lost one of its hardest workers in the realms of pure physics by the death of Prof. G. H. Wiedemann. He was one of those who pursued the study of science in the true spirit of an investigator, out of pure love of his self-imposed tasks, leaving to others the work of applying the results of scientific progress to industrial problems. To our readers, Wiedemann will best be known as editor of the *Annalen der Physik und Chemie*, more commonly known, since 1887, as *Wiedemann's Annalen*, and before that, when it was published by Gren, Gilbert and Poggendorf, as *Poggendorf's Annalen*, This journal has always been the principal organ by means of which the research work of German scientists has been published to the world, ranking on an equal footing with the official publications of the Royal Society in this country and of the Académie des Sciences in France.

Gustav Heinrich Wiedemann was born in Berlin on Oct. 2, 1826, and was the son of a wholesale merchant. He was educated at the Berlin Gymnasium which was then under the direction of Prof. August, and at the age of eighteen he became a student of the Berlin University. Here he had the good fortune to be admitted to the private laboratory of Magnus, and it was under the guidance of this expert experimentalist that he completed his chemical researches respecting biuret, a derivative of urea. In 1847 he took his degree of *Dr. Phil*, and two years later he published an account of his first electrical researches—into the conducting power of crystals. Other valuable work followed, on the magnetic rotation of the plane of polarisation, on electrical endosmose, and on the coincidence of the conductibility of metals for heat and electricity, the last having been in conjunction with W. Franz. Soon after his marriage with the eldest daughter of the celebrated chemist, Eilhard Mitscherlich, he was appointed (in 1854) to a professorship at the University of Basle, and thence he moved in 1863 to the technical high school at Brunswick, and in 1866 to Karlsruhe. It was in 1871 that he came to the University of Leipsic where he remained until his death. He was first appointed profesor of physical chemistry, but in 1887 he exchanged this professorial chair for the professorship of physics.

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Among Prof. Wiedemann's researches are those, commenced in 1859 and continued until comparatively recently, on the relations existing between the magnetic and mechanical properties of bodies. Other researches he has published were on the relations between the chemical combinations and magnetic properties of bodies, on electric discharges, and on a determination of the ohm. In 1868 appeared a work by him on galvanism and electromagnetism, in 1871 a second edition of this in three volumes was published and in 1885 the third edition enlarged to five volumes, and with the altered title, "Die Lehre der Elektricität." The latter, besides being a complete theoretical treatment of the subject, contained many new and valuable suggestions. It may also be mentioned that Prof. Wiedemann was a foreign member of the Royal Society.

The death of Gustav Wiedemann will be deplored by scientists of all countries.

REVIEWS.

Distribution de l'Energie par Courants Polyphases. Par J. Rodet. (Paris: Gauthier-Villars.) 1898.

This is a work of some 350 pages; yet, in spite of the fact that many of these are covered with a majestic array of mathematical symbols, we can confidently assert that the interest of the reader need not flag from first to last, so ably and attractively are the subjects of the various chapters dealt with. The mathematical portions—though from the necessities of the case of a somewhat intricate nature—are clear and, as a rule, easily followed; consequently, even should time not permit of their careful study step by step, the meaning of the results obtained can be readily understood. Further, and what is of much greater importance, the results when understood will generally be found to be of real practical interest. In short, the author is one who has had practical experience of polyphase plant, and hence is able to gauge the relative importance of the many considerations involved in its design and working. But too often in technical treatises the writers are led away by their algebra, and after pages of juggling with all the letters of the Greek and English alphabets give us nothing of the slightest real value as a reward for our mental anguish in following their necromancy.

The descriptive and explanatory portions of the book are skilfully interwoven with the more theoretical; and, as we have said, the result is eminently readable. There are seven chapters in all in the work—the first dealing with the history and fundamental principles of the subject, the succeeding four with the generator, the line, the transformer and the motor respectively, the sixth (a very short and, as we think, incomplete one) with meters for polyphase circuits; and, finally, there is a seventh devoted to an interesting decription of the chief polyphase installations yet designed and constructed. It is throughout assumed that the principles of ordinary alternate current working have been previously grasped by the reader, which renders the work at once compact and of moderate bulk. Yet we confess that it seems to us that the laudable desire to keep the treatise within modest limits as regards size has frequently been overdone, with the result of incompleteness in many places. For instance, in the chapter on motors, the very important question of the reaction of the rotor or armature current upon the magnitude and distribution of the field has received but scant consideration; and, again, in the same chapter, it is scarcely sufficient to merely note that there is such a phenomenon as magnetic leakage, whereby a certain portion of the field generated in the stator fails to pass through the rotor, and that this increases with the length of the air-gap and with the load. Considering that the leakage, as M. Rodet himself tells us, amounts to no less than from 10 to 15 per cent. of the total field at full load, we ought at least to be informed of the laws according to which it varies, and of how it can best be guarded against. So also more might profitably be said concerning the leakage of transformers and its effect on the drop of volts, and in the chapter on meters, some mention ought to be made of wattmeters and the methods of measuring the power of polyphase circuits, as wellas of the—perhaps less important—watt-hour or energy meters which are described. Likewise, in many passages, it is a pity that more exact practical details are not given, particularly as the author seems to have had considerable experience with the different types of machine he treats of. To take, at random, an example of this insufficiency, on p. 257, it is annoying to be told that regard must be had for the cooling surface available for the dissipation of the heat generated in the stator. We are aware of that already. What we do want to know is what area of cooling surface per watt wasted has actually been found necessary in practice for a given rise of temperature in one or more types of motor. And such instances might be multiplied. Possibly the author would reply that had he in all cases dealt fully with the matter in hand the work would have become unweildy; yet in the preface he states that he is writing for the good, among others, of those actually employed in the construction of polyphase plant; and it is just such detailed information that the latter require. So also, both from the practical and the theoretical point of view, we think that the question of resonance in polyphase circuits should have been at least briefly dealt with, as with underground mains, where capacity plays a fairly important part, it might under certain conditions happen that a dangerously high voltage would be generated. Yet such faults are common to most technical works, the majority of which possess but a fraction of the merit of the one before us; and it is pleasanter to dwell on the latter's many excellencies.

In the discussion of the line, the effects on the voltage produced by varying the loads on the different circuits of diphase and triphase systems, and the advantage of the star formation with triphase currents provided a fourth wire is employed connecting the centres of the stars, are carefully gone into; while, in the chapter on transformation, the rationale of the Scott system of obtaining a triphase current from a diphase, or a diphase or two simple alternating currents from a triphase, as well as of the various forms of rotary convertor, is considered. In the description of the most important installations given at the end of the work the fact which strikes us most is that, with the single exception of the Dublin line, no British plant is mentioned. Thus once more the humiliating fact that we are lamentably behind our American and continental rivals in this branch of electrical industry is borne in upon us; and yet not only is there a great field for polyphase transmission on a large scale from suitable centres in England itself, but (and this is of greater immediate importance) there is much work for the colonies and abroad now passing, or about to pass, into the hands of others, which our manufacturers might secure for this country would they but rouse themselves into taking more than mere dilettante interest in the subject. F. W.

Industrial Electricity. Translated and adapted from the French of Henry de Graffigny, and edited by A. G. Elliott, B.Sc. (London: Whittaker and Co. 1898.)

This book is the first of a series of volumes upon electromechanics. The present work is said to be introductory to the rest of the series, and while it can hardly be described as elementary, its 149 pages are by no means limited to the broad principles of the law, measurement and application of electricity, but an attempt is made even to discuss details of practical management of plant. Of the twelve chapters the first four of the book deal with the nature, the principles and the measurement of electricity, while the eight last are devoted to its generation and applications. The best written chapter is certainly the first, on the "Nature of Electricity." It forms a short, but more than usually lucid essay on the subject of its title. There are a few references which appear to be slips; thus, on page 45, we read about the "Bellie" meter, when probably the Brillié meter is meant, and (on page 50) Callaud is spelt "Calland." The treatment of the subject of units in the second chapter is, on the whole, clear but rather loosely worded; thus, we read that "electricity is to-day an exact science governed by laws founded on a sound mechanical basis. These laws were formulated by a congress of electricians," and, further on, "These three (the fundamental)

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units form what is known as the C.G.S. system. . . .' Chapter VI. (on accumulators) is useful, but the next, on "Dynamo Electric Machinery" is comparatively curtailed as a single volume of the series is to be devoted to this subject. There is a fairly obvious mistake on page 100 in the description of parallel and series methods of distribution.

The Electro-Plater's Handbook. By G. E. BONNEY. Third Edition. (London: Whittaker and Co. 1898.)

The chief feature of this—the latest—edition of a deservedly popular work on electro-plating is the revision of the chapter dealing with dynamos for low-pressure electro-plating currents. In this chapter the older machines have been replaced by more recent types. There is also a useful addition to Chapter VIII. dealing with the electro-plating of bicycle and such like fittings, the information on this head now being embodied in two sub-sections dealing respectively with "Nickel-Plating Cycle Fittings" and "Nickelling Small Articles."

THE INDUCTION MOTOR.*

BY ERNEST WILSON.

(Continued from page 731).

Before going further, it might be useful to examine the conditions of a pure rotating magnetic field produced by two or three-phase currents. Let a coil be wound so that the induction for current x may be $x\,(b_1\cos 2\pi\theta + b_3\cos 6\pi\theta + \ldots\ldots)$, and let a series of such coils be wound, n to the period of θ, with equal currents but later in period. In Fig. 3, θ would be represented by the surface between 0 and 8.

$$x = a_1\cos 2\pi t/\mathrm{T} + a_3\cos 6\pi t/\mathrm{T} + \ldots\ldots$$

Next coil $x = a_1\cos 2\pi t/\mathrm{T}\,(t - \mathrm{T}/n) + \ldots\ldots$

Induction $= (a_1\cos 2\pi t/\mathrm{T} + \ldots\ldots)\,(b_1\cos 2\pi\theta + \ldots\ldots) + \{a_1\cos 2\pi/\mathrm{T}\,(t - \mathrm{T}/n) + \ldots\ldots\}\,\{b_1\cos 2\pi\,(\theta - 1/n) + \ldots\ldots\}$.

Work out a simple case first two-phase. Induction in coil $= x\cos 2\pi\theta$. In next coil $= x\cos 2\pi\,(\theta - 1/4)$. Currents are $a\cos 2\pi\,t/\mathrm{T}$ and $a\cos 2\pi\,(t/\mathrm{T} - 1/4)$.

Induction is $= a\,\{\cos 2\pi\theta\cos 2\pi t/\mathrm{T} + \cos 2\pi(\theta - 1/4)\cos 2\pi(t/\mathrm{T} - 1/4)\} = a\,\{\cos 2\pi\theta\cos 2\pi t/\mathrm{T} + \sin 2\pi\theta\,\sin 2\pi t/\mathrm{T}\} = a\cos 2\pi(\theta - t/\mathrm{T})$.

Taking the simple case of three-phase currents we have—Induction in coil $= x\cos 2\pi\theta$; in next coil $= x\cos 2\pi\,(\theta - 1/6)$; in next $= x\cos 2\pi(\theta - 1/3)$. Currents are $a\cos 2\pi t/\mathrm{T}$ and $a\cos 2\pi(t/\mathrm{T} - 1/6)$ and $a\cos 2\pi(t/\mathrm{T} - 1/3)$.

$$\text{Induction} = a\{\cos 2\pi t/\mathrm{T}\cos 2\pi\theta + \cos 2\pi(t/\mathrm{T} - 1/6)\cos 2\pi(\theta - 1/6) + \cos 2\pi(t/\mathrm{T} - 1/3)\cos 2\pi(\theta - 1/3)\} = 3/2\,a\cos 2\pi(t/\mathrm{T} - \theta).$$

In this manner any number of phases may be treated. Now consider a two-phase with the higher periodic terms:—

Induction $= x(a_1\cos 2\pi\theta + a_3\cos 6\pi\theta + \ldots\ldots)$

In next $= x\{a_1\cos 2\pi(\theta - 1/4) + a_3\cos 6\pi(\theta - 1/4) + \ldots\ldots$

In first coil $x = b_1\cos 2\pi t/\mathrm{T} + b_3\cos 6\pi/\mathrm{T} + \ldots\ldots$

In next coil $x = b_1\cos 2\pi(t/\mathrm{T} - 1/4) + b_3\cos 6\pi(t/\mathrm{T} - 1/4) + \ldots\ldots$

$$\text{Induction} = (b_1\cos 2\pi t/\mathrm{T} + b_3\cos 6\pi t/\mathrm{T} + \ldots\ldots)\,(a_1\cos 2\pi\theta + a_3\cos 6\pi\theta + \ldots\ldots) + (b_1\sin 2\pi t/\mathrm{T} - b_3\sin 6\pi t/\mathrm{T} + \ldots\ldots)\,(a_1\sin 2\pi\theta - a_3\sin 6\pi\theta + \ldots\ldots) = a_1 b_1\cos 2\pi(t/\mathrm{T} - \theta) + a_3 b_3\cos 6\pi(t/\mathrm{T} - \theta) + \ldots\ldots + a_3 b_1\cos 2\pi(t/\mathrm{T} + 3\theta) + a_1 b_3\cos 2\pi\,(3\,t/\mathrm{T} + \theta) + \ldots\ldots$$

If any one of a_3, b_3, &c., are not zero, the result will give terms travelling round with different speeds. It is essential to have a simple harmonic current and a simple harmonic field. In this motor a nearer approximation to a pure rotating field might be attained by allowing the coils A and B to overlap. It is evident that, with magnetising coils placed as they are in this motor, a pure rotating field cannot be produced with two-phase currents.

We now to the two-phase current experiments. Each of the coils A B was supplied with alternate currents differing in phase by a quarter period. The results are given in Tables III. and IV.

Table III.

Angle in 60ths of a period.	x_1 in amperes	$\frac{dI_1}{dt}$ in volts.	$\int\frac{dI_1}{dt}dt$ in 10^6 C. G. S. units.	x_2 in amperes	$\frac{dI_2}{dt}$ in volts.	$\int\frac{dI_2}{dt}dt$ in 10^6 C. G. S. units.	Coil 2–3.		Coil 3–4.		Coil 4–5.		Coil 5–6.		Tot. induction over surface 23456 in 10^6 C. G. S. units.	Tot. induction over surface 34567 in 10^6 C. G. S. units.
							Volts.	Induction in 10^6 C. G. S. units.	Volts.	Induction in 10^6 C. G. S. units.	Volts.	Induction in 10^6 C. G. S. units.	Volts.	Induction in 10^6 C. G. S. units.		
0	+ 6·62	− 0·835	− 0·245	− 9·45	− 0·742	− 0·247	− 0·217	− 0·105	+ 0·0724	− 0·120	+ 0·449	− 0·054	+ 0·362	+ 0·0411	− 0·239	− 0·028
2	...	...	− 0·195	...	...	− 0·289	...	− 0·09	...	− 0·123	...	− 0·081	...	+ 0·0174	− 0·277	− 0·0972
3	+ 3·21	− 0·997	...	− 11·7	− 0·510	...	− 0·319	...	− 0·029	...	+ 0·377	...	+ 0·377	...	...	...
4	...	...	− 0·131	...	...	− 0·320	...	− 0·07	...	− 0·120	...	− 0·105	...	− 0·0062	− 0·302	− 0·162
6	− 1·39	− 1·26	− 0·057	− 12·3	− 0·122	− 0·336	− 0·362	− 0·048	− 0·159	− 0·113	+ 0·232	− 0·123	+ 0·333	− 0·028	− 0·312	− 0·216
8	...	...	+ 0·024	...	...	− 0·335	...	− 0·025	...	− 0·101	...	− 0·133	...	− 0·0467	− 0·306	− 0·256
9	− 4·35	− 1·27	...	− 11·4	+ 0·256	...	− 0·377	...	− 0·304	...	+ 0·029	...	+ 0·232	...	...	...
10	...	...	+ 0·103	...	...	− 0·319	...	− 0·0012	...	− 0·082	...	− 0·135	...	− 0·0617	− 0·280	− 0·278
12	− 8·19	− 0·983	+ 0·172	− 9·14	+ 0·599	− 0·275	− 0·435	+ 0·025	− 0·435	− 0·058	− 0·0869	− 0·132	+ 0·188	− 0·0741	− 0·239	− 0·289
14	...	...	+ 0·229	...	...	− 0·234	...	+ 0·052	...	− 3·030	...	− 0·125	...	− 0·0841	− 0·187	− 0·290
15	− 10·8	− 0·817	...	− 6·11	+ 0·756	...	− 0·406	...	− 0·464	...	− 0·188	...	+ 0·116	...	...	...
16	...	...	+ 0·280	...	...	− 0·187	...	+ 0·076	..	− 0·0012	...	− 0·113	...	− 0·091	− 0·129	− 0·282
18	− 13·1	− 0·589	+ 0·323	− 2·27	+ 0·958	− 0·131	− 0·333	+ 0·099	− 0·449	− 0·027	− 0·275	− 0·098	+ 0·043	− 9·0955	− 0·0673	− 0·265
20	...	...	+ 0·353	...	...	− 0·066	...	+ 0·117	...	+ 0·054	...	− 0·080	..	− 0·096	− 0·0044	− 0·239
21	− 13·8	− 0·218	...	+ 1·13	+ 1·15	...	− 0·174	...	− 0·377	...	− 0·377	...	− 9·072	...	...	...
22	...	...	+ 0·366	...	...	+ 0·006	...	+ 0·128	...	+ 0·078	...	− 0·057	...	− 0·0916	+ 0·0573	− 0·198
24	− 12·8	+ 0·254	+ 0·357	+ 4·03	+ 1·11	+ 0·077	+ 0·014	+ 0·130	− 0·217	+ 0·095	− 0·391	− 0·032	− 0·203	− 0·0854	+ 0·107	− 0·153
26	...	...	+ 0·334	...	...	+ 0·142	..	+ 0·126	...	+ 0·106	...	− 0·0062	...	− 0·076	+ 0·150	− 0·102
27	− 9·95	+ 0·625	...	+ 7·44	+ 0·878	...	+ 0·145	...	− 0·145	...	− 0·493	...	− 0·319	...	...	...
28	...	...	+ 0·295	...	...	+ 0·197	...	+ 0·117	...	+ 0·115	...	+ 0·024	..	− 0·0623	+ 0·194	− 0·0399

Table IV.

0	0·0	− 0·919	− 0·315	− 60·9	− 0·878	− 0·216	+ 0·0287	− 0·101	+ 0·100	− 0·0964	+ 0·416	+ 0·0097	+ 0·115	+ 0·0206	− 0·167	+ 0·0351
2	...	...	− 0·257	...	...	− 0·267	...	− 0·107	...	− 0·101	...	− 0·0164	...	+ 0·0133	− 0·211	− 0·003
3	− 10·6	− 1·06	...	− 60·9	− 0·679	...	− 0·0143	...	+ 0·014	...	+ 0·445	...	+ 0·100	...	...	...
4	...	...	− 0·193	...	...	− 0·307	...	− 0·102	...	− 0·102	...	− 0·0436	...	+ 0·0073	− 0·244	− 0·04
6	− 31·8	− 1·23	− 0·121	− 51·4	− 0·227	− 0·328	− 0·244	− 0·0933	− 0·272	− 0·0903	+ 0·459	− 0·0715	+ 0·158	− 0·0018	− 0·257	− 0·0703
8	...	...	− 0·0448	...	...	− 0·335	...	− 0·077	...	− 0·0776	...	− 0·0982	...	− 0·0103	− 0·263	− 0·109
9	− 49·5	− 1·26	...	− 37·0	+ 0·091	...	− 0·287	...	− 0·344	...	+ 0·387	...	+ 0·115	...	...	...
10	...	...	+ 0·0315	...	...	− 0·328	...	− 0·06	...	− 0·0564	...	− 0·121	...	− 0·017	− 0·254	− 0·135
12	− 61·6	− 1·17	+ 0·104	− 15·9	+ 0·418	− 0·310	− 0·344	− 0·04	− 0·330	− 0·0358	+ 0·186	− 0·137	+ 0·100	− 0·025	− 0·236	− 0·156
14	...	..	+ 0·173	...	...	− 0·275	...	− 0·0188	...	− 0·017	...	− 0·145	...	− 0·0297	− 0·210	− 0·173
15	− 66·2	− 1·07	...	− 0·38	+ 0·914	...	− 0·330	...	− 0·272	...	+ 0·0287	...	+ 0·129	...	...	...
16	...	...	+ 0·237	..	...	− 0·219	...	+ 0·0012	...	0	...	− 0·146	..	− 0·0376	− 0·182	− 0·185
18	− 65·4	− 0·879	+ 0·296	+ 7·18	+ 1·14	− 0·153	− 0·344	+ 0·0212	− 0·358	+ 0·0194	− 0·129	− 0·141	+ 0·043	− 0·0418	− 0·142	− 0·185
20	...	...	+ 0·342	...	...	− 0·0862	...	+ 0·0424	...	+ 0·0406	...	− 0·131	...	− 0·043	− 0·0909	− 0·176
21	− 56·0	− 0·518	...	+ 30·6	+ 1·00	...	− 0·358	...	− 0·287	...	− 0·244	...	0	...	...	...
22	...	...	+ 0·373	...	...	− 0·0242	...	+ 0·0642	...	+ 0·0576	...	− 0·116	...	− 0·0424	− 0·0364	− 0·165
24	− 39·7	− 0·0611	+ 0·387	+ 50·7	+ 1·06	+ 0·040	− 0·244	+ 0·0824	− 0·229	+ 0·0727	− 0·401	− 0·0945	− 0·057	− 0·040	+ 0·0206	− 0·144
26	...	...	+ 0·379	...	...	+ 0·103	...	+ 0·0945	...	+ 0·0842	...	− 0·0673	...	− 0·0353	+ 0·0764	− 0·113
27	− 19·7	+ 0·40	...	+ 60·5	+ 0·96	...	− 0·086	...	− 0·100	...	− 0·501	...	− 0·129	...	...	...
28	...	...	+ 0·355	...	...	+ 0·161	...	+ 0·100	...	+ 0·0903	...	0·037	...	− 0·0273	+ 0·126	− 0·074

* Paper read before the Institution of Electrical Engineers, March 9th.

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Table III. refers to the motor when its armature is working on open circuit. The frequency is 53·5, and $\sqrt{\text{mean}^2}$ E_1 and E_2 65 volts. Table IV. refers to the motor when its armature has an extra resistance in each circuit of 0·15 ohm. The frequency is 55, and $\sqrt{\text{mean}^2}$ E_1 and E_2 60 volts. The curves have been integrated, and Fig. 7 shows the important result. The abscissæ represents time in 60ths of a period, the ordinates total induction respecting the surface 2, 3, 4, 5 and 6 in Fig. 3.

Referring to Fig. 3, in which the areas or total inductions due to the two phases are sine functions of *time* and displaced nearly 90deg., we see that if we combine the two-phase curves Nos. I. and II. at different points along $l\,l$, the result is the curve No. III. The curves Nos. I. and II. have areas per half period ($\theta/2$), which, when added together, equal $\sqrt{2}$ of the maximum area of either curve, and the resultant, therefore, represents the maximum induction density experienced, which occurs at positions 1, 3, 5, 7, &c. The induction density over other portions of the surface will be less; curve No. IV. has maximum area and shows maximum density at 2, 4, 6, 8, &c. In Fig. 7 the curve No. I. is the curve $\int \frac{dI_2}{dt} dt$ in Table III.; curve No. 2 is the sum of the inductions given by coils (2 – 3), (3 – 4), (4 – 5), (5 – 6), Table III. when the motor armature is on open circuit. When loaded by inserting 0·15 ohm in each armature circuit, the curves Nos. 3 and 4, Fig. 7, represent the same combinations. We see that the curves Nos. 1 and 3 have the same amplitude and are nearly in phase. This will be seen to have importance in a subsequent part of this Paper.

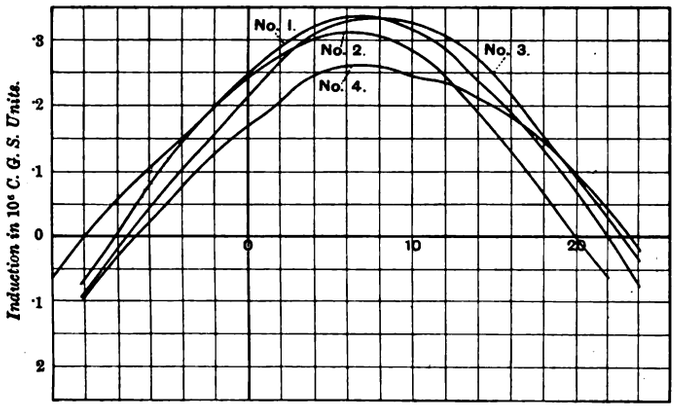

FIG. 7.

Taking the figures as given by the curves in Fig. 7 at the maximum value, and correcting Nos. 1 and 3 for 0·83, the differences between Nos. 1 and 2 on open circuit and Nos. 3 and 4 on closed circuit amount to 23 and 35 per cent. of the greater ordinate in each case. Table III. shows that on open circuit the maxima for the coils (2 – 3), (3 – 4), (4 – 5), (5—6) are 0·130, 0·123, 0·135, and 0·096 in 10^6 C.G.S. units. Table IV. shows that when loaded these maxima are 0·107, 0·102, 0·146, and 0·043; coil (5 – 6) suffering the greatest diminution. On open circuit the phase differences with regard to maximum induction are 48deg. for coils (3 – 4), (4 – 5), and 30deg. for coils (2 – 3), (5 – 6) as against 45deg. with a pure rotating field. On load these phase-differences are 72deg. and 72deg.

(*To be continued.*)

THE CROWDUS STORAGE BATTERY.

A year ago* we described the method of manufacture of the Crowdus storage battery, a cell of American origin. The battery is now being made in this country, a small factory, which we have had the opportunity to inspect, having been equipped by the Crowdus Accumulator Syndicate (Limited), under the direction of Mr. W. A. Crowdus, the inventor, who is now in London. Since our description last year the battery has been modified to some extent, the principal alteration being the abandonment of aluminium as the material for the negative plate. The principle underlying the mode of construction is that the lead grid which holds the active material is made extremely light, there being no advantage in increasing its weight and strength sufficiently to outlive the active portion of the plate. The thickness of lead has, after prolonged experiment, been chosen at 0·037in. Sheet lead of this thickness and of the proper width is passed through an automatic press, driven by an electric motor, and the series of elongated perforation seen in Fig. 1 are cut in it, the strips of material left between the perforations being bent to alternate sides of the plate. This is clearly shown in Fig. 1. The plate is then passed through the cutting machine and cut off to the proper length, after which it is pickled in caustic soda and washed in sulphuric acid previous to being pasted.

The plate in this form is quite light and flimsy, the lead being very thin as already mentioned, and the perforations having diminished the weight of the plate by about 50 per cent. When lifted it is not even strong enough to carry its own weight without bending over. The reason for this has been stated above; the weight of the paste it contains afterwards is twice that of the lead foundation

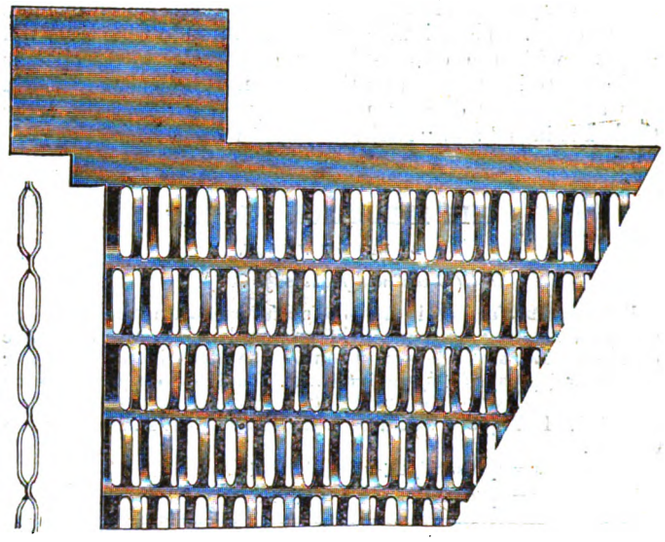

FIG. 1.—Plate before Pasting.

itself. Next, the plates are placed in turn on a rough balance, and the lighter ones chosen for negatives and the heavier for positives; the lightest of all being set aside for the outside positive and negative plates. We say outside positive and negative plates, as an even number, and not an odd number, of plates is employed. The paste—a red lead mixture—is then put in by hand with the help of a rubber spatula, and the plate then presents the appearance shown in Fig. 2. The same paste is used both for positive and negative plates. After a sojourn in the drying room the plates pass a hand-worked machine, which folds up an edge for soldering, and they are then burned together. A thick lug of lead-antimony alloy is used at the top and a solid bridge-piece at bottom, as shown

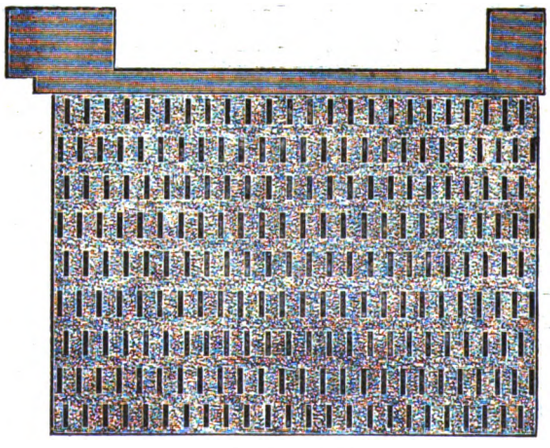

FIG. 2.—Pasted Plate

in Fig. 3, so as to ensure an equal current-density on all parts of the plate. The terminals are made of a sufficiently hard alloy, claimed to be absolutely acid-proof.

The next process is that of forming. This is done in heavy lead dummies, the plates being kept ¼in. from the surface of the dummy plates by ebonite separators. By chemical and electro-chemical processes the positive plate is converted into spongy lead, and then by a modification of the ordinary forming process into peroxide. The forming of the negative plate is by the first part of the process used for the positive. This method of forming was alluded to in greater detail in the description referred to above. The formed negative plates are kept in water until the cell is assembled for sending out.

* *The Electrician*, Vol. XL, p. 682.

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In assembling the cell, each plate is first wrapped with sheets of cellulose obtained from wood pulp, resembling stiff paper. In addition, a perforated sheet of a pulpy insulating material, resembling bad cardboard or over-thick soft blotting paper, is placed

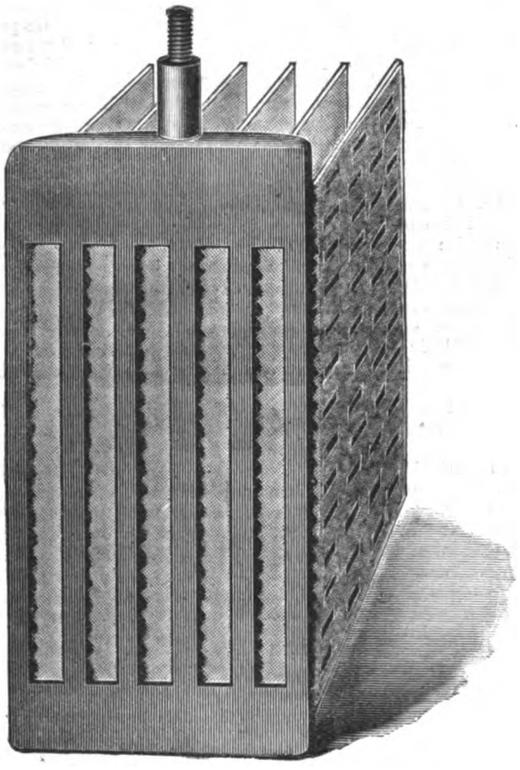

FIG. 3.—Plates ready for Forming.

between the plates. This absorbs most of the liquid in the cell, and in doing so swells, and thus acts as an efficient separator between the plates The boxes are of ebonite with bars at the bottom to keep the plates clear of any material that may have fallen down, and with tightly fitting covers sealed with rubber solution.

ELECTRIC LIGHTING SCHEMES FOR THE CITY OF LONDON.

Sir Courtenay Boyle, K.C.B., opened a Board of Trade inquiry on Monday, at the Guildhall, London, on the applications by the Charing Cross and Strand Electricity Supply Corporation (Limited), the Metropolitan Eiectric Supply Co. (Limited), and the Smithfield Markets Electric Supply Co. (Limited), respectively, for Provisional Orders to supply electricity for public and private purposes within the City of London district.

The following counsel appeared: For the Charing Cross Company, Mr. Shiress Will, Q.C., and the Hon. Sydney Holland; for the Metropolitan Company, Mr. Pope, Q.C., Mr. Fitzgerald, Q.C., and Mr. Moon; for the Smithfield Company, Mr. Balfour Browne, Q.C., and Lord Hugh Cecil; and for the City of London Company, Mr. Cripps, Q.C., Mr. Freeman, Q.C., and Mr. Roskill. Mr. A. J. Walter represented the City Corporation.

I.—The Smithfield Company's Case.

Mr. BALFOUR BROWNE, in opening for this case, said they had struck out of their application power to supply in St. Luke's and Holborn district, as the local authorities there had refused consent. They had now decided to ask the Board of Trade to sanction a Provisional Order for supplying the City of London, and to dispense with the consent of the Corporation, because there were special circumstances which justified them in doing so. The present City of London Company was incorporated in 1891, under three Provisional Orders, which were afterwards amalgamated into one. This Company claimed to have the exclusive right of supply for 21 years, granted them by the Commissioners of Sewers, but he contended that the Commissioners had no power to make such a grant, as the idea of Parliament, in the clause in their Act, was to give the Board of Trade power to sanction two companies in one area. This had been done in the case of the Marylebone Vestry and the Metropolitan Company. The proposed competition had reference to two different sorts of lighting. The Company he represented would give a continuous current supply, which was of real advantage for private lighting. That system was much better than the alternating system of supply by the City Company, which he was instructed had now gone to America for machinery for providing a continuous current supply. Without competition the price of lighting in the City would necessarily be high. The capital of the City Company was £1,200,000, and it had succeeded very well under the shelter of its monopoly. He was not going to make complaints, but he took the line that the Board of Trade would come to the conclusion that competition was a good thing. The Smithfield Company was incorporated in 1897, with a capital of £100,000 and £50,000 four per cent. debentures. The primary object of the Company was to supply light to the Corporation markets under a concession from the Corporation. The business of the Smithfield Company had been carried on without a Provisional Order, but they were prepared to place themselves under the Board of Trade, having, in fact, all along carried on their business on those lines. The Company was already in the City, and there were strong objections to big companies covering large areas because they put their generating stations outside the districts,

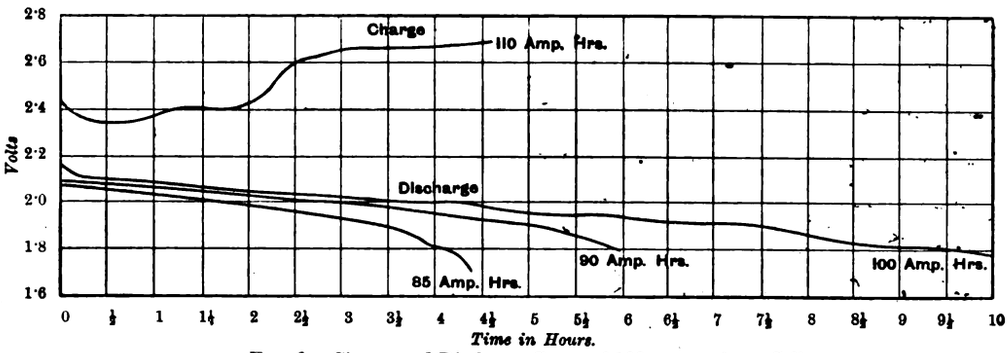

FIG. 4.—Charge and Discharge Curve of 100-ampere-hour Cell.

The following dimensions and data are of interest. They refer to the 100-ampere-hour 12-plate cell:—

Dimensions of box	5⅛in. × 3⅞in. × 8⅛in.
Total weight	14lbs.
Height over all	9⅛in.
Active surface of each plate	6⅛in. × 4⅝in.
Internal resistance	0·008ohms.

Available capacity at	10	amperes	100	ampere hours.
"	"	15	"	90 "
"	"	20	"	85 "

Results of tests on a 100-ampere-hour cell—4½ hour charge and 4½ hour discharge.

Watt-hour efficiency	51·9 per cent.
Ampere-hour efficiency	76·9 "
Current density	0·064 ampere hours per square inch
Ampere hours per lb.	5·98
Watt-hours per lb.	11·0

Fig. 4 is a typical charge and discharge curve of one of these cells. It will be noticed that 50 per cent. of the discharge is at over 2 volts. We should mention that the Crowdus cell is designed essentially for traction and not for central station work.

and so evaded the obligations they were under to sell the whole of their plant and generating stations to the local authority. The Smithfield Company would have a site inside the City, while the Metropolitan Company had their station at Willesden. He also referred to the Charing Cross and Strand Co., which even now was competing with the Metropolitan Company. The threat of competition had already led the City of London Co. to reduce their charges, and he urged finally that of the three companies his was in the best position to compete with the existing company.

Mr. V. B. D. COOPER, consulting engineer to the Smithfield Company, stated that the Company at present supplied electric light for the avenues of Smithfield Market free of charge to the Corporation. Their system was the continuous current, which was the best system where power was required. There was a large opening for that system in the City, and a large demand would arise if the Provisional Order they asked for was granted. The Company was in a position to commence operations at an early date. The City of London Company had, up to the time of these applications, been charging 7d. per unit, and had now reduced it to 6d. That Company's system, except for the street lamps, was alternating current. There were 90 insurances offices who had signed the petition in the Smithfield Company's favour. They had sufficient land to make a large extension of their premises in Charterhouse-street, and could begin supply as soon as their mains were laid, while the other companies would have a great deal of work to do. They had offered to supply at 5d. per unit for

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light as a maximum, with discounts, and for power at 2¾d. per unit. This was with a view of having their plant in operation all day, and to induce printing works to take current for power, which they supplied at present at 2½d. per unit for power purposes. They could pass by the railway line to Blackfriars. To supply the City the Company would require an additional acre of land for a generating station to increase their supply by 15,000 H.P. The Corporation were not the lighting authorities of the City when the contract with their Company was drawn up. The Commissioners of Sewers held that position. He was not aware that the Corporation had refused to recognise the Smithfield Company, the contract being with two gentlemen who were the only persons recognised by the Corporation. They were liable to be removed at six months' notice. The site adjoining their premises was originally reserved for cold storage. His Company had not yet paid a dividend. The City of London Company had made a suggestion to compete with them at Smithfield.

Mr. SCHENCK, one of the Directors of the Smithfield Company, said they would require additional plant and capital to enable them to supply the City. There would be no difficulty in raising the necessary capital. Their present capital was about £110,000, and the capital was subscribed by the public twice over at par.

II.—The Charing Cross and Strand Corporation's Case.

Mr. SHIRESS WILL opened the case for the Charing Cross Company. That company, he said, had a capital of £150,000 in debentures, £100,000 4½ per cent. preference shares; and £250,000 in 5 per cent. ordinary shares. They had issued £70,000 debentures at 5 per cent., and they had borrowed on the rest £80,000 at 4 per cent. The preference shares, first issue, were subscribed four times over, and the second issue at a premium of 20 per cent., and £150,000 ordinary shares had been subscribed. They had 104 miles of mains, and among their consumers were several Government offices, all the large hotels within their area, and 20 theatres. If they had not done their duty there would have been plenty of evidence against them. Their petition was signed by upwards of 5,000 persons, including a large number of newspapers and printers, and the great bulk of the trading community. The petition maintained that a monopoly was adverse to the interests of the public. In one portion of St. Martin's there were three electric lighting companies, but he was not afraid of competition. There was an enormous demand for electric lighting in the City, and there was room for more than one company. Their average price for current was 4·36d., as against 6·22d. of the City of London Company. All they asked for was the power to compete.

Mr. E. WILMOT SEALE (secretary of the Charing Cross Company) said their financial position was one of the best in London. They supplied the London County Council, nearly all the hotels in Northumberland-avenue, 23 theatres and other important places, also a number of leading newspapers and others with motor supply at low tension. Their pressure was the most even in London, and the less pressure over the proper pressure of 100 volts produced an even and less costly light to the consumers. They went to the Corporation in 1897. It had been suggested that they should purchase the City Company for £3,000,000, and that led to a correspondence which, however, came to nothing. They were prepared to supply the City customers at from 5d. to 4d. per unit, and motive power at 3d. to 2d. The Metropolitan Company were purchasing current from other companies, and he submitted that that was contrary to their Order. That company's nearest station was in Sardinia-street, which had been scheduled by the London County Council. At present they had a station at Lambeth and two others in contemplation. The Charing Cross Co. purchased the plant from Messrs. Gatti for £70,000. The Company had the order before they bought the plant. They were always in favour of competition, and had been and were now actively competing with the Metropolitan Company. They supplied 1½ miles in Holborn and had mains in St. Giles. The supply was partly brought from Lambeth and partly from Maiden-lane (Strand). They had a distributing station with a large output nearly ready to start. There was nothing in their Provisional Order to prevent their laying mains outside their area of supply.

By Mr. MOON: Have you the right to break up streets in all parts of London?—We break up streets by agreement with the local authorities and the consent of the London County Council. We have also the consent of the Duchy of Cornwall, the freeholder in part of Lambeth. We get across the Thames by consent of the London County Council.

If you obtain your new site anyone under the nuisance clause can bring actions against you?—No, the plant has been perfected, and there will be no vibration or other nuisance. I am not prepared to disclose the site.

Witness continued that the figures previously put in were prepared by Mr. Campbell Swinton, who no doubt would be called if they were questioned. The price, 4·36d., was the price for the whole supply, whether for lighting or motive power.

Well, compare that with the Metropolitan?—I cannot do that, because I do not know what motive power the Metropolitan Co. employs. The Metropolitan have bought from other companies to the extent of £4,000.

Mr. MOON: We do not deny that we have purchased up to the end of last year.

Sir COURTENAY BOYLE: Is that a permanent arrangement?

Mr. MOON: No; last year we only bought to the extent of £500.

By Mr. WALTER: In the event of the Board of Trade holding that the consent of the Corporation be dispensed with, will your Company be willing to submit to a clause giving the Corporation power to purchase the whole undertaking, whether the generating stations be within or without the City?—Yes.

Will your Company give an undertaking to keep the generating and distributing stations for the City separate from the other districts?—Yes, that is until the new generating stations are ready. Until then we should use our present stations.

Sir COURTENAY BOYLE: That is a qualification of the answer.

By Mr. FREEMAN: His Company was in a very favourable position. It supplied large buildings in a small area. It would be the same if they supplied the City. Their average charge was 4·36d. since last year, when it was 4·46d.

Mr. W. H. PATCHELL, chief engineer of the Charing Cross Company, said there had always been active competition with the Metropolitan Company. The Strand district included half-a-dozen parishes. They were now going with the Holborn and St. Giles districts. He produced a chart for the foggy days in March this year, which proved the evenness of the pressure. The difficulties suggested as to the supply for the City could easily be met. Since they had offered to supply the City, the City of London Company had been putting down continuous-current plant for motors. They joined the City boundary, and could readily extend their mains. If they obtained their Provisional Order they would take immediate steps for additional generating stations. There was room for extension at their Lambeth station. Their charge for current was 7d., then 6d., then 5d. and then 4d., but this obviously did not mean that the consumer would get all his current at 4d. per unit. If the lamps burnt for 24 hours the mean price would be 4·4d. The surplus power at Lambeth and Maiden-lane was a reserve for 68,000 lamps. The capacity at their two stations was 210,000 8 c.p. lamps, and 142,000 were actually burning. They had space to make the capacity up to 360,000 by Christmas. That would leave them ample power to supply the City at first.

By Mr. CRIPPS: At what time of the day is your maximum load?—It varies between winter and summer. In the winter it is about 5 o'clock, and in summer about 8.

If you were to supply the City you would have to have a distinct and separate generating station from your present establishment?—Ultimately, certainly.

By Mr. BALFOUR BROWNE: They were earning a dividend of about 8 per cent. Their present district was considerably under a square mile. The price of 4·36d. per unit was calculated to include motive power supply, but that was under 10 per cent. of the total. They would have a good market for such a supply in the City of London.

By Mr. FITZGERALD: They brought their current from Lambeth over Waterloo Bridge and the South-Eastern Railway bridge. It would be a little over a mile farther to come into the City. They, of course, would have to lay further mains.

By Sir COURTENAY BOYLE: Allowing for the growth of St. Giles's and Holborn, will not your margin of 68,000 lamps be eaten up very rapidly?—At last year's rate it would be about 28,000 for this year. But we are laying down further plant which would give us about 48,000 8 c.p. lamp capacity.

You contemplate the possibility of acquiring a new generating station. I don't want to know the exact site, but have you any estimate as to the amount of supply it would produce?—We should require 15,000 H.P. for the City, which, allowing for the growth of the City of London Company, would need 300,000 lamps.

Evidence was also given by a number of customers of the City of London Company who complained of bad and irregular service. These witnesses included representatives of Messrs. Smith, Payne and Smiths (bankers); Messrs. Capper, Son and Co. (drapers); Messrs. Hitchcock and Williams (warehousemen); the Sun Fire Office; and the Union Bank.

Mr. BROOKE HITCHING (who admitted he was not representing anybody but himself) said if the Board of Trade gave a competing order to one of these three companies he did not believe that competition would result. The citizens would have their streets and pavements torn up, but would not get their electric light at a lower rate than at present. There was little demand for electric light at night, as there were no theatres in the City, and the public-houses there were almost empty at night. The load was a day load. His opinion was that if two, three or four companies were coming into the City there would be some *sub rosa* agreement to keep the prices at one level and benefit the shareholders to the disadvantage of the ratepayers and consumers. He hoped that the Board of Trade would not recommend any order unless competition could be reasonably assured. He was in favour of the municipalisation of all these undertakings, and then competition would not be necessary.

III.—The Metropolitan Company's Case.

Mr. FITZGERALD (for the Metropolitan Company) said the Company had a share capital of £1,000,000 and powers to issue a similar amount of debentures. They had actually a paid-up share capital of £743,530, and their credit was excellent, their £10 shares standing at £18, so that whatever powers they got they were in a position to execute them. They had five generating stations, and in addition to that they had acquired under their Act of last year a large area at Willesden for a generating station, which was bounded by the Regent's Canal and two railways, so they could get coal on good terms. They were prepared to give a supply on the continuous current system. Their alternate-current supply would be taken to sub-stations and reduced to a continuous current. The boundaries of their district were conterminous with the City at Aldersgate down to the Thames Embankment, and they could supply a large portion of the City in a short time. The main point before the inquiry was whether competition was desired in the City, and, if so, which of the three companies should have the Order. He could not regard the application of the Smithfield Company as serious. Its capital was small, and it was barely paying its way. Its present generating station was wholly unsuited for the purpose, and they could be compelled to give it up at six months' notice from the Corporation. The Charing Cross Company had two stations, but they had an increasing business, and had recently obtained a considerable accession of territory; their margin of supply, therefore, was absurdly small. They talked of a new station, but had not even selected a site for it. As to price, the Metropolitan Company was prepared to take 5d. for light and 3d. for power as a maximum. If the Order was granted to them, the competition would be of a most practical character. The Charing

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Cross Company had a small, compact and valuable district, while the Metropolitan district extended over a wide area. It was, therefore, not fair to take the average of a small wealthy district against a large, straggling district. In addition to that, the moment they had their Willesden station complete they would be able to generate and distribute more economically than the Charing Cross Company. It had been suggested that there was an alliance between the Metropolitan and the City of London companies. There was nothing of the sort. The position was this. Of the three companies applying, they were the strongest financially, the strongest electrically, and their position at Willesden made it certain that they would be able to supply the City before any of the others could do so.

Mr. E. CUNLIFFE OWEN, secretary of the Metropolitan Company, said that all their stations were coupled up, with the exception of Whitehall, which was quite separate. Competition had been permitted in part of their area. Their buildings at Willesden were practically complete. The demand for their supply had risen rapidly and steadily, so that they had been able to gradually decrease the charge. The first charge was 7¼d. per unit, and at the present time the average was rather under 5·2d. per unit, and they hoped to supply even more economically.

By Mr. SHIRESS WILL: They had no competition in Paddington or Marylebone, and in both those districts the demand would be very great, but it would not exhaust the Willesden station. He was not in favour of competition in Marylebone, where they had an arrangement with the Vestry.

Sir C. BOYLE: You do not object to competition in Marylebone?—No; but we do to rate-aided competition.

Mr. R. R. TODD, resident engineer at the Metropolitan Company's Willesden station, said they could supply the City by the end of the year. When their works were complete their supply would be 27,000 to 30,000 kilowatts. The present generating power was 7,000 to 8,000 kilowatts. The Willesden works would more than double their generating powers, and be quite able to supply the City of London. They would have direct current at high pressure. The pressure would be 10,000 volts, to be converted into continuous current by rotatory transformers.

Mr. J. CECIL BULL, manager and secretary of the City of London Co., said the agreement of his Company with the City was registered in July, 1891. They first paid a dividend in 1895 of 5 per cent., in 1897 10 per cent., and last year 6 per cent. on their ordinary capital. The number of private consumers and the number of 8 c.p. lamps was in 1892, 242 consumers and 11,860 lamps; and in 1898, 7,414 consumers and 355,825 lamps. There had been a continual increase. The number of units sold in 1895 was 2,814,000 at an average price of 7·56d, and in 1898 5,837,317 at 7·22d. Since the starting of the Company a large number of consumers had come on their mains who had previously provided their own supply. They had received very few complaints, but they did get some in December last, and on March 14 they received 38 written complaints. Those came from 10 transforming districts out of 22 or 23. In almost every case the lamps were very old. Nine out of ten of the complaints, with the exception of foggy days, were entirely due to the consumers' own fault. In December last they had a series of mishaps which were practically unavoidable. Pipes necessary for some new boilers were not delivered according to contract, and they had to use bad coal, and the local authorities had harassed them as regards smoke. Their present capital was £800,000 ordinary shares, £400,000 preference shares and £400,000 debentures. They had issued that capital with the exception of £200,000 ordinary shares. They had a large reserve fund. They were bound to provide 7½ per cent. for depreciation, and they had satisfied the Corporation. They objected to competition because of the particular circumstances of the City. The proposed competition was most unjust, because their capital was raised on the faith of their agreement with the Corporation, and the demand for current was practically only during the winter months. Ninety of their customers were tenants of offices, and they had no theatres in the City. The net cost of their supply was about 5d. per unit.

By Mr. FITZGERALD: Is not competition advantageous to consumers?—On the point of price, I suppose it would be.

By Lord HUGH CECIL: His company was not more liable to accident than other companies. They had 502 arc lights. They had paid £196. 7s. 3d. in penalties in 1893 in reference to street lights, but that was a very small matter.

By Mr. POPE: Are your accounts kept strictly according to the Board of Trade rules?—Yes; but the Charing Cross Company's are not. The Corporation inspect our accounts. It required double the outlay in the City to get the same net result as elsewhere. In the West End there was a regular demand which did not exist in the City. He objected to competition on unfair terms. His Company could not poach on other districts, as they were confined to the City.

Mr. FRANK BAILEY, engineer to the City of London Company since 1895, said that up to last winter the supply at full pressure had been given without difficulty. They had had great trouble with their coal supply. The total capacity of their plant was 11,500 kilowatts with 20,000 H.P. They had 66 per cent. of their lamps burning at a time, whereas the demand was only 30 per cent. In consequence of that they required double plant. The number of lamps was 355,825, and the price for public lighting was 2·93d., and for private lighting 6·23d. They had 22 distributing districts, and in no other city, so far as he knew, was there so ample a supply. Competition would not guarantee the consumers from breakdowns. The conditions of the Company in the City were peculiar. They had a sure rise in the curve and heavy loads, but only for a short time. The load rose so rapidly that special plant and handling were required.

Sir COURTENAY BOYLE said it was very important that the Board of Trade should have evidence from the City engineer as to his aspect of the present problem, and some information from the Committee of the Corporation charged with the business as to whether, supposing any Provisional Order were granted, they had or had not any preference for one or other of the competing companies. The Board of Trade were most anxious to consult the views and wishes of the citizens of London.

Mr. WALTER said the matter would doubtless come before the Court of Common Council.

The inquiry was adjourned until April 11.

PARLIAMENTARY INTELLIGENCE.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING CO.'S BILL.

The Committee resumed their inquiry into the petitions against this Bill on Friday, Sir W. Coddington again presiding.

Mr. A. J. LAWSON said the Company proposed to carry their mains through Shoreditch to supply districts beyond, the object being economy. He had estimated what it would cost to put up generating stations and to lay cables under the Bill. The cost of the extension in St. Luke's would be £33,000 or £35,000. The total cost of the cables which they would run under Shoreditch would be less than £10,000. The contemplated expenditure would probably approach some £432,000. In the Northern district £53,866 had been spent, and a further £15,000 in Holborn. They had spent £243,212 in Wandsworth, and in Camberwell £45,900. Inclusive of what had been spent in the provinces in connection with other undertakings, the total expenditure of the Company amounted to £562,587. The Company's called-up capital represented £400,000 of Ordinary shares, £200,000 of the £400,000 authorised Preference shares, at 6 per cent.—on which the Company got a substantial premium—and £200,000, out of the authorised £400,000 Four per Cent. Debentures issued at 108. The Company's energies were not confined to the metropolis, and the grand totals given referred to other districts besides London. Nothing had been paid as dividend on the Company's Ordinary shares up to the present. Interest had been paid on other shares and debentures out of profit on sales of investments, the Company doing a financial business as well as that of an electric lighting company. Apart from financial operations, the total amount of profit made last year, after deducting rents and establishment charges, amounted to £17,375. The financial operations had been directed to finding capital for undertakings in the provinces and in London. So far as concerns London, the Company is one for the supply of electricity, and the powers are sought in that capacity alone. Last year the Company supplied 917,000 units of electricity to a population of 830,000. He was aware that Shoreditch alone supplied 885,000 units, but the greater part was for their own use. Shoreditch had recently reduced its price to 5d. per unit for the first two hours, and 2d. afterwards. His Company charged 7d. per unit for the first 1½ hours, and then 3d. Although the possession of a station on the Thames by the Company would enable it to obtain their coals at 1s. 6d. per ton less, the cost of a site on the Thames, even if they could obtain it, would be prohibitive. Land on the Thames was of greater value than land within a mile of the Bank of England. The promoters were also applying for a Provisional Order for Lee (Kent). The proposed increases and the erection of the new generating station at Camberwell were necessary for supplying the Company's present district, without regard to any fresh area that might be served. The objection raised by Guy's Hospital had reference to the construction of a station on a piece of land adjacent to their institution, indeed running up to the wall of the hospital; but there would be practically no nuisance from noise or vibration if the Company placed its works there. In comparing the Company's charges for current with those of local authorities, regard should be had to the fact that such authorities could effect a saving by using existing offices and present servants in connection with the supply of electricity. They could also arrange their accounts as they liked, and, so far as he knew, they did not submit their accounts to audit. For instance, he believed that last year Shoreditch borrowed from the rates £20,000 without paying interest. Neither was their machinery rated, as they took good care that the Company's should be. It had been suggested that the Company should get no powers to lay down mains before obtaining Provisional Orders in respect of the districts they desired to supply, but he thought it preferable to deal with these matters in once instead of making continual applications to Parliament. The Company did not seek any new areas of supply under the present Bill, but only for rights-of-way and sites for extending existing stations and erecting a new one.

By Mr. COLVILLE: If the Bill were rejected, the Company would not be able to enlarge their station at Wandsworth, so as to meet the demands which would in the future be made for electricity from Camberwell.

Sir. F. BRAMWELL said he had visited the site of the proposed extensions and of the proposed new generating station at Camberwell, and agreed with last witness as to the necessity for, and the capacity of, the sites. They were admirably adapted for the purpose. If the proposed new station was not on the Surrey Canal they would have to go without water and use non-condensing engines. The number of generating stations should be as few as possible. The area of supply of the County of London Company was 25 square miles. There would be no danger of electrolysis to the mains of the Chelsea Water Company. As to the question of breaking up the streets, that was a bugbear which it was not worth while talking about. Depend upon it the local authorities would rate them very heavily when they had the power.

Mr. VIGERS, surveyor, said every description of loss incurred by anyone whose premises were taken would be met by compensation.

Mr. LAWSON, recalled, said the £35,000 he had mentioned would be for the cost of extending the buildings along the canal, but not for laying the mains. The total expense under the Bill would be some £260,000. When

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the Company offered lately £200,000 Four and a-Half per Cent. Debenture stock to the public it was subscribed some 8½ times over, which showed that the Company was not, as had been suggested, an impecunious one.

This concluded the promoters' case.

Mr. LITTLER, Q.C. (for the Whitechapel Board of Works), said the Bill would inflict upon the petitioners considerable burden and responsibility, as their streets were honeycombed with underground mains, sewers, wires, &c., and were largely covered with wood pavement, which could not be interfered with without loss to the road authority. If the promoters were once allowed to pass through Whitechapel they might, in some future session, do something in the way of competition with the Board of Works, who were themselves supplying electricity. He held that there was some *arrière pense* behind the Bill—that the promoters contemplated something which the Committee knew nothing about. He submitted that the proper course for the Company to adopt would be to go to some site on the banks of the Thames, where there was no population, and where land was comparatively cheap.

Mr. H. HECKFORD, surveyor to the Vestry of St. Luke, Middlesex, declined to reply to Mr. Pember (for the promoters) as to what effect the extension would have on the district.

Mr. G. W PRESTON, clerk to the Vestry, said the effect of the proposed works would be to deprive them of rates to the amount of £1,227. The Vestry lost nothing in the matter of rates in connection with the present generating works of the Company. When the proposed works were constructed, if the buildings were similar to those already in existence the Vestry would no doubt benefit, but there was no guarantee that they would be similar. He saw no reason why in the present case the Company should not pay rates during construction.

Mr. CASTLE, Q.C. (for the St. Luke's Vestry), said that before the Electrical Energy Committee, Mr. Pember, Q.C., in examining the engineer to an electric lighting company, had got the witness to admit that an electrical company coming to Parliament for powers to acquire property should not be distinguished from a railway company coming for powers to take land for a new station. If that held good the parish would be protected against loss of rates. In the case of the Brompton and Piccadilly Railway a generating station was included, and the Vestry in whose district it was were allowed rates during construction.

Mr. PEMBER said that in the Brompton case the clause was put in in respect of the parish where the railway was, but not in respect of the parish where the generating station was.

The CHAIRMAN said that to his mind the difference was this—that in the case of a railway station three or four years were occupied in construction, but that was not to happen in connection with the two undertakings which the Committee had already had before them, and in which they had decided against the contention of Mr. Castle. The value of the property in the district of the Vestry would be almost doubled when the proposed works were constructed, so that the Vestry would be recouped in the course of three or four years. The ratable value of the property which would be taken was £1,237, whereas that of the existing works was £3,500.

Mr. WHEELER, Q.C. (for the Vestry of St. Matthew, Bethnal Green), submitted that the essence of the report of the Committee of last year, on which Mr. Pember had relied, was that if the Electricity Generating Company could not find a generating station in its own district it might go into another district to find it. Then, as to clause 15, which dealt with accounts. However simple the Bill might be in appearance, this clause alone would justify the strenuous opposition which was offered to it. If the clause, which he called the "pooling" clause, and which was to relieve the Company of the necessity of furnishing separate accounts of each of its undertakings, were passed it would put an end to all existing contracts as to purchase at the end of 42 years. It was said that the clause would modify the Act of 1892. Why it would revolutionise it. To exempt the promoters from liability to keep separate accounts would be to sweep away every bargain they had made in the various areas. And it must be borne in mind that it was only on the terms that they should keep separate accounts, and that the local authority was to have power to buy, that the promoters had been allowed to go into those areas. This clause not only prevented purchase, but also reduction of charge. He opposed the preamble of the Bill *in toto*, and trusted that the Committee would not pass a Bill so vicious and so unprecedented.

Mr. W. F. DEWEY, Vestry Clerk of St. Mary, Islington, said his parish had already spent £200,000 on electric supply, and proposed to spend another £100,000. They supplied electricity for electric lighting at 3½d. per unit, for power during the daytime at 3½d., and for private lighting at 7d. for the first hour and 4d. for every subsequent hour. As an electric lighting authority, they had a strong desire to reserve to themselves the streets down which the promoters were seeking powers to go. One of his great objections to the Bill was that the Bill, as drawn, in the clause dealing with accounts, would render it impossible to acquire the Company's undertaking in Islington. He knew it was said that the Bill did not enable the Company to supply electricity in Islington, but the moment they had laid a main down a street there was nothing to prevent them from spreading wires transversely in order to supply private consumers. He maintained that Islington was not between St. Luke's, where the Company's generating station was situated, and Hackney, which the Company wished to supply with electricity. At present the streets of Islington were congested with electrical mains. The Company were seeking to evade the possibility of Islington purchasing any part of their undertaking which might be in the parish. The powers contained in the Orders already obtained did not apply to this Bill. Under the Bill private consumers might be supplied. On this point his objection would be met by the insertion in the Bill of a clause declaring that electricity should not be supplied to private consumers in the parish of Islington. If the powers sought in the Bill were granted, the Vestry should have the option of dictating the route by which the Company's wires should go. He should not be content to leave the power of deciding the route with the Board of Trade, as then the Company would be able to suggest the route in the first instance.

Mr. BARBER, surveyor to the Vestry, gave evidence as to the crowded state of the streets underground with wires, mains, sewers, &c. The Vestry were about to start a new 1,000 H.P. engine at their generating station. The nearest route from St. Luke's to Hackney would not be by way of Islington.

Mr. PEMBER, Q.C., said the Committee desired to have details as to the districts affected by the Bill. The facts were these:—Battersea had obtained an Electric Lighting Order in 1896, and Fulham in 1897, and no work had been carried out, though it had been commenced, and the same thing applied to Whitechapel, which had obtained its Order in 1892, and Stoke Newington, which had obtained its Order in 1893. Hackney and Poplar had obtained Orders in 1893, but nothing had been done. Lambeth had got an order in 1893, but had transferred it to a company in 1897. Islington and Shoreditch had got Orders in 1893 and 1892 respectively, and were carrying out the work; Bermondsey and Rotherhithe were applying for an Order, and the Company sought to supply them. In the case of Greenwich an Order had been granted to the Company for a part of the district, and the Company were asking for an Order in that district. In the Lee district an Order had been granted to a company to supply a part, and the present promoters were seeking to supply the district. The Bethnal Green Vestry were applying for an Order, and so was the Company; Camberwell was the Company's district, and so was Wandsworth, and St. George the Martyr, and St. Luke's, Midd'esex, and in Lewisham powers were being sought both by the authority and the Company.

The Committee then adjourned.

LEGAL INTELLIGENCE.

W. T. Glover and Co. (Limited) v. William James Glover and Co. (established 1818), Limited.

On Monday, in the Chancery of Lancaster, before Vice-Chancellor Hall, Q.C., a motion was made on behalf of the plaintiffs for an injunction to restrain the defendants from carrying on business as electric cable and wire manufacturers under the name or title of "Glover." Mr. Maberly, for the plaintiffs, said his clients were Messrs. W. T. Glover and Co. (Limited), of Salford, who had carried on business for many years as electric cable manufacturers, and the defendant company had been formed under the name of William James Glover and Co. (established 1818), Limited, whose head office was in Manchester. The prospectus had been issued about a week previous.

The VICE-CHANCELLOR: I see the business is announced as having been established in 1818.

Mr. MABERLY (for plaintiffs) said there was such a business, but it was simply and solely a wire cable business, and had nothing to do with electricity.

Mr. SUTTON (for defendants): We do not admit that.

Mr. MABERLY, continuing, said that since the notice of motion had been given for that day defendants had inserted an advertisement in the Manchester and London papers to the effect that having been challenged by the plaintiffs as to the right of the defendants to use the name of "Glover," no allotment of shares would take place, and the money received on application would be returned forthwith. This, of course, considerably altered the position of affairs.

The VICE-CHANCELLOR asked if they were ready to go on.

Mr. SUTTON: Certainly.

Mr. MABERLY: I am not. Some of the affidavits have only been received this morning.

The VICE-CHANCELLOR said it was not now as urgent as before. Would it be convenient to let it stand now to the trial of the action?

Mr. SUTTON said it had better so stand. They did not wish it to be supposed that they did not intend to fight, and to fight hard, for that was their intention.

The VICE-CHANCELLOR: I quite understand that. The Company is registered, I understand, and is, therefore, in operation, and nothing will be done now to prevent those who have carried on the business carrying it on on the same lines as hitherto.

Mr. SUTTON: There will have to be a new action against W. J. Glover.

Mr. MABERLY: I was going to ask that it be with liberty to me to amend.

The VICE-CHANCELLOR: Yes.

The proceedings were ordered to stand over to the trial.

In re Whitehead; Ex parte Edison and Swan United Electric Light Co. (Limited).

In the London Bankruptcy Court on Monday, before Mr. Justice Wright and Mr. Justice Bigham, the appeal *in re* Whitehead, ex parte the Edison and Swan United Electric Light Co., from the Staffordshire County Court, was heard. Mr. Muir Mackenzie was for the appellant (the debtor), who appealed from a receiving order made against him on the petition of the Edison and Swan Company. He contended that at the time of the act of bankruptcy there was not a sufficient debt due to support the petition. The Act of 1883 provides that no person is entitled to present a petition unless the debt amounts to £50, and Mr. Mackenzie quoted a judgment of Lord Justice Melluish in support of his contention. It appeared that debtor received goods from the Company on sale or return. He had previously dealt with the Manchester Edison Swan Co., who were taken over by the United Company, together with all the arrangements they had made. The debt due from Mr. Whitehead to the former

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Company at the beginning of 1898 was £92. 10s. 2d. On June 25 the United Company commenced an action for £105. 17s. 7d., which included the £92 and £13. 4s. 5d. for further goods supplied. Debtor resisted the claim, with the exception of £19, which he paid. He returned goods to the amount of £50. 15s. 6d., and was given credit for £69. 16s. 3d., leaving due £35. 18s. 4d. and on Jan. 13, 1899, judgment was given for that amount, with £25. 0s. 7d. costs. But on Jan. 10 debtor executed a deed of assignment for the benefit of his creditors, and the point was that at the time of this act of bankruptcy the debt was only £35 odd, and that the costs of the action did not become due until after judgment. Mr. Reid, Q.C., for the Company, submitted that the costs became part of the original debt. The appeal was ultimately allowed, with costs.

Henwood v. Howell.

At the City of London Court, Mr. E. N. Henwood sought to recover from Mr. T. J. Howell, telephone engineer, £40 and a declaration that he was entitled to a tenth of his receipts in respect of a new telephone. It appeared that defendant wanted to put his patent telephone transmitter on the market, and went to plaintiff for assistance. Plaintiff stated that defendant signed an undertaking to give him 10 per cent. commission on all money raised at once (funds being urgently needed to take out foreign patents) and a tenth share of all future profits. Plaintiff had introduced the defendant to a firm of stockbrokers, who were to have formed a syndicate, and who advanced defendant £300 on account. Defendant had, however, taken the matter elsewhere, and was about to receive 4,000 shares in a company. Plaintiff asked to be paid the balance of commission on money actually received by defendant, and to have assigned to him 400 of these shares. Defendant admitted receiving some money, but said the shares had not been transferred. He denied knowing the full extent of plaintiff's commission note. He admitted plaintiff had assisted him, but he had no right to a tenth of the profits which might accrue. Plaintiff had taken advantage of his blindness! He did not know the nature of the document he signed! Mr. Commissioner Kerr said that was a serious allegation to make, and he could find no ground for it. There must be judgment for plaintiff for £40 and for a tenth of the shares which were about to be acquired by defendant, and costs.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"LABORATORY NOTES AND FORMS."—With the above title we have ready the New Edition of a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free; abroad 11s.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition now ready.*

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"ELECTRIC MOTIVE POWER," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s. *New edition ready May 1, 1899.*

"WIRELESS TELEGRAPHY: SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES."—By Dr. O. J. Lodge, with many original illustrations. *Enlarged Edition*, 2s. 6d. net, 2s. 9d. post free.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II. ready May 1, 1899.*

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s. 6d.; post free, 1s. 9d.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of genera as well as special information bearing upon the whole subject of electrica discharge research. Price 5s., post free; abroad, 5s. 3d.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. Prospectus on application.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. A fine large paper edition with wide margins for notes can also be supplied. Price 12s. 6d.; post free, 13s.; abroad, 13s. 6d. *New Edition in the press.*

"THE ALTERNATE CURRENT TRANSFORMER," Vol. I.—By Prof J. A. Fleming, M.A., D.Sc., F.R.S. *New Edition.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s. post free; abroad, 6s. 6d. Digest post free.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free; abroad 13s. 6d. Prospectus post free.

IN THE PRESS.

"THE ELECTRIC ARC."—By Mrs. Ayrton.

"THE MANUFACTURE OF CARBONS FOR ALL ELECTRICAL PURPOSES."—By Francis Jehl.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. *Vol. II. ready May 1, 1899.*

"SECONDARY BATTERIES, THEIR DESIGN AND MANUFACTURE."—By E. J. Wade.

"PRIMARY BATTERIES: THEIR CONSTRUCTION AND USE."—By W. R. Cooper.

"PRACTICAL TELEPHONY."—By Dane Sinclair and F. C. Raphael.

"'THE ELECTRICIAN' WIREMAN'S POCKET-BOOK."—By F. C. Raphael

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The "Big Blue Book" for 1899 is NOW READY. The Directory Division has been corrected up to Feb. 8, 1899, and all the latest new names, changes of address, &c., will be found included. The Handbook Division has been much extended, many valuable tables having been added. The volume contains, also, the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways, finally corrected to Feb. 9, 1899. The price of the Directory and Handbook remains the same—10s., post free 10s. 9d.; abroad, post free, 12s. (United States 13s. 6d).

TENDERS INVITED.

The *Bradford* Corporation invite tenders for the supply of a complete battery and switchboard for their electricity supply station, Bolton-road. Specifications can be obtained at the electricity offices, Town Hall, Bradford, and tenders must be sent in to the town clerk (Mr. George McGuire), by Wednesday, April 12. Further particulars will be found in an advertisement.

As advertised elsewhere, the *West Ham* Council invite tenders for two 1,500 I.H.P. engines, two 800 kilowatt alternators and exciters, or two steam alternators and exciters. Specifications, &c., may be obtained at the borough electrical engineer's office, Abbey Mills, West Ham, on and after the 31st inst. Tenders must be sent to the town clerk (Mr. Fred. E. Hilleary) by 4 p.m. of Tuesday, April 25.

The Electric Light committee of the county borough of *Belfast* invite tenders for the supply and erection of mechanical stokers, economisers, pipe work and condensing plant. Specifications, &c, may be obtained from the city electrical engineer (Mr. Victor A. H. M'Cowen). Further particulars are given in an advertisement, and tenders must be sent in to the town clerk (Sir Samuel Black) by noon of Thursday, April 20.

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The Corporation of *West Hartlepool* invite offers from firms or companies for "free" wiring of premises in the district. Further particulars are given in an advertisement, and offers must be lodged with the town clerk (Mr. Higson Simpson) by April 15.

The *Bristol* Electrical committee require tenders for high-tension switchboards, instruments, &c. Specifications from the city electrical engineer (Mr. H. Faraday Proctor), and tenders must be in by April 10. See advertisement.

The *Poplar* (London) District Board of Works invite tenders for engine and pump room equipment and all electrical plant except battery; boiler house equipment; battery and battery stands; and public street lighting. Tenders to Mr. Potts by 10 a.m. of April 25.

The *Tynemouth* Corporation invite tenders for boilers, &c., economisers and fittings, ejector-condenser, circulating pumps, tanks and pipework and water cooler, pumps, feed pipes, &c., travelling crane, traction switchboard, lighting switchboard, accumulators, cables, and traction steam dynamo. Tenders to town clerk (Mr. Horatio A. Adamson), by noon of April 15.

The Great Northern Railway Co. (Ireland) invite tenders for cables for feeders, returns, potential lines, &c., 6 motor and 6 trailer cars, overhead construction, and battery and booster. Tenders to secretary (Mr. T. Morrison), by April 20.

The Directors of the Lancashire and Yorkshire Railway invite tenders for stores during the 12 months ending April 30, 1900, including signal and telegraph fittings, signal, telegraph and electric light wires, screws, oil, springs, wire, &c. Tenders to secretary (Mr. C. W. Bayley), Hunt's Bank, Manchester, by 10 a.m. of April 3.

The Electric Light committee of the *Salford* Corporation invite tenders for stores. Tender forms from the borough electrical engineer (Mr. Chas. L. Turner), Walness-road electricity works, Broughton, Salford.

The *Leeds* Corporation invite tenders for the supply and erection of coal elevators and conveyors at the tramways power station, Crown Point. Tenders by noon of April 6.

The *Leeds* Corporation also invite tenders for the electric lighting of the new Dead Meat Market and Abattoir. Tenders by April 8.

The Guardians of the Poor of *Rochdale* Union require tenders for a complete electric light installation at the workhouse buildings and cottage homes. Tenders to Mr. R. A. Leach, clerk, Union Offices, Townhead, Rochdale, by April 12.

The *Aberdeen* Corporation invite tenders for the supply of:—(1) two Babcock-Wilcox boilers, (2) one 180-kilowatt steam dynamo (Belliss or Willans and Robinson engine), with steam and exhaust pipes, and one 75-kilowatt balancing set. Tenders to town clerk by April 5.

The *Peterborough* Corporation invite tenders for the supply and erection of Lancashire boilers and economiser; steam dynamos, balancers and boosters; secondary battery and accessories; switchboard and instruments; piping, tank, condensers and pumps; and insulated cables. Tenders to town clerk by April 20.

The *British Electric Traction Co.* require tenders for the construction of about 2½ miles of tramway permanent way from Dudley to Cradley Heath. Tenders by April 14 to the secretary.

The *Rhyl* District Council invite terms for preparing plans, specifications, &c., for a refuse destructor. Further information from the town surveyor (Mr. Robert Hughes). Terms by April 3.

The *Edinburgh* Corporation invite tenders for installing the electric light at the City Chambers (extension buildings). Tenders to town clerk (Mr. Thomas Hunter, W.S.) by 10th April.

The *Wolverhampton* Lighting Committee invite tenders for supplying and erecting about 110 tons of steel stanchions, girders and decking at electricity works. Tenders to borough engineer by April 8.

TENDERS RECEIVED AND ACCEPTED.

The Ipswich Guardians have accepted the tender of Martin and Newby for electric bell work at the workhouse, for £30. 1s. 6d.

The London School Board has accepted the tender of Messrs. Woods and Co. for wiring Upper Kennington-lane School, at £267.

APPOINTMENTS VACANT AND FILLED.

The Wolverhampton Corporation require a mains superintendent, at a commencing salary of £104 per annum. Applications to borough electrical engineer (Mr. C. E. C. Shawfield) by Tuesday, April 4. See advertisement.

The Manchester Tramways committee have appointed Mr. J. Eades, jun. (deputy manager of the Manchester Carriage and Tramway Co.'s works in Pendleton), manager of the municipal car building and repairing works, at a salary of £200 per annum.

BANKRUPTCIES, LIQUIDATIONS, &c.

The statement of affairs of Easton, Anderson and Goolden (Limited) at Oct. 28, 1898, is issued, which shows gross liabilities, £409,091. 13s. 10d. The secured creditors include the holders of the 4½ per cent. first mortgage debenture stock, amounting to £152,250, and the 6 per cent. second mortgage debenture holders, amounting to £30,600. There is a surplus of £79,795. 18s., which figures as an item on the asset side of the account, against which there are liabilities £182,850, showing a total deficiency of £139,907. 5s. Against this deficiency are a number of items (including patents, patterns and drawings, and a claim against Ernest Terah Hooley), which are marked as "uncertain" in value. The unsecured creditors stand for £59,743. 3s. A meeting of creditors will be held at the Guildhall Tavern, Gresham-street, London, E.C., on Wednesday, April 12, at 11 a.m.. when a summary of the statement of affairs will be submitted by Mr. W. B. Peat, liquidator, 3, Lothbury, London, E.C. Creditors are asked to forward their statements of claim against the Company up to Oct. 28 last, to Mr. Peat.

A meeting of the North-Eastern Telephone Co. (Limited) will be held at 22, Dean-street, Newcastle-on-Tyne, on April 13, to receive an account of the winding-up.

A meeting of the Hope-Jones Electric Organ Co. (Limited) will be held at 8, Fenwick-street, Liverpool, on April 25, to receive an account of the winding-up. The Company's business was acquired by the Electric Organ Co.

A meeting of the Electric Date and Time Stamp Co. (Limited) will be held on April 25, at 2, Moorgate-street-buildings, London, E.C., to receive an account of the winding-up.

At a meeting of Electricity (Limited) on Feb. 17 it was resolved to wind up the company voluntarily, and Mr. P. W. Davis was appointed liquidator. These resolutions were confirmed on the 17th inst.

The first meeting of creditors of Charles and Blackwell, trading as electrical engineers under the style of the Central Electrical Engineering Co., at London and Leicester, was held at the London Bankruptcy Court on Tuesday. No offer was submitted and Mr. Wm. Richards was appointed to administer the estate in bankruptcy, with a committee of inspection. Debtors commenced business in October, 1897, and attribute their bankruptcy to the failure of the flotation of the Steady Arc Lamp Co. (Limited). Liabilities £1,626, and assets £571.

Claims against F. Jones (trading as F. Jones and Co.), electrical engineer, 147, St. John's-hill, and 77, Darin-road, New Wandsworth, London, S.W., must be in by April 11. Mr. A. Mackintosh, O.R., 24, Railway-approach, London Bridge, S.E., is trustee.

Sale by Tender.—Pursuant to an order of the High Court there is for sale by tender the stock-in-trade, plant, furniture, fixtures, goodwill and British patents owned by the Elieson Lamina Accumulator Co. (Limited). Particulars will be found set out in an advertisement on another page. It will be seen that tenders are to be sent in not later than Wednesday, April 12.

Workmen's Compensation.—At the time when the Workmen's Compensation Act came into operation (July, 1898) we took occasion to complain of the excessive premium rates charged for risks under the Act by the established insurance companies, and prophesied that these companies were likely to seriously damage their businesses in insisting upon such extortionate premiums. We have reason to believe that a good deal of climbing down has been done by the companies, and that this process will have to be considerably extended before large employers of labour will agree to pay the wholly extravagant rates demanded. We are surprised that some well thought out scheme of mutual insurance by large trading concerns has not been arranged. That such a scheme would be highly successful we have no manner of doubt. An example: Messrs. Waring and Gillow (Limited), the well-known decorators and furnishers, were asked by the insurance companies £2,500 per annum as premium under the Workmen's Compensation Act. This sum was considered excessive, and the firm decided to take their own risks. For the first six months, although the number of accidents was greater than in any previous half-year, only £93 had to be paid as compensation, and the firm started the next six months with £2,407 plus interest in hand. For the first nine weeks of 1899 not a single claim has arisen! As was pointed out in one of the leading London papers, recent experience has shown that the insurance companies were wildly wrong in their estimates of risks under this Act. It will be remembered that no sooner was the Act passed than the insurance companies combined to fix the rates, and, instead of giving the Act a chance, and helping to render it popular, and so support the action of Parliament, such excessive rates were fixed as to lead the trading public to the conclusion that the Act was not only unwise but unjust. Such action on the part of the insurance companies leads one to feel that the fixed premiums for other risks are inflated, and so soon as this feeling becomes general it is not unlikely that the "tariff" companies will suffer for their temerity in dealing with risks under the Workmen's Compensation Act.

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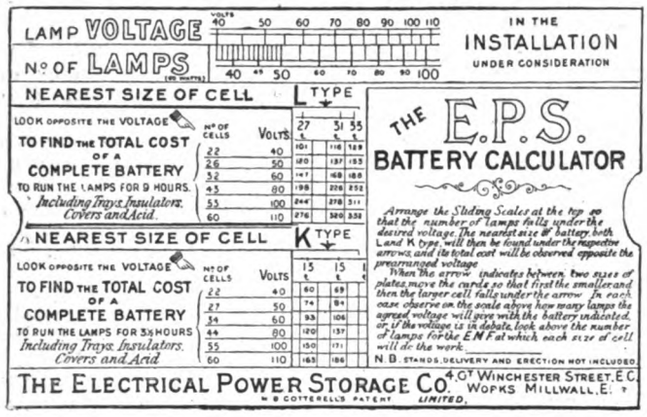
Motor Gun.—It is announced that the 26th Middlesex (Cyclists' Corps) will experiment, at the volunteer manœuvres at Aldershot during Easter, with an electric motor cycle equipped with a service patent Maxim gun. The wheels of the tricycle are fitted with pneumatic tyres and ball bearings, and, should the electric power prove insufficient, an ingenious arrangement provides for four separate safety cycles being coupled together and attached to the pole of the gun carriage. The result of the experiment will be watched with interest, as it is generally considered that a large demand is likely to arise for this class of motor-driven vehicle.

E P S. Cells.—The Electrical Power Storage Co. have forwarded us a copy of the "E. P. S. Battery Calculator," which is a cardboard slide rule of similar character to the well-known Trotte Wiring Slide Rule, and gives a mass of tabulated information concerning E.P.S. batteries which is likely to prove of much service to installation contractors. By means of recesses cut in the two faces of



the card and a sliding tablet, numbers, prices, &c., of L type, K type, Kws type, and Klp type cells is available for different voltages and numbers of lamps. The whole of the information is obtained at a glance, and by means of this calculator a contractor is able to find the total cost of complete battery equipments for any given output and conditions. The illustration (a half-size reduction of the original) shows one side of the calculator, which gives the number of L or K type batteries for certain numbers of lamps at specified voltages.

Messrs. Schuckert and Co.—We have received a large and well-printed volume descriptive of the history, development and present condition of Messrs. Schuckert and Co.'s works. It is illustrated with fine full-page views of the various shops, and gives a good idea of the enormous amount of work that is being executed there. The following figures alone would be convincing:—In the year 1897-98 no less than 4,547 machines were manufactured, representing an aggregate of 72,477 kilowatts, and in addition 441 transformers, aggregating 8,862 kilowatts, 10,788 arc lamps, 120 projectors, 5,088 ammeters and voltmeters, and 8,017 meters, the turnover being 46,500,000 marks. The works cover an area of 88,100 sq. m., 41,500 of which has been built on. In November last 660 officials and 5,329 workmen were employed at the Nuremberg works, and the total number of employés at the Berlin and Nuremberg works together was 7,757.

Fire.—On Wednesday a fire of no serious importance occurred on the works premises of the India Rubber Co. at Silvertown. The local fire brigade succeeded in extinguishing the flames, which will in no way interfere with the company's operations. All sorts of alarming reports were published in London, which we have the authority of the company to state are exaggerated.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from March 22 to March 28, with the ports of destination:—

Australasia—Adelaide, £1,625; Auckland, £379; Freemantle, £272; Hobart, £95; Sydney, £1,322 (including £192 telegraph material); Melbourne, £167; Wellington, £225. *Brazil*—Rio Janeiro, £170 (including £120 telegraph material). *Canada*—Toronto, £92. *Ceylon*—Colombo, £182. *Denmark*—Copenhagen, £53. *France*—Boulogne, £95. *Gibraltar*, £250. *Greece*—Piræus, £71. *Holland*—Amsterdam, £70; Rotterdam, £25 (telegraph material). *Hong-Kong*, £20. *India*—Bombay, £43; Calcutta, £98. *Malta*, £28. *Russia*—St. Petersburg, £128 (telegraph material). *Siam*—Bangkok, £383. ***South Africa***—Cape Town, £73; Durban, £407; East London, £526; Port Elizabeth, £96. *Spain*—Bilbao. £30. *Sweden*—Gothenburg, £105; Stockholm, £209 (telegraph material). *West Indies*—Teneriffe, £162 (telegraph material); Trinidad, £80. Total £7,481, against £16,509 in the corresponding week last year (March 23 to March 29).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Acton.—Hammersmith Vestry have notified the Acton Council that they cannot undertake the supply of electricity in bulk to Acton.

Adelaide (South Australia).—Mr. F. C. Howard, secretary, South Australian Electric Light and Motive Power Co. (Limited), writes under date Feb. 25:—

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of Jan. 13 appears a statement made by Messrs. Lanyon and Sons, agents for the local gas company, and some of its directors, evidently with a desire to damage my company. The gas company has for many years had a monopoly of lighting in this city and its suburbs, and has always paid large dividends, and now, seeing its fat profits endangered by the arrival of an electric company, has strained every nerve to block and damage the said rival.

The gas company's contract is *not* for lighting the whole city, the Corporation having the right to place the gas lamps where they choose, as witness the fact that my company is shortly to provide arc lamps for some miles of the principal streets to replace a large number of gas lamps. The particulars given of this contract are in the main correct, except as to some important omissions. It would be instructive to know how Messrs. Lanyon arrive at the £4,000 loss this company is to make over the contract, and no doubt your readers will smile at the assumption.

The reason so few ratepayers troubled to vote at the poll taken in September last was that everyone knew that the Gas Company would be badly beaten and that the Electric Company would succeed. Messrs. Lanyon state that in 1894 the citizens declined to allow the Corporation to erect electric arcs and supply electricity. How true this is you will be able to gather from the two questions put to the ratepayers on that occasion, viz.: "Are you in favour of having the streets lighted with electricity at present?" and "Are you in favour of continuing the lighting of the streets with gas?" The Gas Company worked hard, spent their money, and on that occasion were successful.

My company has recently been in getting a private Bill through Parliament which gives it very full powers. We have also acquired all the rights of the Corporations of Adelaide and Port Adelaide, to the exclusion of all others, and are receiving a very large support, so you will understand why the Gas Company have been so bitter in their opposition. No doubt you will say this is only history repeating itself.

It is clear that the S.A. Electric Light and Motive Power Co. is alive to its responsibilities, and that here, as elsewhere, electricity supply has come to stay.

Argentina.—According to the *Review of the River Plate* there were in 1895 17 electric lighting stations in Argentina, with 78 dynamos and 37 steam engines. There were 1,257 customers, with 17,122 incandescent and 651 arc lamps connected. The capital amounted to $3,773,500. The number of houses connnected up at the present time (1898) must be very nearly 10,000, and the incandescent lamps in use nearly 100,000. There are 41 telephone companies, with 15,047 kilometres of lines and a capital of $10,918,740. Telegraphs, 40,814 kilometres with 1,237 offices.

The chief lighting official of the city of Buenos Ayres Lighting Department has submitted a scheme for lighting the whole of the city and suburbs by means of 7,000 arc lamps, 3,000 of which would be lighted all night and 4,000 up to midnight. The annual cost of maintenance is estimated at $690,000 gold, and the capital expenditure entailed in the erection at $1,000,000 gold, repayable in 20 years and bearing 6 per cent. interest. The lighting, interest, and amortisation would amount to $780,000 gold per annum (equivalent to $1,560,000 paper), which is about the present price of gas.

Bangor.—Electric lighting matters here are somewhat involved, and the gas interest is endeavouring to make them more so. Owing to counsel's opinion that the signatories to the electric lighting bond were disqualified from sitting on the Council, the guarantors proposed to withdraw the bond. At the last meeting of the Council it was decided (14 members being virtually disenfranchised) that the town clerk should take steps to obtain possession of the document, which the leader of the electric light party declared he held under the advice of counsel. The Lighting committee now recommend the Council to allow the bond to be withdrawn, on condition that it is given up to the town clerk.

Barrow-in-Furness.—The Electric Lighting committee recommend the expenditure of an additional £4,000 for plant at the generating station, sufficient to double the capacity of the works. It is proposed to apply for sanction to borrow £15,000 for extensions, but only £4,000 will be expended immediately. The committee's proposals were adopted by the Council on Tuesday.

Bath.—Electric light mains are to be laid in four additional streets, at an estimated cost of £1,100.

Bury.—An inquiry was held last week into the application of the Council to borrow £20,000 for electric light extension purposes. The applications for current were given as equivalent to 11,561 8 c.p. lamps, the present capacity of the station as only 10,000 8 c.p. lamps, and a constantly increasing demand for current. Extensions were, therefore, absolutely necessary.

Customs Tariff Changes.—The following rates of duty are now levied on electrical goods entering the island of Cuba:—$2·50 per 100 on incandescent electric lamps, mounted or not; $7 50 per 100 kilos on wire covered with insulating material and electric

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cables, and wire enclosed in iron or lead pipes or armoured; $3 per 100 kilos on electric light carbons.

Electric arc lamps entering Spain will in future be assessed for customs under No. 79 of the Custom tariff.

A duty of 30 per cent. is imposed upon the metal stems of all insulators entering the colony of Victoria, porcelain insulators are admitted free.

Dover.—The receipts of the electric tramways during the past year amounted to £9,000, and the net profit to over £2,000.

Electric Power Distribution in the Black Country.—The Midland Electric Corporation for Power Distribution are making progress with their scheme for the generation and distribution of electricity in South Staffordshire and East Worcestershire. Powers have been acquired for Wednesbury, Bilston, Coseley, Darlaston, Heath Town, Rowley Regis, Sedgley, Short Heath, Tipton, Wednesfield, Willenhall, and Bentley in the district of Walsall. The Oldbury and Kingswinford orders are to be transferred to the company, and the councils of Amblecote, Quarry Bank, and Walsall (rural) have consented to an application which the company are making in the present session. A site for a generating station has been acquired on the West Bromwich side of Tipton, with ample canal and railway facilities for the supply of coal, and from this no main or feeder to the outskirts of the district need exceed eight miles in length. The engineer of the company is Mr. G. L. Addenbrooke. It is proposed to commence by putting down plant equal to 5,000 H P., but the works will admit of easy extensions. The site chosen has an area of 30 acres, and extensions can readily be carried to 40,000 H.P. if required. Before raising capital the company are making an effort to come to terms with the authorities of Dudley, Brierley Hill, West Bromwich, Handsworth, Smethwick, Hales Owen, Lye and Stourbridge. The proposed charges for current are: For lighting, 6d. per unit for the first 100 hours per quarter, and 3d. per unit afterwards, with discounts varying from 5 per cent. to 20 per cent. where the consumption is over 100,000 units per annum. For power, 3d. per unit for the first 78 hours per quarter, and 0·825d. per unit for subsequent hours. The company offer current to local authorities for public lighting at 1·6d. per unit.

Electricity in Mining.—The *Financial News* states that an inventor at the Klondike gold fields, struck with the costliness and slowness of the methods used to thaw the frozen soil, has called electricity in to aid the miner, and by means of an electrical contrivance it is claimed that 24ft. of frozen earth can be thawed in the same time that is taken by the more primitive method to thaw 1ft. It is stated that the invention has been sold to an English syndicate for £7,000. If so, we shall probably hear more about it.

Exhibitions.—Increased space having been placed at the disposal of the promoters of the Brussels Exhibition of Domestic Electric Appliances, the time for sending in applications has been extended to April 10. A reduction of 50 per cent. will be made on the cost of carriage of exhibits on the Belgian State lines.

We are asked by Messrs. Handcock and Dykes to notify that, in order to meet the wishes of several surveyors, it has been decided to include in the International Building Trades Exhibition at the Agricultural Hall, London, N., from April 26 to May 6, a display of plant and materials for electric tramway working, so far as they affect the road surface. The opportunity will be a favourable one for bringing to the notice of surveyors, members of district councils and roads committees the latest appliances in this branch of electrical work.

Glasgow.—Sheriff Berry has fixed April 19 for hearing the dispute between the Postmaster-General and the Glasgow Corporation as to laying underground telephone wires.

Hammersmith (London).—At the Hammersmith electricity station, on Tuesday evening, the inauguration took place of the first extension of the generating station and of the public and private lighting. The company were shown over the new station by the consulting engineer (Mr. A. H. Preece). The extensions consist of the following plant:—A new engine-house, 40ft. by 27ft., with rectifier and pump-room adjoining, designed by Mr. Hugh Mair, the Vestry's surveyor; two engines of 500 H.P., built by Messrs. Robey and Co.; two E.C.C. alternators, one Ferranti main feeder switchboard, one 250 H P. water tube boiler, a 500 H P. Ledward evaporator condenser, and three pumps by Messrs. W. H. Allen, Son and Co.

Imperial Penny Postage.—Postage to Malta has been reduced to one penny.

Keighley.—Negotiations are proceeding between the Gas committee and the Keighley Tramways Co. as to the adoption of electric traction and to the supply of electrical energy by the Corporation, who already possess electric lighting powers.

Light Railways —The following further light railway schemes have been approved by the Board of Trade:—From Trowse (Norfolk) to Beccles (Suffolk); from Cheddleton Junction to Caldon Low and Hulme End; from Grimsby to Saltfleetby, with a branch to Cleethorpes; from Stourbridge to Kinver; from Barking Town to the Beckton Gas Works; and sundry short lines in Northumberland and in the townships of Chirton, North Shields, Tynemouth, Cullercoats, Whitley and Monkseaton.

The adjourned inquiry by the Light Railway Commissioners into the projected Finchley, Hendon and District, the Hampstead, Finchley and Edgware, and the Highgate, Finchley and Wood Green Light Railways was resumed on Tuesday. At the conclusion of the promoters' case, the chairman said that in the circumstances the Commissioners decided that the first two schemes should not be proceeded with.

It is proposed to construct a light (electric) railway between Kelsall and Chester, and application is to be made to the Light Railway Commmissioners in May. The estimated cost of the line, which will be equipped on the overhead trolley system, is put at £40,000.

London County Council.—At Tuesday's meeting the Parliamentary committee reported upon the Central Electric Supply bill, recently passed by a Select committee of Parliament. The power proposed to be given to the company to break up roads, &c., outside the area of supply had an important bearing upon the question of purchase, and the committee considered it one which might perhaps be dealt with as a matter of public legislation by an amendment of the provisions of the Electric Lighting Acts with regard to purchase. It was for the Council to say whether or not the bill should be further opposed in the House of Lords with a view to obtaining some satisfactory arrangement with respect to the purchase of electric light undertakings. It was recommended that a petition be presented to the House of Lords with this object, and the recommendation was approved.

The same committee reported that they had had the London County Tramways bill prepared to enable the Council to use one or more systems of electric traction on all or any of its tramways, and for that purpose to reconstruct the tram lines. The schedule to the bill contained particulars of lands in the parishes of Streatham, Camberwell, Lambeth, and Greenwich, which might be used as sites for generating stations, and which at present belonged to the Council as part of the undertaking of the London Tramways (Limited). It was recommended that the bill be approved, and the recommendation was also agreed to by the Council.

The Highways committee reported that a conference had taken place with representatives of the Lambeth and Wandsworth local authorities as to a proposal that the Council should apply for a licence for the experimental use of mechanical traction on the tramways between Westminster Bridge and Tooting. The consent of both those bodies as the road authorities concerned would doubtless be given. Prof. Kennedy, who had been asked by the Council to advise as to the system of mechanical traction most suitable for London, had proceeded to America to investigate the systems in use, and would probably be able to report within a month or six weeks. A proposal that the Lambeth and Wandsworth authorities be asked to give the required current was approved by the Council.

Lucan-Leixlip (Dublin) Electric Tramway.—A Board of Works inquiry into the engineering details of this line was held on Thursday. For the promoters, it was stated that the gauge would be 3ft. 6in. and the rails would be on a raised platform, the height of the surface of the rail not to exceed a foot above the level of the carriage way. The line would be constructed of steel girder rails, 50lbs. per yard, on transverse sleepers. At road crossings, grooved steel girder rails would be substituted, and would be laid level with the roadway. The total length of the line would be 1⅛ miles. The total cost of construction for the electrical equipment (including poles, cables and motor cars) would be £4,950. The motive power would be supplied by the Dublin and Lucan Co. The feeders would be both under and over ground.

Non-County Boroughs Association and Electrical Matters.—The annual meeting of the Non-County Boroughs Association was held at the Westminster Palace Hotel, London, on Friday last, the Mayor of Southport presiding. In their report for the year, the Executive Council of the Association stated that they had considered the General Power Distributing Co.'s bill, the Lancashire Electric Power bill, the South Lancashire and Cheshire Electricity bill, and the Leicestershire and Warwickshire Electric Supply bill, and considered that the rights of the boroughs were threatened by a new danger. If, for instance, the General Power Distributing Co.'s bill was passed, it would sanction a new policy and create a new danger. It had been the settled policy of Parliament to allow municipalities peaceful possession, to sanction the policy of having only one service—municipal monopoly—in a borough. The passage of these bills would break down that policy. The Council were in perfect harmony with the principle that where boroughs (county or non-county) had with the sanction of Parliament established, or were in the course of establishing, undertakings for the public benefit, and had not failed in the performance of their duties, it was not right or expedient that powers should be granted to companies to compete with such local authorities. The Council further considered that the bills promoted by the National Telephone Co. were, doubtless, objectionable and

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inimical to the interests of non-county boroughs, and that the powers of the Company should not be extended. They objected to any act being passed which might tend to delay or interfere with the Government undertaking the telephone service of the country. It appeared to the Council to be the duty of non-county boroughs to resist the bills on the general principle of objection to hiring what might be termed national powers to a private company. The report of the Council here outlined was approved.

Newport (Mon.).—Thirty-four additional arc lamps have been erected here, bringing the total to 76.

Perth.—Of the offers received by the Town Council for the electric lighting of the town, Mr. Hawtayne considers that of Edmundson's Electricity Corporation the best, but the Council are recommended to retain their electric lighting powers, and to establish municipal electricity supply.

Private Bill Legislation.—On the motion for the second reading of the Baker-street and Waterloo Railway Bill in the House of Commons on Tuesday, Sir T. G. Fardell said the Paddington Vestry objected to the Bill principally because the promoters contemplated establishing a generating station in the district. They had since offered to withdraw the clauses embodying that proposal, but other objections remained. If the promoters would be content to link Paddington Station with their line, all opposition would be withdrawn. The Bill was read a second time.

Ramsgate.—The Town Council are at last awakening to the importance of electric lighting. The engineer has been instructed to prepare a report on the desirability of establishing electricity supply works or of allowing a company to undertake the work.

St. Mary (Islington) **v. St. Pancras.**—For some time past there has been a deadlock, so far as electric lighting is concerned, in two important thoroughfares in the north-west of London—York-road and Brecknock-road—owing to the clashing of interests of the above-named vestries. It is suggested that the new London Government Bill may prove a favourable opportunity for adjusting the boundaries of the two districts, so as to enable electric light mains to be carried down these two thoroughfares for the supply of current to a large number of consumers.

St. Pancras (London).—The Vestry are increasing the salary of Mr. P. N. Hooper, engineer-in-charge of the King's-road station, from £200 to £220 from May next, with annual increments of £20 up to £300.

Shoreditch (London).—The Vestry have accepted an offer of the County of London Company to pay £100 per annum for permission to lay two electric cables through the parish from the company's generating station for the supply of outside districts.

Smoke Nuisance.—At Bow-street on Monday the Charing Cross and Strand Electricity Supply Corporation (Limited) were summoned under the Public Health (London) Act for disobedience to an order requiring them to abate a smoke nuisance. Mr. H. Avory, who defended, said his clients had put in the best possible furnaces and burnt the best Welsh coal, mixed with coke, to diminish the smoke as far as possible. They were under a statutory obligation to give a supply of electricity, and he submitted that under Sec. 24 of the Act they were entitled to claim exemption from further proceedings. Sir James Vaughan adjourned the summons *sine die*, that the defendants' furnaces might be examined as to their efficiency by an expert to be nominated by the President of the Institution of Civil Engineers. This decision is in striking contrast to that of Mr. Slade in the prosecution of the City of London Co., recorded in our last issue.

Southampton.—The Tramways committee recommend the borrowing of £17,159, Mr. Manville's estimated cost of providing and erecting buildings, plant and feeders for the supply of electrical energy to the proposed electric tramways, extending the electric light mains to Shirley, adding two new boilers to the existing boiler house, and the extension of the mains to the Isolation Hospital, which requires current for about 400 8 c.p. lamps.

State Commercial Agents.—It was announced in Parliament on Monday that Her Majesty's Government contemplate the employment of three new British commercial agents abroad.

Stratton.—The Parish Council have been recommended in public meeting to adopt electric lighting.

Trade with Russia.—The U.S. Consul-General for St. Petersburg has recently sent home an interesting set of suggestions concerning trade with Russia. The report states that the population of the Russian Empire at the present time is 130,000,000, increasing annually by about 2,000,000. The area of the country is about 8,500,000 square miles, or one-sixth of the land of the globe. The country obviously constitutes a world large enough to command the attention of leading manufacturers and exporters, who are seeking markets for their surplus manufactures. Preference is given by Russian merchants to dealing direct with manufacturers rather than through agents in London or Hamburg. Catalogues and circulars intended for Russian merchant houses should be printed either in German or Russian (preferably Russian), should state price of the article offered, largest discount, and terms of payment in Russian values. The surest and best plan for introducing goods into Russia is to send samples by a thoroughly competent representative of the business it is proposed to push. An acquaintance with Russian, German or French, while not absolutely necessary, is of great assistance. During the winter season in Russia there are less than seven hours daylight, while between May and September there is no night. Russia offers a rich field for inventors, and manufacturers should study the markets and methods of doing business. It is pointed out that the number of representatives of American firms who visit Russia annually is rapidly increasing, and a long list of well known trading corporations in the States, including several in the electrical industry, accompanies the report. There is a large field in Russia for the introduction of electric street cars, elevators, electrical apparatus and supplies used in electric light, power and traction work. It is probable that immediately after the Paris exhibition of 1901 the goods exhibited by American firms will be re-shown in St. Petersburg and Moscow with the view of influencing orders for American goods.

Village Lighting.—The Tanfield (Durham) Council have arranged to light their district (including Tantobie, Mountsett, Clough Dene, Hobson and Tanfield Lea) electrically. Lighting is to be effected by incandescents, and it is estimated that a substantial saving will be effected in the annual cost.

Weston-super-Mare.—Major P. Cardew held an inquiry on Tuesday into the application of the Weston-super-Mare and District Electric Lighting and Power Syndicate for a provisional order, and into the proposal of the District Council to transfer their order to the Municipal Electric Power and Distribution Company. For the syndicate it was contended that the Council had forfeited their right to transfer their powers. Mr. F. E. Gripper, electrical engineer to the syndicate and managing director to Edmundson's Electricity Corporation, said he had made a rough estimate of the cost of carrying out an electric lighting scheme for Weston-super-Mare, and he thought £15,000 would be necessary to establish works sufficient to supply the compulsory area. He had recommended that £25,000 should be expended in laying mains during the first year, and a further sum of £10,000 for extensions during the succeeding two years. His company originally made offers to the Council, prior to the syndicate, but were informed that the Council intended to carry out the work themselves. The town clerk (Mr. Sidney C. Smith) stated that the terms offered by the Municipal Distribution Company had been accepted by the Council after due discussion. Mr. Offer, of the Municipal Company, repudiated an insinuation of having in any way used undue influence upon members of the Council. Mr. W. C. C. Hawtayne, consulting engineer to the Council, compared the terms submitted by the contending companies, giving preference to those offered by the Municipal Company. At the conclusion of the evidence, Major Cardew said he would report to the Board of Trade at an early date.

Windsor.—The public electric lighting was inaugurated on Saturday evening. Ten 2,000 c.p. arcs and eight 500 c.p. lamps have been erected. Some streets are to be illuminated by means of 16 c.p. incandescents. The Company's tender for the public lighting was only accepted about three weeks ago, in consequence of the Gas Company's proposal to make an increased charge of 12s. 6d. per lamp.

Woking.—By the casting vote of the chairman, the District Council last week decided not to purchase the undertaking of the local electric supply company.

COMPANIES' MEETINGS AND REPORTS.

Willans and Robinson (Limited).

The ordinary general meeting of Willans and Robinson (Limited) was held on Wednesday, at the Cannon-street Hotel, under the presidency of Mr. MARK ROBINSON.

The SECRETARY (Mr. C. S. Essex) having read the advertisement convening the meeting,

The CHAIRMAN said: Gentlemen, the last time I had the pleasure of addressing you, I think, I began by congratulating you on the fact that I had next to nothing to say, and that we had nothing to recommend but a dividend. In rising this time to move the adoption of the report and accounts, I have a different tale to tell, for though the dividend we recommend is happily larger than ever before, I fear you must this time listen to a long speech, for our recommendations are extensive. Growing prosperity has brought upon us necessities which six months ago we could only foreshadow to you, and which we then hoped to postpone somewhat longer. I allude, of course, to the extensions we propose to carry out, and to the additional capital they necessitate. It is a large subject, deserving full explanation by the Directors, and full consideration by us all, and I propose to defer it for a few minutes, so that we may deal first with those matters which really arise out of the half-year's accounts. First, let us congratulate ourselves upon a successful half-year, and the more so as its success is due to reasons which seem

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to promise even better results for the future. The half-year's net profit has risen from £17,521 to £22,628, an increase of over £5,000. As the paid-up capital increased during the half-year, more interest would be payable, even at the old rate, but even with this correction our real disposable increase in comparison with the preceding half-year, is over £4,000. Profit has increased much faster than capital, which is a true test of success, and one to which I would specially direct your attention. It may be objected that we are now reaping the benefit of capital subscribed in previous years, but this is only partially true; at any rate the improvement in profits has been for several half-years continuous, and not only continuous, but progressive. I think we may fairly attribute it to the success of our plans for increasing the output and diminishing the cost of production; in fact, we are entitled to claim that the advice we gave you four years ago, to sanction new works and a large increase of capital, has been justified by the results. As you know, we shall this afternoon again ask your sanction for a similar step, for reasons identical with those which gained your approval then, and with results which, we believe, will be as satisfactory. Turning now to the report, you will notice in paragraph 2 that the sum applied to depreciation is less than last time, viz., £5,013, against £5,591, which may look like retrogression in our accustomed methods of prudence. This change is due, however, to an alteration in accounts, by which we shall in future deal with the replacing of certain very perishable articles otherwise than through the depreciation account. There is in reality an increase in the total sum thus applied, as might naturally be expected, and not a diminution. Next, with regard to the dividend. When Directors propose a higher dividend than before, with plenty of reason to show for it, I believe they are expected to carry themselves as those assured of the praise of all men. But we know better, because we have taken this rash step before, and remember what happened then, when, after long consideration, and much carrying to reserve, we raised our modest 7 per cent. to 8. The great body of the shareholders undoubtedly approved, but at least one shareholder, of deservedly great weight in our counsels, thought we were rash, and said so. We think the result shows that we were not, and in the proposal we now make, viz., to pay 10 per cent. on the Ordinary shares, while carrying to the reserves, as you will observe, at the rate of no less than £11,000 per annum, we believe that we hold only a fair balance between the interests of the present shareholders and those of their successors. You will readily believe, gentlemen, without our assurances, that your Directors have no wish to face the unpleasantness of a reduced dividend in the future, and if we recommend 10 per cent. it is because we hope to keep it up. Assuming that this increase of dividend receives your sanction, we have a balance left which we propose to apply as set forth in the report. You will notice that we carry an increased sum to the reserve fund. It is but two years since we congratulated ourselves on carrying £3,000 in all to the debenture redemption fund and to the reserve fund combined. This time, for the same two objects, we jointly reserve £5,500, nearly twice as much, and we make still another reserve of £1,265 by increasing the sum carried forward; in fact, the profits reserved this half-year would be by themselves sufficient to pay an additional dividend on the Ordinary shares, at the rate of over 9 per cent. per annum. Further justification for a 10 per cent. dividend can scarcely be asked for. The paragraph showing the appropriation of the balance of the share premiums account will meet, we hope, with your approval. We have carefully considered the valuation of our Thames Ditton property and plant, and, in accordance with views expressed from the chair at former meetings, and received by the shareholders with approval, we have written it down sufficiently to discount any probable chance of a serious loss in disposing of the Ditton property, should we decide later (as no doubt we shall) to remove the whole of the plant to Rugby. We have paid all the expenses of our move, and we have still kept a little in hand for clearing up old matters which remain unsettled in connection with it. And finally we have added £5,000 to our already handsome reserve fund. The growth of the reserve fund, briefly mentioned in the report, gives us all, we think, solid ground for congratulation, and the fact that we have completed five years of existence gives us also some excuse for talking about it; it is the end of a quinquennial period, as the insurance offices say. It is a period we may be proud of. At the end of our first year's work, our paid-up share capital stood at just under £200,000, and our profit for the first year at a little over £14,000. At the end of the fifth year's work, the paid-up share capital stands at £300,000, and the profit for the year a little over £40,000. In the interval we have nearly doubled the capital, if we include the debenture capital, but we have nearly trebled the profit. In the prospectus we talked of earning not less than 12 per cent., available for dividend or reserve, upon £112,500 of ordinary capital; in our fifth year we have actually earned, though of course we have not wholly distributed, about 16½ per cent. upon £150,000 of ordinary capital. The horse-power ordered from us in our fifth year is more than double that ordered in our first year, These figures show not only great advance, but progressive advance; the increased amount of capital we have put into the business has justified itself, by improving the returns upon what was there before. It is with the conviction that the same result may reasonably be expected to follow, that we now ask your sanction to a further increase. That we may not have to trouble you again in the same way, we propose to raise the authorised share capital at once from £300,000 to £500,000, but we do not contemplate issuing at present more than £100,000. It would be idle to say that we look upon our business as anything but a highly progressive one, and in fact we believe that, under the conditions of trade which are now arising, advance is not only safe, but necessary; that for us, standing still means going back. Therefore, we do not pretend to any strong hope that we can stop at £100,000 for more than a couple of years or so, but you may rely upon our stopping there as long as we possibly can. It is difficult to give expression to views which, I can assure you, have been most thoroughly thought out and discussed, which shall be at once full enough to do justice to the arguments in support of them, and yet not so full as to put information unduly at the disposal of rivals. Very briefly, then, the position is this. We believe the electrical industry, whether in municipal hands or others, is about to make great advances. Much more horse-power will be wanted, and much larger engines. In past forecasts of the plant and space we should be likely to require in the future, we have been sometimes charged with rashness, but, in fact, we have been too timid, and as the size of the engines required for driving dynamos has increased, we have sometimes been found unprepared, and the first orders for the larger sizes have gone elsewhere. Happily we have been able to divert the new stream of business, or a sufficient part of it, back to our own shops, when, later, we have qualified ourselves to receive it. But we may not be so fortunate if we again neglect the signs of the times, while I am bound to say that even if the probabilities of very large work coming our way were much less than they are, it would still answer our purpose to enlarge our shops and put down heavier tools, if only for the excellent position it would put us in for taking orders for early delivery. As regards the foundry, that was knowingly built far below our expected requirements, and so we desire it to remain even after doubling it, for castings, at least of some classes, are easily obtained from other foundries. The main feature of our proposals, however, is that we propose to extend the machine shop chiefly by moving the boiler work altogether from Rugby, at some saving, of course, in the extensions at Rugby, but at the cost of building new works elsewhere. An excellent site has been secured near Chester on a 99 years' lease, at a satisfactory rental. It abuts on one side upon the North-Western Railway, and upon the lower part of the river Dee on the other, so that we shall be able to bring moderate-sized coasters, both sailing and steam, alongside our own wharf. A colliery siding connects with our own. We have secured 30 acres, so as to have plenty of room for storage, and for extensions. Of the advantages of the site, for the particular class of work intended, we think there will be little doubt, but perhaps some shareholders are surprised that we are willing to have our boiler works so far from Rugby. The explanation is that the two classes of work are very different, and, further, that the boiler works will require little or no commercial staff upon the spot, the commercial business of boiler selling, and its account keeping, being easily conducted at Rugby. The constructive staff will be wholly separate from that required for the engine business, and complete separation will be a gain to both, while we are confident that only a moderate amount of the Directors' time will be required at Chester. From the point of view of administration, we distinctly prefer a complete separation, and although the distance in miles is a good deal, that in time, between two principal stations on the same railway, is not excessive. It is also worth remembering that some day we may be glad to do some of the engine foundry work at the northern works, which has communication with Rugby by canal as well as by rail. Probably the crucial question you will desire to put is, why have we thus come to the conclusion that a business we intended to work as a mere adjunct to the engine business at Rugby, and which, in fact, we have practically not worked at all, is now worthy of works of its own, and of a large investment of capital? What has changed in the position? Gentlemen, the slow progress we have made in developing the Niclausse boiler business has been frequently commented upon, and none of us have liked it. Let me tell you the reasons, and since I have been largely responsible for the delay, allow me to state them as for myself, though I am sure my colleagues agree with me. The water-tube boiler of the various French types is essentially foreign in details, and though we took long to consider the design before adopting it, and put it through many tests, we never doubted that long, practical use in this country would show the need of changes of some kind. That, in our opinion, has happened. The design is all we thought it, and we believe there is no boiler in the world so good, but we wish to meet English views, or even English prejudices if you will, to modify some points of construction—not of design. It is not desirable to enumerate them, but the methods we wish to substitute are such as can only be carried out upon a large scale. That was not the case in the original construction of the boiler, which appealed to us as involving no speciality beyond high-class machine work, which we were just the people to undertake, while a comparatively few boilers could be made to nearly as good purpose as a great many. We had, therefore, to face this position: We have to make certain changes in the methods of manufacture, which in a sense disqualify the boiler from being made upon the scale, and by the means which we first contemplated; we cannot even begin small, as we always intended. At the same time, by excellent luck, we can find other uses for the Rugby boiler shop, with only small loss in shifting, or even in selling, the special boiler tools we have so far laid down. Shall we abandon the Niclausse boiler, and write off the not very serious amount of capital we have locked up in it? That was the question before us. But while our views about the construction of the boiler had developed, so also had the public demand for water-tube boilers, and so also had our views about the value of the Niclausse boiler. We had begun by believing it at least good enough to make upon the small scale; now we are confident that it is good enough to make upon the largest scale, and that a corresponding demand for it exists, and further that it promises to add to our business an even more profitable branch than we supposed at first. These, gentlemen, are in outline the reasons which have led us to propose to use the present boiler shop as an additional machine shop, and to start new boiler shops elsewhere, and so leave the Rugby site in its entirety for the growth of our engine business. Assuming that we have your approval so far, let me pass now to the mode of issue of the £100,000 of capital which we consider sufficient for the present. We propose to offer all the new shares *pro rata* to the existing shareholders, at the rate of one for every three of the same kind they now hold, and to issue half as Preference, and half as Ordinary shares. As you know, this requires a special sanction by the Preference shareholders, whose separate meeting is to follow this one, at four

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o'clock. We trust they will remember the rule that the better is the position of the Ordinary shares (and we aim by this scheme at improving that position) the greater is the value of the Preference shares. There will be more of them, but, if our hopes are well founded, they will each be worth more money. We propose to issue at the same moderate premiums as last time the £5 Preference shares at £6 and the £5 Ordinary shares at £7, and to let the shareholders have the benefit of the low rate of issue. Additional applications will also be invited, as usual, for such shares as may not be taken up by those to whom they are allotted. A question which has always come up in our issues has been whether payments should be made promptly or over a long period. Naturally, the Company does not want the money quickly, and, as we ask you to leave the matter in our hands, I may say that we incline to a long period, asking for the first £1 and the premium upon acceptance of allotment—£2, say, in October this year, and £2, say, in April next year. If our scheme is approved the Company will receive £30,000 in premiums, which we propose to dispose of on the same lines as before, first paying from them the cost of removing the remaining tools from Ditton to Rugby, should that course be decided upon, and the cost of moving the boiler tools from Rugby to the Northern site, then writing down any assets which may seem to require special treatment—as to which we suggest writing off "Patents" altogether, and not allowing that heading to arise again as an asset, unless under very special circumstances. These services might together absorb about one-fourth of the amount, leaving a very substantial sum to go to the reserve fund, which we might then hope soon to see in the neighbourhood of £60,000. The question does not arise directly now, but we ought, after this, to address our efforts to so increasing the reserve fund, that when we have the option of paying off the whole of the debenture debt (£100,000) in 1906, we may be ready to do so, and still leave the reserve fund larger than the goodwill. In fact, all this will come about, and more, if we but keep up our present rate of putting by. It is unnecessary to point out what a splendid position we should then find ourselves in, and the dream, after all, appears to be a very probable one. Next, permit me to refer to a personal matter in regard to increases of capital. Those shareholders who have studied the articles of association of the Company will be aware that those there called "the original Directors" (whose share in the management differs from that of our more recent colleagues; in fact, they might be fairly described by the words "managing Directors") receive salaries which increase with the capital of the Company. Roughly speaking, it is not an unfair arrangement, for a big concern takes more managing, and involves more real responsibility, than a small one. But we think there should be a limit to it, and it is right you should know that the "original Directors" have executed supplementary agreements with the Company to the effect that no increase of capital, subsequent to the £100,000 now proposed to be issued, shall carry with it any increase in their salaries, notwithstanding the rights conferred upon them by the articles of association. I have detained you so long, and there is so much to get through, that I refrain from commenting upon the items of the accounts, though pleased, of course, to answer questions. Several of the items of expenditure, which often provoke comment, are lower than usual, but probably such reductions, like the increases which preceded them, and may follow them, are accidental. With a growing business such items tend generally upwards, in spite of all watchfulness. I now move the adoption of the report and accounts

Mr. H. PERCY BOULNOIS seconded.

Mr. PEACH thought that the reserve fund was increased unnecessarily, and that the profits available for distribution among the shareholders were thus unduly curtailed. He moved an amendment, in effect, increasing the dividend payable on the Ordinary shares, remarking, however, that he brought the amendment forward more with a view of discussion on the subject than with any idea of getting it carried.

The CHAIRMAN said he could not put the amendment, because a larger dividend than that recommended by the Directors could not be paid.

Mr. PEACH (continuing) said that a reserve fund, as he understood it, had three uses—for equalising dividends, for providing against contingencies, and for providing capital for the purposes of the business at a time when it might not be possible to raise money on advantageous terms on the outside market. He thought the existing reserve fund was more than ample for the first two purposes, and that so long as any extension that was proposed was legitimate, there would be no difficulty in raising the capital that might be required.

A SHAREHOLDER pointed out that another use of the reserve fund, which Mr. Peach had overlooked, was to strengthen the financial position of the Company, and to enable the Directors better to meet competition.

Another SHAREHOLDER remarked that a very important point in connection with their having a good reserve fund was that it might enable them in a few years' time to pay off their debentures—a measure which would place the ordinary shareholders in a much stronger position.

The CHAIRMAN then put the motion, and declared it carried *nem con.* He afterwards proposed the declaration of dividends for the half-year ended December 31st last, at the rate of 6 per cent. per annum on the Preference shares, and at the rate of 10 per cent. per annum on the Ordinary shares. He remarked, with reference to the discussion which had just taken place, that some would always think that it was better to pay a larger dividend than to carry forward so much, while others would maintain, with equal force, that it was better to carry forward a larger amount instead of paying a higher dividend. Speaking as a Director, however, he might state that the possession of a good reserve fund greatly eased the responsibilities of Directors and facilitated their work if they had to go to their bankers.

Mr. R. S. ERSKINE seconded the motion, which was carried unanimously.

Sir Gilbert Augustus Clayton-East, Bart., and Mr. Thomas Orger Lazenby, J.P., were re-elected as Directors, and Messrs. Cooper Bros. were afterwards reappointed auditors.

The meeting then considered resolutions for increasing the capital.

The DEPUTY-CHAIRMAN (Sir Gilbert Clayton-East) said he had much pleasure in proposing the resolution increasing the capital of the Company. It was intended to extend the works at Rugby and to procure more and more powerful tools they proposed to use part of the new capital. Another portion of the capital they proposed to use in starting boiler works at Queensferry, on the Dee, near Chester. They had been slow about their boiler, but the time had not been lost or wasted, and had now arrived for them to commence its manufacture with confidence. He concluded by moving that the capital of the Company be increased to £500,000 by the creation of 40,000 additional shares of £5 each, half in Six Per Cent. Cumulative Preference and half as Ordinary shares, ranking for dividend *pari passu* with the existing Preference and Ordinary share capital.

Mr. A. R. HOLLAND seconded the motion.

Mr. PERCY HUNTER doubted the wisdom of imposing on the existing successful business additional capital in order to develop the boiler. He suggested that the boiler part of the business might be conducted by a separate company.

The CHAIRMAN said the work which had been done with the boiler hitherto had been experimental, but there was not the slightest notion of experimenting at the proposed new works. He believed the physiological moment for bringing out the boiler had arrived. He believed they had a most valuable property in their boiler, which would make profits quite out of proportion to the capital invested in it. The administrative expenses connected with the new enterprise would be small.

The resolution was carried *nem con.*

It was also resolved that the new shares should be issued at such times and at such premiums as the Directors should determine.

A meeting of the holders of the 30,000 Preference shares was held subsequently, at which it was resolved that the Company be empowered to create and issue the new Cumulative Preference shares ranking for dividend, and in all other respects, with the existing Preference shares in the Company.

A cordial vote of thanks to the Chairman and Directors brought the proceedings to a close.

National Electric Free Wiring Co. (Limited).

The first ordinary general meeting of this Company took place on Friday last, under the presidency of Mr. R. STEWART BAIN.

The SECRETARY (Mr. Percy B. Wilson) read the notice convening the meeting, and the report and accounts having been taken as read,

The CHAIRMAN said: Gentlemen, you will see from the report that the accounts are made up from the inception of the Company—that is to say, from the time of our taking over the business of the Electric Free Wiring Syndicate in July, 1897—to December 31, 1898, but as we did not start work until about the beginning of October, 1897, they really only cover a period of 15 working months. During that time we completed 976 installations, with an aggregate of 24,498 8 c.p. lamps. Of these 680 were free-wired installations and 296 were for ordinary contract work. The free-wired lamps numbered altogether 24,498, and the contract lamps numbered 9,623. We had in hand at the end of the year 423 orders, with the aggregate of 13,224 lamps, and since the books were closed we have received orders for 293 installations, with the aggregate of 5,563 lamps. Considering that the business is a new one, I think we have every reason to be satisfied with the progress it has made and the prospects it holds out for the future. In addition to the contracts we took over from the Syndicate, further free wiring contracts have been completed during the period under review with the Taunton, Canterbury and Lincoln Corporations and with the Blackheath and Greenwich, Fleetwood, and Prescot Electric Supply Companies, and since the end of the year we have completed contracts with the Corporations of Tunbridge Wells and Redditch and the Salisbury Electric Supply Co, and other contracts are in course of negotiation; in fact, we have heard this morning we have received another one. You will see from this that the business is increasing in a satisfactory manner. We have opened branch offices at Peckham, Shoreditch, Blackpool, Bradford, Canterbury, Lincoln, Prescot, Redditch, Taunton, Worcester, Tunbridge Wells and Salisbury. If you will turn to the accounts, you will see that during the period under review, our total revenue amounted to £3,244. 11s. 3d., and, of this amount, £735. 6s. 4d. represents the amount we received from revenue from the free wired installations. As we shall probably look to this item as our principal source of revenue in the future this amount does not, perhaps, look very large, but a more favourable aspect is put upon it when I tell you that out of 680 installations completed at the end of the year only 85 had been completed for a full year, and consequently had borne revenue for that period, the remainder having been completed during varying periods—a large proportion during the last quarter of the year—and that the revenue for the last quarter of the year amounted to nearly one-half of the total amount shown under this head. It will be apparent, therefore, that, having commenced the present year with 680 installations, all of which are revenue-bearing, our receipts from this source during the present year will show a considerable increase. Our profits from contracts and sales amount to £2,037. 4s. 4d. The Board consider this is satisfactory, considering that the business is a new one and that our men had to be trained to use the system of wiring. We have carried out some important contracts, as, for example, the wiring of the new General Post Office at Liverpool—the second largest in the kingdom—the West Ham Technical Institute (for the West Ham Corporation), the Derby Technical Institute (for the Derby Corporation), the Metropolitan Fire Brigade Headquarters (for the London County Council), and many others, and in almost every case our work has given complete satisfaction. We have had complaints—every new business must have complaints—and considering the difficulties we had to overcome in training our men to practically new system of

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wiring and the difficulty we have had in obtaining suitable men, I think we have done exceedingly well to have had so few. These complaints have now almost entirely disappeared, and we have lately received some excellent testimonials as to the quality of our work. Our system meets all the requirements of the new wiring rules which have been formulated since the introduction of the high-voltage system by various lighting authorities, and it is equal, if not superior, to any system for efficiency and durability. The work has been carried out at less cost than the figures in the prospectus, although we have installed a larger proportion of 8 c.p. lamps than we anticipated. The cost of installing an 8 c.p. lamp is practically the same as installing a 16 c.p., although the revenue received from a 16 c.p. is nearly double. The amount received for interest and discount was £414. 18s. 1d., and the greater part of this item was the interest received on money we had on deposit. We have only called up 10s. per share, and of this we had at the end of the year £20,000 on deposit. Our balance would have been less than this if we had not received some large payments on account of contracts towards the close of the year; but we were fortunate in placing the money at very good rates of interest during the time that money was comparatively dear. I might mention here that we hope to have a new source of revenue to show in this account next year. We find a number of people object to free wiring, but cannot afford to pay for the wiring of their houses in one sum, and for this class of customers we have adopted what is commonly known as the hire-purchase system, by means of which customers may become the possessors of their installations on easy terms of payment extending over one, two, or three years. Of course, these payments are under proper guarantees, and we have already every reason to be satisfied with the success of this new system. If you will now look at the debit side of the account you will see that the management expenses were £1,330. 7s. 10d., after charging the proportion of the expenses to free wired installations in accordance with the conditions of the agreements we have with lighting authorities. This proportion was carefully ascertained, and, after being checked by our auditors, carried to the proper account. The next item is Directors' fees. The Directors are entitled to £1,750 for the period, but the Board are more concerned in the ultimate success of the Company than in drawing the full fees to which they are entitled. (Hear, hear.) We have agreed to relinquish £1,375—nearly four-fifths of the total—and the amount drawn about recoups us for the out-of-pocket expenses in attending to the business of the Company. We have considered it prudent to at once commence writing off amounts for depreciaton. The prospectus stated that before a dividend was paid a sufficient amount was to be set aside yearly to form a sinking fund. We have not waited until we paid a dividend before commencing to write off certain amounts for depreciation, &c., and in writing off this amount of £233. 11s. 8d., our auditors are of opinion that we have done all that we could be reasonably expected to do in the first year. The balance (£1,222. 8s. 3d.) is, perhaps, better than it looks at first sight. The total amount of capital we have received is £51,060, out of this we had to pay £11,149 in cash to the vendors, and as we had £21,838. 17s. 7d. in hand at the end of the year, this leaves a sum of about £18,000, which we have used as working capital. Of this £14,000 was in our possession, and used by us for 17 months and £4,000 for five months. This balance of £1,222 would, therefore, nearly represent 6 per cent. per annum on the total capital employed and rather more than 2½ per cent. per annum on the total capital called up, a result which I hope you will consider fairly satisfactory on the first year's working of an entirely new company, for which the business had to be made. The Board consider it would be prudent to carry this amount forward to the credit of the current year. I have already referred to the principal items in the balance-sheet. The items I have not referred to are Stock at head offices and branches (£3,521. 0s. 9d). This is the amount of Stock certified by our manager and district managers at the various branches. The item of £3,951 represents the amounts due from our customers up to the end of the year, and are all certified as being good. I now formally move "That the report and accounts be received and adopted."

Mr. J. W. SWAN seconded the motion.

A SHAREHOLDER asked what was the object of calling up the second 5s. per share if there was not to be any use made of the money.

Mr. A. E. FRANKLIN asked how it was the profits appeared so small on the contract business, that 296 installations only produced a revenue of £2,000, considering the very large installations that had been in existence, and said he thought it would interest the shareholders to know what percentage of profit was made on these contracts.

The CHAIRMAN replied that the balance of £21,838 would have been considerably less if the Company had not received towards the end of the year considerable sums on account of large contracts which had been completed. The Board did not consider it desirable to distinguish in the accounts between the profits from the sales and from the contract work, because they did not wish to give their trade rivals information as to the profits that had been made on the contracts. On some of the large contracts completed in the early stages of the Company's existence only small profits were made, but they did not look for large profits in the early stages of their undertaking. The Government was satisfied with what had been done at the Liverpool Post Office, and he hoped it would lead to their receiving other contracts.

The motion was then put and carried unanimously.

The retiring Directors (Mr. James T. Jervis and Mr. W. R. Davies) were re-elected, and the auditors (Messrs. Monkhouse, Stoneham and Co.) re-appointed.

The meeting then became extraordinary for the purpose of considering a resolution—"That the name of the Company be and it is hereby altered from the National Electric Free Wiring Co. (Limited), to the National Electric Wiring Co. (Limited)."

The resolution was carried unanimously and a vote of thanks to the Chairman terminated the proceedings.

County of London and Brush Provincial Electric Lighting Co. (Limited).

The fifth ordinary general meeting of this Company was held on Monday, under the presidency of the Right Hon. Lord RATHMORE.

The SECRETARY (Mr. H. B. Renwick) read the notice convening the meeting.

The CHAIRMAN said: The report and accounts having been taken as read, I now propose their adoption. In doing so I hope that you will all agree that the story we have there told you is, on the whole, very satisfactory and encouraging in the proof it gives of steady progress in the development of the business and of the policy of our Company, and encouraging in the hopes it holds out of substantial results in the near future and of the still greater successes which we believe will ultimately follow. Of course, as you all know, this Company is still passing through that transition stage through which all undertakings similar to ours have had or have to pass, and during that transition stage checks, delays and disappointments are more apparent, and are more severely felt, than when the undertaking attains maturity. As to the accounts, the capital expenditure on our London stations amounted during the year to £148,798; but of that sum £104,906 was on account of mains, transformers, motors, and meters, of which £45,322 was in respect of Camberwell, and £12,828 of Eastern Holborn, much of which expenditure is, for the moment, necessarily not productive. In the case of Camberwell it is unproductive to any extent at present, owing to the delays which we encountered in obtaining access to that district—delays over which we had no control—and in the case of Eastern Holborn, on account of the fact that the supply has only been available for so short a time. But I am glad to say that those obstacles have now been overcome in Camberwell, and both in that district and in Eastern Holborn we anticipate satisfactory returns. "Expenditure on buildings" (£13,479) was the greater part in respect of works which were really carried out in 1897. The item of £20,395, under "Sundry debtors," are debts principally for current supplied to consumers, and interest and dividends owing to us by our associated companies. They were all good debts, and since the end of the financial year have been almost all collected. On the other side, "Sundry creditors" and "Bills payable," £45,007 are in respect of cables, conduits, and various kinds of machinery, as well as of other small accounts incidental to the ordinary working of our business, and they have either been already paid off, or are very shortly to be. "Loans against security" amount to £101,000, and this represents temporary advances which we have had from our bankers. Owing to the favourable state of the money market, and also, to a great extent, to the wise and able advice of our Vice-Chairman, Mr. J. B. Braithwaite, jun., those advances were obtained at very favourable rates of interest, and they have now been considerably reduced. With regard to our London stations, I will ask you to bear in mind that a great deal of the expenditure has been up to the present necessarily unremunerative. As time goes on that expenditure becomes daily more reproductive. Nevertheless, you will see that a gross revenue of £22,261 has been contributed from our two London stations, and that is after allowing for the considerable rebates which we make to some of our customers. I think you will agree that this sum of £22,261 is almost as much as we could fairly have expected from these two stations, bearing in mind, of course, what is the real key to the situation—that last year, 1898, was really the first completed year of working in the case of both stations. Coming to the net revenue account, so far as the North London station is concerned, I must frankly say that the proportion of net revenue to gross earnings is not very satisfactory, but there were many causes which contributed to this untoward result. In the first place the fuel bill, for reasons upon which I need not dilate, was much larger. Then the station lighting is also rather larger than we like to see. That was caused by the necessity of carrying on construction works during the night. Repairs is a rather large item, but I believe these repairs were of rather an exceptional character. But putting all those—what I would call rather excessive and accidental expenses—together, a considerable sum is arrived at, which would no doubt have gone to swell the net revenue of the North London station. One unsatisfactory item, rates and taxes, comes to nearly £1,000, or 10 per cent. of the gross earnings. However, on the other hand, I am glad to say there has been a saving already this year in the fuel bill in the North London station of ¼d. per unit, and Mr. Lawson, our engineer and manager, hopes before the end of the year this saving may amount to ½d. Turning to Wandsworth station, we consider the result of the working there altogether satisfactory, because we find that out of a total of £11,042 received £4,958 was clear profit, and at this station, again, we hope that further economies may be effected. Testing the case by the amount of sales of current, our engineer and manager estimates the sales in both St. Luke's and Holborn for the present quarter (March) will be equal to those of December quarter, generally by far the best quarter of the year, and he also expects that a like rate of progress will be maintained to the end of the year. If that expectation is fulfilled, he further estimates that the result of the sales of current in Wandsworth during the present year will be double what they were in 1898, and that in St. Luke's they will be three-fourths more. If these estimates should be fulfilled the result will be that, on the working this year, there will be a very much larger proportion of net revenue to gross receipts, as compared with last year. I, therefore, think that, although it cannot, perhaps, be said that the result of the working for the past year of our two London stations appears very large in the accounts, still last year was really the first completed year of those stations. Our policy has been to build and equip these two powerful stations in the best way possible, and to supply current from the mains in every part of the district we have secured which seems likely to be productive. The principal mains have now been laid or are being laid throughout all our districts in north and south London, and therefore, in the future, as custom arises, it will only be necessary to go to the expense of a short amount of subsidiary mains to connect that demand

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with the principal mains. I should like also to refer to the demand for and supply of current for power purposes; and here I may say that we have made rather a new departure. We have installed at our St. Luke's station, a plant to generate continuous current at sufficient pressure for distribution throughout the whole of our North London system, and in such a way that the cost of conductors afterwards will be but small. Already the results are, I think, satisfactory and encouraging, because we have had applications for motors amounting to the equivalent of about 300 H.P., and inquiries for several 100 H.P. additional; and negotiations for even larger supplies are under consideration. I need hardly point out what a great advantage such a source of custom will be in those stations where for lighting purposes the load in summer must necessarily be rather a light one. I must now refer to the Bill we have introduced into Parliament in connection with our London stations. That Bill will enable us to cope much better with the demand for current already developed, and which promises to become still greater in our existing districts, and also, of course, in any districts which we may hereafter acquire. It will also enable us to cross the intervening spaces which separate our central stations from our outlying districts. The Bill has passed its second reading in the House of Commons, and is now before a Committee, and I can say that we feel pretty confident the Bill will soon pass into law. Finally, with respect to our London station we hope when the next annual meeting comes round that all our mains will have been laid in the Camberwell, St. George the Martyr, and the St. Olave districts, and will have begun to bring in a substantial revenue to the Company. In the case of Camberwell there is a residential district which corresponds very nearly with the residential district of Wandsworth, of which we have had so good an experience, and in the northern part of the Camberwell district and in the districts of St. Olave and St. George the Martyr, we expect also rather a brisk demand for power. On the north side we expect also that the mains will by this time next year be laid through Western Holborn, and we hope to derive a substantial revenue from all these districts. Now, as to our provincial stations at Richmond, Dover, and Bournemouth. I always held that our investment at Richmond would turn out a good one, and that expectation has been most entirely fulfilled, for during the past year the Richmond Company, besides placing a considerable sum to depreciation account, and paying off a large part of the balance of losses on the working of the station before it came under our control, have been able to declare this year a dividend of 4 per cent., against 3 per cent. for last year. We have no doubt that the prospects of the Richmond station are excellent, and that our investment will considerably increase in value. As to Dover, the progress there has been very satisfactory. Here the gross revenue has increased by over £1,000. The remainder of the Ordinary shares, amounting to about £25,000, have been issued, part being allotted to this Company, and dealings in these shares have taken place at a premium of more than 20 per cent. Here, again, we feel confident that the value of our investment will considerably improve. As to Bournemouth, at the end of 1897 we transferred our shares in the old Bournemouth and District Company to the new Bournemouth and Poole Company, reserving for ourselves a considerable interest in the shares of the new Company. I am glad to tell you that there has been a rapid advance in the revenue of the Bournemouth and Poole Company, and they have been able to declare a dividend of 4 per cent. for the past year. There can be no doubt at all that, as time goes on—and especially in this current year—the value of that investment will also be considerably enhanced. It is evident that in these provincial stations we have very valuable assets; and several inquiries have been made to us already as to whether we would be disposed to part with our interests in those provincial companies. We have thought it better—and I hope you will agree with us—not to avail ourselves of these overtures, at any rate, for the present. I hope what I have said will have justified the view I took of the progress, the present position, and the prospects of our Company. A little while ago we applied for £200,000 in debentures at 4½ per cent., and offered £100 at £108. The issue was subscribed for nearly nine times over; the total amount offered to us for our £200,000 was £1,721,000. I think that that was very satisfactory. We were sorry it was not possible to give a larger proportion than we did to our own shareholders who applied. We must all regret that we have not been able to recommend a dividend for the past year, but that is an experience which has fallen to the lot of every company similiar to ours which has had anything at all of the same experience to go through. However, that period of preparation and probation for us is now almost ended, and we may look forward with confidence in the future to constant, steady and substantial success.

The DEPUTY-CHAIRMAN (Mr. J. B. Braithwaite, jun.) seconded the resolution, and said: You will all feel that the working of our London station is the key of our position. Our provincial investments have turned out extremely well, and no doubt we shall get substantial profits from them, but the future success of this Company must, after all, depend on the working of our London stations. If you compare what we earned at our London stations last year with what we earned this year, you will see that, broadly speaking, we have now doubled our net profit. Last year we earned £3,802. 14s. 10d., and this year £7,117. 12s. 1d. With respect to St. Luke's itself, we only commenced working at the beginning of October, 1897, and, therefore, that year's results only showed three months' working. For the previous nine months we obtained current from an adjoining company at wholesale prices and sold it at retail prices, naturally making a certain profit on it. This past year we have had to work the station for the twelve months, and the local authorities kindly put up our rates by about £1,000. The fact that we came out so nearly the same as we did last year, when we only bore the expenses of working the station for three months, is rather significant and decidedly encouraging.

Mr. HOLLAND said he had gathered from what had been said that the supply of power would play an important part in their Company, especially in St. Luke's and Clerkenwell. He understood that other companies were supplying electricity for power from their lighting plant and with the same mains, but that their Company had a special generating plant for electricity for power from special mains. Of course, this meant additional capital expenditure, and occupying of more room at the stations, which might ultimately be wanted for lighting purposes. He thought a little further information about it would be interesting. In the revenue account the item of gross profits stood at £3,996 and dividends receivable at £2,562. He took it these items represented the whole of the income derived from the associated companies, and the amount together was £6,558, against £7,767 in 1897. He noticed the investments in the associated companies had been increased by £34,178, and there were four associated companies.

Mr. LEIGHTON thought they would seriously feel the loss of revenue when the South London Company ceased to take current from them.

Mr. TUCKETT said the sum of £10,000 figured as calls in arrear, and he thought the people owing this money ought to pay interest on it. He had always had, and he still had, great confidence in the Company's future. Could the Directors see their way for carrying out installation on a system of deferred payments, as some of the other companies had done?

The CHAIRMAN, in reply, said the system of deferred payments had been considered by the Directors, and if it were desired by a considerable number of customers, they would favourably consider the application. The £10,000 was only due for calls in arrear on Dec. 31. Their Wandsworth station, when the South London Company ceased to take current, would suffer to that extent; but, on the other hand, he had the greatest confidence in the development of Wandsworth, where everything had turned out as favourably as they had anticipated, and where the demand was steadily increasing. When Wandsworth supplied Camberwell, St. Olave's and St. George the Martyr, the results would be still better. With reference to the new system of supply for power purposes, they had been obliged to adopt it under their Provisional Order for St. Luke's district; but, apart from that in anticipating the great demand that there would be for other than power purposes, they fully believed that this would prove a good investment as the demand for current grew. As to the gross revenue from the associated companies, the reduction would, he thought, be accounted for when they remembered that the Company had parted with a considerable portion of their interest in the Bournemouth Company, and that the profit made by them on that transaction in 1897 really added considerably to their revenue account for that year.

He then put the motion, and it was carried unanimously.

A resolution confirming the payment of the dividends was carried unanimously.

Lord Rathmore and Mr. F. W. Reynolds were reappointed Directors, and Mr. R. H. Marsh was reappointed auditor.

A vote of thanks to the Chairman terminated the proceedings.

EASTBOURNE ELECTRIC LIGHTING CO. (LIMITED).—The ordinary meeting of this company was held on Monday. In moving the adoption of the report, the Chairman (Mr. G. Boulton) referred to the satisfactory nature of the balance-sheet. They had always met under agreeable circumstances, which were even more agreeable on this occasion, when they met to offer the shareholders an increased dividend. The motion was adopted. A cordial vote of thanks was accorded the officials of the company, Mr. H. W. Wilkinson and Mr. H. Towner, for their past valuable services. Subsequently an extraordinary meeting was held to consider an amended offer of the Eastbourne Town Council for the purchase of the company's undertaking. The Corporation agreed to pay a sum equivalent to £2 for every £1 of capital subscribed and to pay a sum of £2,000 compensation to the officers of the company in the event of their services not being continued. The Corporation would also accept responsibility for the new machinery under order and not supplied. The total amount of the amended offer is about £83,000. The company would retain their reserve and depreciation funds, and would themselves discharge certain liabilities incurred on capital account; the date for the transfer to be Jan. 1, 1900, the company having all benefit of the present year's trading. This offer was eventually accepted.

GAS, WATER AND GENERAL INVESTMENT TRUST (LIMITED).—At the meeting of this company, the chairman (Mr. J. B. Braithwaite) announced that the Union Electric Light and Power Co. (an American venture in which this trust is interested) had perfected their electrical arrangements. They had an electric installation which does what he thought was not done in any other place in the world. They had the Pioneer Company's power, which they got from Ogden, 30 miles from Salt Lake City; they had the power which belonged to them previously in the big Cottonwood Cañon, which was some 20 miles away, and they had steam plant which belonged to them and the Citizens Co., with which they had previously amalgamated in Salt Lake City itself. Their electrical engineer (Mr. Hayward) had, during the year, managed to perfect the system in such a way that he had now in one small room, what he called the conning tower of a battleship, where, by moving a switch, he could get his power either from Ogden, the Cottonwood Cañon or the steam plant, thus giving great reliability in supply, and one of the results of that reliability had been that they had recently secured as customers one of the largest smelting works in that vicinity, which were taking 200 to 300 H.P. entirely on the ground of reliability of supply. For the twelve months ended Oct. 31 last, the gross earnings were £50,000, the expenses about £30,000, and the net profit about £20,000. In order to pay interest on the prior lien bonds £7,500 a year was required, so that the company was earning a very substantial surplus over the amount required to pay interest on these bonds. There was no doubt that they had got a fine property in Salt Lake City, and if it were not so far away, and they had not quite so large an investment in it, he thought they might possibly regard it as one of their best assets.

ISLE OF MAN TRAMWAYS AND ELECTRIC POWER CO. (LIMITED).—The annual meeting of this company was held at Douglas on Friday last. The Chairman (Mr. Alex. Bruce) commented on the increasing sources of

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revenue from the extension of the line from Laxey to Ramsey, and to the saving in expenditure which is expected by utilising water power, whereby the systems will be worked for eight months in the year without steam power.

LIVERPOOL DISTRICT LIGHTING CO. (LIMITED).—The annual meeting of this company was held last week. The directors' report stated that the company was now in a profit-earning state. The plant at the Waterloo generating station had been working up to its full output, and it would be necessary to increase the capacity of the station before next winter. The number of lights supplied at the beginning of the year was about 450 ; at Dec. 31 the equivalent of 2,059 16 c.p. lamps were connected, and orders had been since received for over 600 further. Owing to various causes the permanent plant at the Gateacre station was not connected up till the beginning of 1899. The number of lights there at the beginning of the year was about 200, which was increased at Dec. 31 to about 1,050. In order to meet the necessary expenditure upon these additions, a further call of £1 per share had been necessary. During the year the company had carried out a fairly successful contracting business. In October last the price of current in Waterloo was reduced from 8d. to 6d. per unit, when a system of free wiring was introduced. Since that time the number of lights supplied or on order had been nearly doubled, and further orders were being continually received. The number of consumers had increased during the year from 15 to 59. As the company had only been working twelve months, and most of that time under very light load, no provision had been made in the accounts for depreciation. The profit and loss account showed that the manufacturing and contracting business made a profit of £131. 11s. 5d., and the supply of electricity a profit of £11. 4s. 5d. The latter account set down £564. 19s. 4d. as cost of generation, £195. 1s. 3d. cost of distribution, and £230. 18s. 8d. proportion of general and management expenses, while the sales of electricity and meter rents brought in £945. 10s. 7d , and rents of property and service lines £56. 13s. 1d. In moving the adoption of this report, the chairman (Mr. A. H. Holme) said that the profit was certainly not very large, but the business was increasing, while the expenses would probably become little or no higher. Electric supply companies, when they became profit-earning, were not subject to such vicissitudes as railway and other companies. There was really a loss on the supply of electricity for the earlier part of the year, and the profit of the last three months had to be reduced to wipe off that loss. The low price at Waterloo had very much increased the consumption. They proposed to follow the same course at Gateacre from July 1 next. Their free wiring system was also one of the causes of the increased demand at Waterloo. Two new engines of the best type had been ordered for Waterloo, and would be ready by July to increase the supply. As to future profits, he thought they ought to be in a position to make between £1,200 and £1,500 next year. They had plenty of money to finish the work in hand and the mains in contemplation, but the time was coming when they must consider the desirability of extending their operations. They might increase their capital or issue debentures, as it was evident it would pay them to increase their business. The report was adopted.

RICHMOND (SURREY) ELECTRIC LIGHT AND POWER CO. (LIMITED).—The fifth ordinary general meeting of this company was held on Thursday last week. Mr. F. W. Reynolds, J.P. (chairman), presided, and said the steady progress shown in the company's business during the past three years has been maintained during 1898. The gross receipts were £5,119, an increase of £650. The gross revenue showed a corresponding increase, the figures being £2,874 for 1898, against £2,234 for 1897. Increased sums had been written off depreciation and suspense accounts, which amounted to £800, against £550 for 1897. Out of the balance (£1,340) a dividend on the ordinary shares at the rate of 4 per cent. per annum was recommended, leaving £129 to be carried forward. £6,452 has been expended during the year on capital account, making £51,246. £3,548 of the year's expenditure was in respect of mains. The equivalent of 2,840 8 c.p. lamps had been added to the mains during the year, against 2,387 during the previous year, making the total at Dec. 31 12,352. In order to meet this growing demand for current, considerable additions to the plant had been made during the year, including new boilers, and additional generating plant was now being installed. The members of the staff had always taken a special interest in the success of the undertaking, and the energy and ability of their engineer and manager, Mr. A. J. Lawson, and their secretary, Mr. H. B. Renwick, have greatly aided the development of the business. Considerable responsibility had been thrown upon Mr. M. Flemying, their resident engineer, during the past year, in consequence of the additional works referred to, but he had again proved himself equal to the occasion. Their best thanks were due to these gentlemen. The report and accounts were approved, and a vote of thanks to the Chairman terminated the proceedings.

ROBEY AND CO. (LIMITED).—The ordinary general meeting was held at Lincoln on Tuesday, the chairman (Mr. F. Andrew) presiding. The report stated that the profits showed a satisfactory increase, the output having been considerably greater. The outlay on labour-saving tools had been further increased, while the buildings and plant had been efficiently maintained out of revenue. The works were still fully employed with profitable orders, and future prospects were most encouraging. The directors have decided to recommend that the whole of the second issue of debentures be paid off, and that the whole of the remaining unallotted capital (2,327 shares) be offered at par to the existing shareholders, £5 per share only to be called up for the present. After allowing for depreciation, debenture interest, &c., there remained a balance of £24,147 available for division, and the directors recommended the payment of a dividend of 10s. per share, free of tax, on both preference and ordinary shares (£13,795. 14s.), placing to reserve £10,000, and carrying forward £351. 6s. The report was adopted.

NEW COMPANIES, STATUTORY RETURNS, &c.

AMERICAN AUTOMOBILE AND MOTOR CO. (LIMITED).—This company was registered on Feb. 28, with a capital of £80,000, in £1 shares (of which 60,000 are Preference), to manufacture, sell, let on hire and deal in motors of every description. waggons, carriages, &c., and to carry on the business of electricians, mechanical engineers, founders, &c. The first Directors are :—F. L. Gardner (chairman), A. Geiger, S. Schlesinger, Rene de la Ville Le Roulx, Baron Paul de Vilaine and Pelayo Soberano.

ANGUS ELECTRIC LIGHT AND POWER CO. (LIMITED).—This company was registered in Edinburgh on March 24, with a capital of £25,000, in £5 shares, to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, and manufacturers of electrical apparatus. The first subscribers are: G. Scott, J. Mitchell, V. Story, M.D., J. Valentine, J. Aird, A. Middleton and D. Campbell.

ARGENTINA ELECTRIC TRACTION CO. (LIMITED).—This company was registered on March 22, with a capital of £500,000, in £5 shares, to enter into an agreement with the Anglo-Argentine Tramways Co. (Limited) to construct, equip, maintain and work tramways under contract or as owners, and by electric or other methods of traction, and to carry on the business of electricians, electrical and mechanical engineers and contractors, suppliers of electricity, &c. The first subscribers are :—E. A. Lazarus, J. F. Nauheim, Albert R. Monks, A. Clements, H. F. Charles, J. T. H. Hudson, and H. A. Bumpus.

AUCKLAND ELECTRIC TRAMWAYS CO. (LIMITED).—This company was registered on March 22 with a capital of £150,000, in £10 shares (of which 7,500 are Preference), to construct, purchase, or otherwise acquire, equip, maintain and work (by electrical, mechanical or other power) any tramways or railways in Australasia, and to carry on the business of tramway and railway proprietors, carriers of passengers and goods, electrical engineers, contractors, electricians, suppliers of electricity, and manufacturers of electrical apparatus. The first subscribers are :—Sir C. Rivers Wilson, G.C.M.G., C.B., Sir C. W. Fremantle, K.C.B., Emile Garcke, John S. Raworth, Stephen Sellon, George Stevens, and C. S. Drummond.

AUTOMATIC MAGNETO-ELECTRO IGNITION CO. (FRANCE AND BELGIUM), (LIMITED).—This company was registered on March 3, with a capital of £15,000, in £1 shares, to enter into an agreement with Messrs. F. R. Simms and R. Bosch, and to carry on the business of proprietors and manufacturers of, and dealers in, motors, motor and other carriages, vans, waggons, &c , carriers of passengers and goods, electricians, electrical and mechanical engineers, machinists, &c. The first subscribers are: F. K. Cheese, J. W. Scott, A. E. Heming, H. M. Scott, B. C. Joy, A. B. Agacio, and E. E. Lefebure. The first Directors are: Frederick R. Simms (chairman), Robert Bosch and C. Harrington Moore.

JOHN JENKINS AND SONS (LIMITED).—This company was registered on March 16, with a capital of £70,000, in £1 shares, to acquire and take over the business of ironmongers, electrical and sanitary engineers, &c , now carried on under the style of John Jenkins and Sons. The first directors are :—John Jenkins, C. J. Clark, S. M. Waterfield and J. Jenkins, junr.

LUX SYNDICATE (LIMITED).—This company was registered on Feb. 28 with a capital of £2,030, in £1 shares (of which 30 are founders), to carry on the business of electricians, electrical, mechanical, metallurgical and chemical engineers, suppliers of electricity, manufacturers of lamps, globes, &c., metal founders, &c. The first subscribers are :—Mrs. C. Webb, R. Webb, S. H. Mills, C. M. Caplen, A. J. Hardy, T. W. Johnstone, and A. H. Atkins. Mr. Harry Godfrey is the first Director.

M'LAUGHLIN AND HARVEY (LIMITED).—This company was registered in Dublin on March 15th, with a capital of 50,000, in £10 shares (1,500 Preference), to carry on the business of electrical, hydraulic and sanitary engineers, &c. Mr. H. M'Laughlin is the first director.

TELEPHONE AND SWITCHBOARD SYNDICATE (LIMITED).—This company was registered on March 27, with a capital of £10,000, in £10 shares, to carry on the business of financiers, promoters of companies, contractors for public works, &c. The first subscribers are: W. H. Sinclair, A. E. Cowley, J. D. Haddock, E. Chevalier, W. Cawthorne, C. E. Craig and E. Griffiths.

YORKSHIRE DISTRICT LIGHT RAILWAY SYNDICATE (LIMITED).—This company was registered on March 9, with a capital of £50,000, in £1 shares, to promote, construct, purchase, or otherwise acquire any railways, tramways, or any works, rolling stock, or materials in connection therewith, to build and maintain electric and gas works, telegraph and telephone systems, &c. The first directors are :—J.W. H.White, S.W. Meyer, B. Day and E. Sisterson.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 2, 1899). Price of silver 27 7/8d. per oz. (March 29). Consols (2¾ per cent.) 110¾—110 7/8 for money, 110 13/16—110 15/16 for account ; 2½ per cent. 103½—103¾ (March 29), Stock Exchange Settling Days: Consols, April 6 ; Stocks and Shares Continuation Days, April 11 and 25 ; Ticket Days, April 12 and 26 ; Pay Days, April 13 and 27 ; Mining Share Carry over Days, April 10 and 24.

BABCOCK AND WILCOX (LIMITED).—The directors' report states that the profit for the past half-year (after deducting amount written off purchase of business account) amounts to £53,422, to which is added £5,912, brought forward, making £59,334. The following dividends are recommended :—Six per cent. on the Preference shares (less tax) and 20s. per Ordinary share (free of tax). After placing £2,500 to reserve, the balance (£9,334) is to be carried forward. A subsidiary company has been formed

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in Germany, under the style of the Deutsche Babcock and Wilcox-Dampfkessel-Werke Actien-Gesellschaft, to which the business of the Company in the German Empire and its German patents had been transferred as from July 1, 1898. The parent company has guaranteed a minimum dividend of 6 per cent. on the shares of the German company for five years.

CANADIAN NIAGARA POWER CO.—The Toronto *Globe* states that owing to the apparent inability of this company to fulfil the terms of its contract, at an early date a resolution will be passed in the Legislature to the effect that if the terms of agreement have not been complied with by Nov. 1, 1899, the concession shall lapse.

COMMERCIAL CABLE CO.—The directors' report for the year 1898, presented at the annual meeting held on 6th inst., stated that the net traffic earnings from cables and land lines increased $107,410 over the previous year. Out of the balance to credit of revenue there had been set aside $350,000 as addition to reserve, and $100,000 to the fund for insurance of stations, apparatus and repair steamer. The reserve now amounted to $3,037,103, and the insurance fund to $200,000. During the year there had been issued $2,000,000 Four per Cent. First Mortgage bonds. The proceeds from this issue had been partly expended in acquiring the undertaking of the Pacific Postal Telegraph Cable Co. and further extensions of land lines, adding to the land line system 3,449 miles of poles, 12,841 miles of wire, and 468 offices. After providing for all operating expenses and reserves, the balance of net revenue, including amount from previous year, amounted to $1,908,759, out of which had been paid interest on bonds and Debenture stock ($704,296), and dividends and bonus on capital stock ($800,000), leaving $404,462 to be carried forward.

DIRECT UNITED STATES CABLE CO. (LIMITED).—An interim dividend has been declared of 3s. per share free of tax (being at the rate of 3 per cent. per annum) for the quarter ending March 31, payable April 26.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH CO. (LIMITED).—Notice is given that on April 11 there will be drawn for payment 473 Five per Cent. Australian Government Subsidy debentures in this company.

WILLIAM JAMES GLOVER AND CO. (Established 1818), LIMITED.—The following notice, in connection with the recent issue of the prospectus of this company has been sent to us for publication:—

"William James Glover and Co. (Established 1818), Limited, Warrington and St. Helens.—*Notice.*—You have our authority to state that in consequence of the action taken against this Company by Messrs. W. T. Glover and Co. (Limited), of Salford, challenging the right of this Company to use the name 'Glover,' as applied to 'Electric' cable making, although the firm of Wm. Jas. Glover and Co. has been established for over 80 years, and long before Messrs. W. T. Glover and Co. came into existence, no allotment of shares will take place on the numerous applications sent in, and the money received on application will be returned forthwith.—Yours truly, WILLIAM JAMES GLOVER AND CO. (1818), Limited, F. G. FAIRHURST, secretary. By order of the Directors."

GREAT NORTHERN TELEGRAPH CO. (LIMITED).—The ordinary general meeting of this company will be held at Copenhagen on April 29.

NORTHERN COMMERCIAL TELEGRAPH CO.—A meeting of the provisional directors of this company will be held on April 11 at the offices of Mr. A. Fergusson, Q.C., Carlton Chambers, Ottawa, Canada.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has appointed April 6 as a special settling day in 233,334 £1 fully-paid Five per Cent. Cumulative Preference shares (Nos. 526,667 to 750,000) of *Doulton and Co. (Limited)*; Wednesday, April 12, for 5,530 £5 fully-paid Vendors' Six per Cent. Cumulative Preference shares (Nos. 1 to 5,530) and the further issue of 7,500 £5 fully-paid Six per Cent. Cumulative Preference shares (Nos. 20,001 to 27,500) of the *British Insulated Wire Co. (Limited)*; and Thursday, April 13, for £167,900 Five per Cent. Debentures (Nos. 822 to 2,500) of the *Brisbane Tramways Co. (Limited)*. These debentures have also been ordered to be quoted in the Official List.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Mar. 25	3 396	+ 26	11	44,791	+ 3,311
Blackpool Corporation...	,, 23	141	+ 14	51	17,930	+ 2,660
Blackpool and Fleetwood	,, 25	174	...	12	2,087	...
Bradford Corporation ...	...	...	...	...	...	...
*Bristol Trams & Carriage	,, 24	2,322	- 58	12	29,832	+ 1,550
City & South London Ry.	,, 26	1,108	+ 42	13	14,386	+ 494
Dover Corporation	,, 25	124	+ 13	51	8,895	...
Dublin United (Southern)	,, 24	557	+ 139	12	7,361	+ 2,611
*Glasgow Corporation ...	,, 25	7,550	+ 502	...	...	...
Liverpool Corporation						
Dingle Route	,, 18	480	...	18	9,400	...
Prince's Park Route...	,, 18	340	...	9	2,755	...
Liverpool Overhead Rly.	,, 26	1,269	- 34	13	16,911	- 532
*Sheffield Tramways.....	,, 26	1,046	+ 224	12	14,239	+ 3,005
*South Staffs. Trams.....	,, 24	543	- 20	12	7,093	+ 188

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price March 22.		Price Tuesday, March 28.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Five Days to March 28. Highest	Lowest
			TELEGRAPHS.					£ s. d.			
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	100	104	103	104	3 16 11	January and July	103	..
25,000	10	—	Amazon Telegraph	3	4	3	4	—	—	—	—
£125,000	100	5%	Do. 5 per Cent. Debentures	87	92	87	92	5 6 5	—	—	—
£905,560	Stock	24 0	Anglo-American	65	68	65	68	5 2 9	Feb., May, Aug., Nov.	—	—
3,047,220	Stock	30/0	Do. Preferred	116½	117½	117½	118½	5 1 11	,, ,,	118½	117½
3,047,220	Stock	18/0	Do. Deferred	13⅝	14½	14½	15	6 0 0	—	14⅝	14½
2'5,181	10	3/0	Brazilian Submarine	16	16½	16	16¼	4 4 10	Mar., June, Oct., Dec.	16½	16
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	110	114	110	114	4 7 9	June and December	..	..
10,000,000	$100	$2½	Commercial Cable Capital Stock	190	200	190	200	4 0 0	Jan., Apr., July, Oct.	..	..
£1,332,523	Stock	4%	* Do. 4 per Cent. Debenture Stock	105	107	105	107	3 15 2	,, ,,	106½	106⅝
16,000	10	8/0	Cuba Submarine Ordinary (Deferred)	9	10	9	10	7 0 0	February and August	..	..
6,000	10	10/0	Do. Preference 10 per Cent.	17½	18½	17½	18½	5 8 1	,, ,,	—	..
12,921	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 8 11	April and October	..	—
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	,, ,,	—	..
£30,000	50	4½%	Do. 4½ per Cent. Debentures	106⅞	109⅞	106⅞	109⅞	4 3 4	January and July	..	—
60,710	20	3/0	Direct United States Cable	12½	12¾	12⅞	12¾	5 2 0	Jan., Apr., July, Oct.	12⅞	—
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	103	106	103	106	4 5 6	—	—	—
£4,000,000	Stock	5%	Eastern Ordinary	180	185	180	185	3 16 1	Jan., Apr., July, Oct.	181½	180
£1,795,000	Stock	3½%	Do. 3½ per Cent. Pref. Stock	103	106	102	105	3 7 0	,, ,,	..	—
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	125	129	125	129	3 2 9	May and November	..	..
£89,900	100	5%	* Do. 5 per Cent. Debentures, 1899	99	102	99	102	4 18 0	February & August	—	..
250,000	10	2/6	Eastern Extension	18	18½	18	18½	3 15 8	Jan., Apr., July, Oct.	18⅛	18
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	129	125	129	3 2 3	February & August	125	—
£16,200	100	5%	* Do. 5 p. c. (Austin. Gov. Sub.) Deb. 1900 (reg.)	99	103	99	103	4 17 1	January and July	..	..
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	,, ,,	..	—
£35,100	100	5%	*Eastern and S. African 5 p.c. Mor. Deb., 1900 (reg.)	99	103	99	103	4 17 1	,, ,,	—	—
£46,500	100	5%	Do, (Bearer)	100	103	100	103	4 17 1	,, ,,	..	..
£100,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102	105	102	105	3 17 8	February & August	..	—
£400,000	25	4%	Do. 4% Mauritius Sub. Debs. (red.)	104⅞	107⅞	104⅞	107⅞	3 15 2	May and November	..	—
180,227	10	1/9	Globe Telegraph and Trust	12¾	13½	12¾	13½	3 17 4	Jan., Apr., July, Oct.	13½	12⅞
180,042	10	6%	Do. 6 per Cent. Preference	16¾	17½	16¾	17½	3 9 7	,, ,,	17⅞	16¾
150,000	10	5/0	Great Northern of Copenhagen	30	31	30	31	3 4 6	January, April, July	30⅛	—
£97,800	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.)	100	103	103	103	4 8 0	June and December	..	—
17,000	25	12/6	Indo-European	57	60	57	60	4 3 4	May and November	..	—
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	108	111	108	111	5 8 1	March & September	—	—
£140,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red)	103	108	105	108	3 14 5	June and December	—	—
11,889	8	4/0	Reuter's	6½	7½	6½	7½	5 6 8	April and October	..	—
8,381	£100 Cert.	6%	Submarine Cables Trust	140	145	140	145	4 4 3	,, ,,	..	—
15,609	10	—	West African Telegraph	2½	3½	2½	3½	..	—	—	—
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99	101	99	102	4 18 0	March & September	—	—
30,008	2½	—	West Coast of America	⅛	1	⅛	1	—	—	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	103	106	103	106	3 15 9	June and December	..	—
88,321	10	1/6	West India and Panama	1⅞	2⅛	2	2½	—	May and November	2⅛	2
34,563	10	6 0	Do. 6 per Cent. 1st Preference	10½	11	10½	11	5 9 1	,, ,,	10⅛	10⅝
4,669	10	6 0	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	,, ,,	..	—
£50,000	100	5%	* Do. 5 per Cent. Debentures	105	108	105	108	4 13 3	January and July	..	—
64,269	15	5,0	Western and Brazilian Ordinary	12¾	13½	12¾	13½	4 9 3	May and November	..	—
38,129	7½	3,9	Do. 5 per Cent. Preferred Ordinary	8½	9	8½	9	4 3 4	,, ,,	..	—
38,129	7½	1/3	Do. Deferred Ordinary	4⅛	4¾	4⅛	4¾	—	,, ,,	..	—
£289,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	106	109	106	109	3 14 1	June and December	..	..
£168,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.)	103	105	100	105	5 14 3	March & September	—	—

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price March 22.	Price Tuesday, March 28.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Five Days to March 28. Highest	Lowest
			TELEPHONES.						
44,000	£5	4/0	Chili Telephone (fully paid)	2½ 3	2½ 3	6 11 4	August	2½	—
214,850	£1 10s.	1½d.	Consolidated Telephone Const. & Manufacturing	⅞ ⅞	⅞ ⅞	6 7 0	July	—	—
22,000	5	6/0	Monte Video Telephone 5 per Cent. Preference	¾ 1	¾ 1	5 0 0	October	—	—
490,000	5	2/0	National	4½ 5	4½ 5	6 0 0	February & August	4 13/16	4¾
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	12 14	11 13	4 6 9	" "	12½	12½
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	12 14	11 13	4 6 9	" "	13⅛	12
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	4¾ 5½	4¾ 5½	4 15 2	" "	4¾	—
1,999,471	Stock	2½%	* Do. Debenture Stock 2½% (red.)	99 101	99 101	2 9 9	June and December	..	..
71,804	1	0/4	Oriental	¾ 1	¾ 1	5 0 0	April and October	⅛	..
58,000	5	6/0	United River Plate	4¾ 5½	4¾ 5½	5 14 3	July	5⅛	—
£161,788	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	104 107	101 107	4 13 11	June and December	—	—
			ELECTRICITY SUPPLY COMPANIES.						
100,000	1	—	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. '10s pd.	⅜ ½	⅜ ½	—	—	—	—
6,000	10	..	Bournemouth and Poole Electricity Supply Ord.	13½ 14	13½ 14	—	—	—	..
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10½ 11½	10½ 11½	4 4 0	—	—	—
20,000	5	5/0	Charing Cross & Strand Electricity Supply Corp	11½ 12½	10 12	3 6 8	February & August	11½	..
20,000	5	2/3	Do. 4½ per Cent. Preference	6 6½	6 6½	3 9 3	" "	—	—
£34,000	5	3 6	Chelsea Electricity Supply Ordinary	8 9	8 9	3 6 8	March	8 1/16	—
£100,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	114 116	114 116	3 18 1	June and December	..	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red.)	101 105	101 105	4 17 7	April and October	—	..
50,000	10	7/0	City of London Elec. Lighting Ord.	14 19	17 18	3 6 8	February & August	18½	17
40,000	10	6%	Do. 6% Cumulative Pref.	15 16	15 16	3 15 0	January and July	..	—
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	124 129	124 129	3 17 10	June and December	..	..
40,000	10	..	County of London & Brush Prov. Ord. (1 to 30,000	11 12	11 12	—	—	11⅝	11½
20,000	10	6/0	Do. 6% Cumulative Preference	14 15	14 15	4 0 0	March & September	—	..
19,661	5	3/6	House-to-House Electric Lighting Supply Ord	8½ 9½	8½ 9½	3 13 8	—	..	..
12,000	5	3/6	Do. 7 per Cent. Preference	9 10	9 10	3 10 0	March & September	9⅝	9½
15,000	5	10%	Kensington and Knightsbridge Ord.	13 14	13 14	3 18 7	—	—	—
10,000	5	6%	Do. 6% 1st Pref.	7⅝ 8½	7½ 8½	3 14 9	January and July	—	—
110,000	3	..	London Electric Supply Ordinary	3½ 4	3½ 4	—	—	—	—
48,050	5	8/0	Do. 6% Preference	6½ 7	6½ 7	4 5 9	—	—	..
£100,000	Stock	..	Do. 4% 1st Mort. Deb.	105 107	105 107	3 14 9	Mch., June, Sept., Dec	106	—
62,500	10	5/0	Metropolitan Electric Supply Ordinary	16 17	14½ 17½	3 8 7	April and October	17½	16½
27,500	10	—	Do. (£7 paid)	12 13	12½ 13½	—	—	13	..
£330,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117 120	117 120	3 15 3	June and December	118	117½
6,452	10	6/0	Notting Hill Electric Ordinary	16½ 17½	16½ 17½	3 8 7	March	—	—
10,000	5	—	Oxford Electric Ordinary	6¾ 7½	6¾ 7½	—	—	—	..
275,000	1	—	Rand Electric	¾ 1⅛	¾ 1⅛	—	—	—	..
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'c'n, Ltd., 5% 1st Mor. Deb	83 93	83 93	5 8 1	—	—	—
150,000	£100	6%	Royal Electric Company of Montreal Shares	170 190	.. 190	4 5 1	—	—	—
180,900	100	4½%	* Do. 4½% 1st Mort. Debs.	107 109	.. 109	4 3 9	April and October	—	—
31,980	5	9/6	St. James and Pall Mall Electric Ordinary	17 17½	17 18	4 0 7	February & August	18	17½
20,000	5	3/6	Do. 7 per Cent. Preference	9 10	9 10	3 10 0	" "	..	..
65,000	5	..	South London Electric Supply Ordinary (£3 paid)	3½ 3⅝	.. 3⅝	—	—	—	..
79,900	5	7/0	Westminster Electric Supply Ordinary	15½ 16	15½ 16½	3 12 9	March & September	16	15½
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
80,000	2	1/2½	Brush Electrical Engineering	1⅞ 2⅛	1⅞ 2⅛	2 16 5	—	2 1/16	2
80,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2⅛ 2⅜	2⅛ 2⅜	5 1 1	—	—	—
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	110 114	110 114	3 19 2	February & August	..	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	103 105	103 105	4 6 7	June and December	..	—
£30,000	5	5/0	Callender's Cable Construction	12½ 13½	12⅛ 13⅛	5 0 0	" "	12½	—
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	114 117	114 117	3 17 5	November and May	..	—
200,000	1	9/16d.	Castner-Kellner Alkali Co. (fully paid)	1⅛ 1⅜	1⅛ 1⅜	5 16 5	—	..	—
50,000	1	—	Chadburn's Ship Telegraph Ordinary	1½ 1⅝	1½ 1⅝	—	—	—	—
50,000	1	7½d	Do. 6 per Cent. Cumulative Pref.	1⅛ 1⅜	1⅛ 1⅜	4 7 3	—	1 3/16	—
32,098	3	1/6	Crompton and Co. (Nos. 1 to 32,098)	3½ 3¾	3½ 3¾	4 0 0	—	—	—
£100,000	100	5%	* Do. 5% First Mort. Deb. (red.)	93 101	98 101	4 19 8	January and July	—	—
99,261	5	1.9½	Edison and Swan United ("A" Shares) (£3 paid)	2⅜ 2½	2 2⅛	7 1 8	February & August	2⅜	—
17,189	5	2/8½	Do. (£5 paid)	4 5	4 5	6 11 0	" "	—	—
£244,023	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	97 99	97 99	4 1 8	June and December	99½	—
17,400	5	5%	Edmundson's Electric Corporation Ord (fully pd)	5½ 5⅝	5½ 5⅝	4 6 11	Half-yearly	—	—
112,100	2	1/2½	Electric Construction Co. (Limited)	2½ 2⅝	2⅜ 2⅝	4 14 10	January & July	2⅝	—
25 000	2	2/9½	Do. 7 per Cent. Cumulative Pref.	3 3⅛	3 3⅛	4 0 0	July	..	—
£140,300	Stock	4%	Do. 4% First Mortgage Deb. (red.)	103 105	103 106	3 15 10	January and July	105½	103½
21,196	1	—	Elmore's Patent Copper Depositing	⅜ ⅝	⅜ ⅝	..	—	—	—
12,500	10	20/0	Henley's Telegraph Works Ordinary	26 27	26 27	5 3 8	February & August	29 1/16	26
8,000	10	7/0	Do. 7 per Cent. Preference	18½ 19½	18½ 19½	3 11 10	" "	19½	—
£80,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	112 115	112 115	3 19 10	" "	—	..
80,000	10	15/0	India Rubber, Gutta Percha, &c., Works	21½ 22½	21½ 22½	4 8 11	" "	22 1/16	21½
200,000	100	4%	Do. 4% First Mortgage Debentures (red.)	102 106	101 105	3 16 2	March & September	..	..
27,380	12	24/0	Telegraph Construction and Maintenance	38 42	38 42	4 5 9	March and July	43	38½
£...,...	100	..	Do. 4 per Cent. Deb. Bonds, 1909	104 107	105 103	3 14 3	..	106⅜	103⅛
£17,40.	5	—	Do. Manufacturing Ordinary	9½ 10½	9½ 10½	—	—	—	..
13,4.0	5	..	Do. 5% Cum. Pref.	5⅝ 6⅛	5⅝ 6⅛	4 0 0	—	—	—
£50,000	5	4/0	Willans and Robinson Ordinary	9½ 9⅝	9½ 9⅝	4 2 1	April and October	9⅝	9⅝
£30,000	5	3/0	Do. 6% Cumulative Preference	7⅛ 7⅝	7⅛ 7⅝	3 17 5	" "	7 1/16	—
£3.0,000	Stock	4½%	Do. 4½% First Mort. Debs	106 108	106 105	3 18 8	May and November	—	—
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	8/0	Blackpool and Fleetwood Tramways	24½ 25½	24½ 25½	3 2 6	—	—	—
50,000	10	7/-	Bristol Tramways and Carriage	23½ 24½	23⅝ 24½	3 1 1	—	—	—
£30,410	Stock	4%	Do. 4% Debenture	120 121	120 121	3 6 2	—	—	—
80,000	10	..	British Electric Traction Ordinary	19½ 20	19½ 20	..	—	20½	19⅝
10,000	10	6/0	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm. pd.)	13½ 14½	13⅝ 14½	4 4 11	—	14½	13⅝
£100,0 0	Stock	6/2·3	Do. 5% Perp. Deb.	123 129	123 129	3 17 6	—	123	—
40,000	5	..	Buenos Ayres & Belgrano 6% Cum. Pref. (£3 paid)	3⅝ 3¾	3⅝ 3¾	..	—	3⅝	3⅝
27,500	5	..	Do. do. do. (fully paid)	4⅝ 4¾	5 5⅛	..	—	5	4⅝
£260,000	Stock	5%	Do. do. 5% Deb.	108 111	108 111	4 11 11	..	108½	—
£35,250	10	3/0	Central London Ordinary	9½ 10½	9½ 10½	2 18 6	June and December	—	..
178,393	10	1/9½	Do. (£8 paid)	7⅝ 8½	7⅝ 8½	2 13 2	" "	—	..
£231,000	Stock	2%	City and South London Railway Con. Ordy.	68 70	68 70	3 0 9	January and July	69	—
22,500	10	..	Do. Ordinary (£5 paid)	4⅝ 5⅛	4⅝ 5⅛	..	..	..	..
9,251	10	5%	Do. 5% Perpetual Preference	14½ 15½	14½ 15½	3 5 7	January and July	—	—
117,701	Stock	4%	Do. 4% Perpetual Debenture	133 135	131 133	3 19 7	May and November	—	—
£0,000	10	7½%	Imperial Tramways Ordinary x new	24½ 25½	24½ 25½	2 13 6	March & September	—	—
10,000	10	6%	Do. 6% Preference x new	16 18	16 18	3 12 9	" "	—	—
£71,000	Stock	4½%	Do. 4½% Debenture x new	118½ 119½	118½ 119½	3 15 4	.. ..	—	—
61,...	10	4%	Liverpool Overhead Railway Ordinary	10 10½	10 10⅛	3 9 2	February & August	—	—
19,000	10	5%	Do. 5% Preference	14⅝ 14⅞	14⅝ 14⅞	3 7 3	" "	—	—
128 000	Stock	4%	Do. 4% Debenture	106 108	106 108	3 14 1	January and July	—	—
90,000	5	2/8½	New General Traction 6% Cumulative Pref	5 5⅛	5 5⅛	5 9 1	—	—	—
£549,000	Stock	5%	Waterloo and City Ordinary	109 112	109 112	2 13 7	June and December	—	—

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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CONTENTS OF THE CURRENT NUMBER.

NOTES	819	Reviews	831
Meetings of Scientific Societies	821	The Hissing of the Electric Arc. By Mrs. Ayrton. Illustrated. Concluded	832
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe	822	Recording Instruments for Testing Insulation. Illus.	836
Magnetic Leakage in the Alternating Current Transformer. By A. Russell, M.A. Illus. Concluded	823	A New Resistance Box. Illus.	837
The Induction Motor. By E. Wilson. Continued	824	Correspondence	839
Wireless Telegraphy	827	Trade Notes and Notices	842
Electricity Works Accounts	828	Companies' Meetings and Reports	847
INDUCTION MOTOR PROSPECTS	830	New Companies, &c.	848
		City Notes	849
		Companies' Share List	850

NOTES.

WE have received from Prof. J. A. FLEMING a copy of a wireless telegram sent to him by Signor MARCONI from Wimereux, near Boulogne. The message runs as follows:—"To Professor Fleming, University College, London. Glad to send you greetings conveyed by electric waves through the ether, from Boulogne to South Foreland, twenty-eight miles, and thence by postal telegraphs.—MARCONI." Since the receipt of this telegram Prof. FLEMING has been experimenting at the station at South Foreland lighthouse, and an account of his experience there, together with some pertinent observations on the subject generally, are embodied in a letter which we reprint from *The Times*. We heartily endorse the PROFESSOR'S view that the time has arrived for a little more generous appreciation of Signor MARCONI'S work by his scientific contemporaries.

WHEN it is remembered that MARCONI freely admits that his system of telegraphy is founded on a scientific basis which he did not discover, but did utilise and apply to practical purpose, the jealousy that has been scarcely concealed in certain scientific quarters is not to be condoned. Just as the work of OERSTED, FARADAY, DANIELL and other scientific workers detracted nothing from the merit of practical originality in the inventions of COOKE and WHEATSTONE, as telegraphists, of the early inventors of dynamo machinery—too numerous to enumerate—and of BELL and HUGHES, in the field of telephony; so the scientific labours of HERTZ and his successors leave an abundant meed of praise for the practical success attained by MARCONI in applying their discoveries to commercially useful purpose. Had MARCONI not justified himself as a "practician," he would thus far have established no claim to recognition. The success of his efforts not only differentiates him from his contemporaries, it also elevates him to the proud position of pioneer of the new telegraphy.

ALREADY, however, one of the practical limits to wireless telegraphy, as at present practised, is making itself manifest in the Marconi group of signal stations to the south-east of this island. "At present," writes Prof. FLEMING, "all signals sent from the South Foreland to France affect the receiver on board the Goodwin lightship." The PROFESSOR thinks that this "offers no difficulty," and he suggests a means for discriminating between the signals. There is a difficulty left untouched, however, in the impossibility of sending messages simultaneously and independently to or from the lightship and France. An uninterrupted stream of messages between the stations on opposite sides of the Channel would render completely useless the apparatus on the lightship, which would never be able to get a word in anyhow. Curiously enough, the first intimation at Wimereux that the apparatus erected there was in working order took the form of harmless eavesdropping, the messages between the two older stations being overheard; indeed, the Wimereux staff read off the message "We are going to speak to Boulogne at five o'clock"—this having been sent from the lighthouse to the lightship.

THIS result, of course, had been foreseen; but its actual occurrence emphasises the need for a means for confining a Marconi message strictly to its proper path. The sphere of influence of a wireless telegraph station has a fatal tendency to become too literally spherical. Messages scattered broadcast not only waste energy by travelling with futile persistence towards celestial space; they do positive mischief by interrupting the everyday business of irrelevant stations in the vicinity. If the Marconi waves would confine themselves strictly to business, the prospects of wireless telegraphy would be enormously brighter than they now are. We are not without hope that ere long a satisfactory method of thus restricting their activity will be discovered.

CURIOUSLY enough, the diffusion of ether waves which constitutes the defect just described is, in another application of wireless signalling, one of its most valuable features. We refer to danger signalling from lighthouses, &c. By a striking coincidence the commencement of cross-Channel wireless

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telegraphy, and its successful performance even through many miles of sea fog, has taken place simultaneously with one of the most lamentable wrecks of recent years—the loss of the "Stella" on the Casquets. Were every island lighthouse surrounded by a halo of warning ether waves, and every sea-going vessel provided with a simple but efficient apparatus responding to the presence of such waves, disasters of this description would occur with much less frequency. Nor is this the only danger which could be eliminated, for, by providing every ship with a transmitter as well as a receiver, the risk of collision between two vessels would by a similar process be minimised. Difficulties of detail, doubtless, there are in regard to the carrying out of this scheme, but the broad principle is almost self-evident. What is now needed is an authoritative, and preferably international, committee of inquiry as to the most efficient means of warning vessels of invisible danger.

Capt. B. Baden-Powell relates an anecdote, in a letter to *The Times* of Wednesday last, which illustrates the unusual character of any defect or breakdown at a Marconi station. He was staying at the French station at Wimereux at the time of the occurrence:—

> Through Mr. Marconi's kind hospitality I have had the opportunity of watching message after message pass throughout the day, at all times and under all conditions, transmitted by different senders, even including myself. Scarcely a single letter has gone wrong, even though experiments were frequently tried to test new instruments or altered dispositions. A little anecdote of my experiences may not be out of place as instancing the rarity and strangeness of a breakdown. About ten o'clock one night, we at Boulogne attempted to ring up the South Foreland. There was no reply. Doubtless, we thought, the attendant had quitted his watch for a few minutes. After an interval we rang again, but answer came there none. Could the instrument be out of order? A careful examination was made, tests were applied, but no fault could be detected. Could anything be wrong at the other end? Again and again we rang up, but all to no good. A fresh receiving instrument was installed and all the wires carefully overhauled. We went out into the black darkness of the night and tested and pulled at the vertical wire suspended from the great mast outside to make sure that was intact. An hour or more passed, the greatest anxiety being displayed by the three officials. It had to be owned that the system had broken down! And there we sat in blank amazement, utterly at a loss to account for this apparent disaster to that great system in which we had all put such faith. Suddenly the bell rang! A short formal message followed, and then, in reply to our eager enquiries, came forth the prosaic message "Have been away to supper"! That is an incident that is not likely to occur again, for I expect that the epicurean telegraphist has since had almost as anxious a *quart d'heure* as did Mr. Marconi that night.

We have sometimes wondered what could be the *raison d'être* of the Wembley Tower; and the explanation that it is in imitation of the Eiffel Tower only shifted back the difficulty without solving it. Only as we go to press does a rumour reach us which throws a flood of light on the question, and turns our perplexity into admiration. These gigantic structures, reminiscent of Mr. Wells' uncouth Martians, were predestined by thoughtful fate to serve as masts for Marconi stations, to provide wireless communication between London and Paris. At any rate it is rumoured that the Eiffel Tower is about to be used for telegraphing in this way; and, doubtless, it was only the present incomplete state of the Wembley Tower that led to the South Foreland lighthouse being selected in preference to that hideous disfigurement of an otherwise picturesque landscape north-west of London. Building Eiffel towers for Marconi stations would be as extravagant a proceeding, however, as burning down the house to get roast pig. So when the 1,100ft. mast talked of for London to New York telegraphy comes to be actually erected it will doubtless prove to be a much less substantial affair. By-the-way, we hear rumours even of this feat being attempted in the quite near future. Much, however, must depend on the success met with in the experiment about to be undertaken with the Eiffel Tower.

Wireless telegraphy an accomplished fact, wireless telephony obviously suggests itself to those seeking fresh fields and pastures new. Where Hertzian waves are made the vehicle, and the coherer is the means of receiving the transmitted energy, the difficulties of telephony are immensely greater than those of telegraphy. The high frequency of sound waves makes it impossible for any known form of coherer to respond to ether waves correspondingly frequent; while their irregularity, when speech is the sound to be transmitted, would render syntony impossible, even were transmission an accomplished fact. Rumour reaches us of successful wireless telephony in Belgium; but, from intimate acquaintance with the difficulties of the problem, we judge that the method adopted, if this rumour be true, was not one involving the use of the coherer. By leakage, or by magnetic or electrostatic induction, telephony without connecting wires is, of course, possible and, within limits, commercially practicable. Its range of usefulness, however, is greatly restricted. Indeed, the immediate prospects of wireless telephony would appear to be decidedly inferior to those of the Marconi system of telegraphy.

It is once more our unpleasant duty to point out the deficiency and imperfection of the knowledge possessed by Mr. Provand and his American correspondent with regard to matters telephonic in the United States. The £16 tariff at Baltimore, referred to in his letter in another column as being lower than the charges for cities of a similar size in England, is *not* lower, and is, moreover, for a *single-wire* service; a metallic-circuit connection at Baltimore costs $125—say £25—per annum. Mr. Provand appears to be quite unaware that the charge for an underground metallic circuit connection in Liverpool, Manchester and other large towns in this country is £10 per annum for the first connection and £8. 10s. for additional connections; and, moreover, that the tariff in London on a five-year agreement is £17 per annum for one metallic circuit line, £12. 15s. for each additional line, and £10 for private houses. The extremely low charges quoted by Mr. Provand are admittedly those charged by the "independent" companies in the United States, for connection to small exchanges which serve limited areas and have practically no facilities for interurban communication. Only a small proportion of the telephonic business is in the hands of these companies; by far the majority is controlled by the American Bell Company, whose charges Mr. Provand admits to be higher than those obtaining in Great Britain and Ireland. The tariff at Baltimore appears also to be the lowest charge for a large city that Mr. Provand's correspondent has informed

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him of. As to the question of municipal corruption, Mr. PROVAND puts himself to some pains to convince us that the municipal authorities in New York are corrupt in their dealings with the telephone company. Surely to place the local control of the telephone into the hands of the municipalities themselves will not lessen the danger of corruption. Further consideration of such matters as these is, however, outside the province of a technical journal.

THE first and all too brief public appearance of the Nernst lamp last February has given rise to expressions of opinion on all sides, both favourable and unfavourable, as to the possibilities of the promised rival to the carbon filament, arc and Welsbach lamps. Mr. T. J. JOHNSTON, a letter from whom will be found in another column, criticises the lamp with considerable harshness, and, we may even say, with some injustice. Although Mr. JOHNSTON attempts to show that the Nernst lamp has a past, we believe that this type of lamp has also a future, but it is not our intention at the present stage in the development of the lamp to consider such criticisms in detail—this task may be left to its introducers. We feel bound, however, to point out some inaccurate statements in Mr. JOHNSTON's letter. In the first place, he quotes us wrongly. We did not say that "Mr. SWINBURNE's neglect of the continuous current side" was "significant," but merely that he was reticent as to the relative merits of the lamp on continuous and alternate circuits. Then, of course, we cannot concur as to the prospect of an "apparent obsolescence of continuous current" in the near future. And lastly, Mr. SWINBURNE both exhibited and described "something better than spirit lamps and matches as igniters," and Nernst lamps were on view working at 100 volts and not 500 volts pressure. Such inaccurate statements as these certainly tend to lessen the force of Mr. JOHNSTON's criticisms.

Cable Interruptions.	Date of Interruption.
Paramaribo—Cayenne	Feb. 10, 1899
Cayenne—Pinheiro	Mar. 10, 1899

Electric Cabs in Paris.—Some 70 new electric cabs of the landau type were put on the Paris streets on Sunday, and were well patronised by the public.

The Proposed Memorial to Gaulard.—M. Sartiaux, president of the committee which has been collecting subscriptions towards raising a memorial to Lucien Gaulard, the transformer pioneer, announces that a sum of 2,560f. has been received.

The Nernst Lamp in Germany.—The *Elektrotechnische Rundschau* states that negotiations are in progress between the Allgemeine Elektricitäts Gesellschaft and the municipal authorities in Berlin, for a trial of the Nernst lamp for street lighting. It is proposed to light some avenues in the Thiergarten district by this means.

Electrical Patent Litigation in Italy.—La Compagnie Thomson-Houston de la Mediterranée has brought an action against the Leghorn Electrical Tramways Co. for infringement of its patents. The Leghorn plant was supplied by Messrs. Schuckert and Co., of Nuremburg, and the case has been adjourned for the latter to reply to the charges.

Paris-Berlin Telephone.—The negotiations for the establishment of direct telephone communication between France and Germany have resulted in an agreement on the main points. It is proposed to lay a line between Paris and Berlin, and another between Paris and Frankfort, and as the latter city is already in communication with Berlin, there will be two separate lines between the two capitals.

The American Government and Wireless Telegraphy.—It is reported that the American War Department is arranging to make tests with the Marconi system of wireless telegraphy. Two experimental stations have been selected, one on either side of the river Potomac, six miles apart, and the necessary instruments have been purchased. The experiments will be conducted by Col. James Allen and Lieut. George O. Squire.

Imponderable Jokes.—Writing to *The Times* of Easter Monday, Prof. J. A. Fleming, in an interesting letter on "Wireless Telegraphy," states that "messages, signals, congratulations and jokes were freely exchanged between the operators sitting on either side of the Channel." The imponderable ether would surely refuse to transmit any other than light and airy humour. Jokes sent between Marconi poles should not lack *point*.

Trinity House and Wireless Telegraphy.—The Deputy-Master of Trinity House, with a committee of Elder Brethren, accompanied by Lord Rayleigh, the scientific adviser, and Captain the Hon. F. C. P. Vereker, of the Board of Trade, visited Dover during the past week, with the object of making an official inspection of the wireless telegraph system as experimentally in operation between the South Foreland lighthouse and the East Goodwin lightship.

Modifications of the Nernst Lamp.—A patent has been field in the United States by Mr. W. S. Hadaway, Jun., for an *arc* lamp, the arc of which is closely surrounded by a sleeve of magnesia. The light of the arc is said to be augmented by the incandescence of the magnesia sleeve. The sleeve is constructed by fusing magnesia in the electric furnace, the resulting crystals being then ground to powder and mixed in a plastic mass with magnesium chloride. This mixture is then moulded under heavy pressure into the required shape, giving a structure of sufficient strength and durability to be supported wholly by the carbons, without any enclosing casing. Photometric tests of this lamp, with and without the magnesia sleeve, might assist in solving the problem whether the light emitted by incandescent lime, magnesia, Welsbach mantles, Nernst "filaments," &c., is merely that corresponding to the high temperature of the material as Mr. Swinburne holds, or is due to a property of the material itself, as most of the leading physicists agree. The same issue of the *Electrical World*, in which the above patent is alluded to, contains a letter, signed Theo. Reyman, describing a method he has devised for lighting the Nernst lamp. This involves a very similar application of the arc lamp to that just described. The apparatus is a series coil arc lamp, the upper carbon of which is raised by the magnet to strike the arc. Around the arc is placed a hollow cylinder of refractive oxide connected in shunt to the arc itself. This cylinder, when heated by the arc, is raised to incandescence and, becoming a conductor, increases the current through the series magnet, but diminishes that flowing through the arc. The increased current lengthens the arc and, owing to the smaller current through the latter, breaks it, and the light is then supplied by the incandescent oxide in the usual way. As the upper carbon is fed by gravity, it descends again into position for lighting as soon as the current is switched off from the lamp. No mention is made of the amount of power consumed in the series coil, which appears always to be in circuit.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

WEDNESDAY, April 12th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "Telephones," by John Gavey.

THURSDAY, April 13th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Continuation of discussion on Mrs. Ayrton's Paper, "The Hissing of the Electric Arc." A Paper on "Experiments on Alternate Current Arcs by Aid of Oscillographs," by W. Duddell and E. W. Marchant, which has already appeared in the *Journal* will also be discussed.

FRIDAY, April 14th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Earth Currents and Electric Traction," by Prof. A. W. Rücker.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Wehnelt's Electrolytic Interrupter.—D'Arsonval communicates some new observations concerning the mode of action of Wehnelt's interrupter. He used a platinum wire 0·7mm. thick, projecting about 2cm. from the glass tube filled with mercury. He obtained Röntgen rays of a steadiness and penetrating power hitherto unknown, enabling him to obtain instantaneous radiographs of the hand. In conjunction with a Berthelot "effluviator," the coil worked by the new interrupter gave very large quantities of ozone. Determined by a revolving mirror, the frequency of the interruptions was found to be 1,700 per second. The best form of interrupter consists of a test tube with a platinum wire introduced through the bottom. Potash may be substituted for the diluted acid, and iron for the lead. The following is the author's theory of what takes place. By the passage of the current the platinum point is brought to a white heat. The heating of the surrounding liquid leads to the formation of a layer of non-conducting vapour round the platinum, which interrupts the current. Then the vapour condenses, the current is re-established, and the process repeats itself. This explanation, which makes the phenomenon analogous to the Trevelyan rocker, also explains why the interruption takes place in one direction only. For when the platinum point is positive it heats up quicker than when it is negative.

[D'Arsonval, *Comptes Rendus*, Feb. 27, 1899.]

Sensitiveness of Galvanometers.—Having had to measure very small currents by means of a Deprez-D'Arsonval galvanometer, C. Féry determined the ratio $r' : r$ of the resistances to be given to the torsion wire and the movable coil to ensure the greatest possible sensitiveness. The result differs according to the requirements of the operater. If the resistance r' of the torsion wire is given, then a maximum sensitiveness is obtained by making $r = r' + \rho$, where ρ is the internal resistance of the battery or other source of E.M.F. If the resistance r of the movable coil is fixed, a maximum deflection is only obtained when $r' = \infty$, so that this case is of no practical interest. Lastly, when the sum r and r' is supposed to be constant, so that the internal resistance of the galvanometer is given, a maximum sensitiveness is obtained by making $r' = 2r$. Now in the Deprez-D'Arsonval galvanometer r' is usually 0·5 ohms and $r = 200$ ohms. On making r' 132 ohms and r 66 ohms, the sensitiveness is increased no less than 153 times. This increase is, however, subject to a disturbance due to the magnetism of the copper of the moving coil. This source of loss may be eliminated either by employing a perfectly uniform magnetic field, or, as pointed out by Lippmann, by adding diamagnetic bodies to the movable coil sufficient to reduce its permeability to zero.

[Féry, *Comptes Rendus*, March 13, 1899.]

Carbon Coherers.—When brass filings are suspended in distilled water and a feeble current is sent through, with about 10 volts, the metallic particles form chains, which break up into rods on stopping the current. If they could be made to break up into individual particles, a result would be achieved analogous to what has often been attempted in the case of coherers. Noticing that the cohering particles showed signs of fusion, T. Tommasina experimented with an infusible body in the shape of carbon. He employed medium-sized grains of sifted arc carbon, and succeeded in preparing coherers of a sensitiveness quite equal to that of the best metallic coherers. Besides, these coherers lose their conductivity with the slightest shock, or even by the mere interruption of the current traversing them, though they do not appear to have the inestimable property of righting themselves when the electromagnetic waves cease. In that respect more may be hoped for from another type of carbon coherer also devised by the author. It consists of two round arc carbons mounted in a glass tube, and held in position by rubber stoppers. The rounded ends are lightly in contact. This coherer requires some "seasoning" before it works perfectly, but then it becomes exceedingly sensitive.

[Tommasina, *Comptes Rendus*, March 13, 1899.]

Current Intensity with Wehnelt's Interrupter.—H. Pellat has made the curious observation that when a Wehnelt interrupter is placed, first in an ordinary circuit, and then in a circuit containing an induction coil, the mean current intensity is increased, sometimes very considerably so. In one such case the E.M.F. was furnished by a battery of accumulators giving some 70 volts. On inserting the coil in the circuit an ammeter indicated 20 amperes. On short-circuiting the primary by a thick wire, the current fell to 15 amperes, to rise again on establishing the circuit as before. In another case, when some 110 volts were used, the current rose from 5 to 25 amperes, and a veritable flame passed between the two secondary terminals. Thus, the mean intensity of the current was raised by introducing an impedance. This fact, paradoxical as it may appear, is yet in accord with the known laws of induction. The author shows from the known formulæ that there are at least two possible ways of accounting for the phenomenon. Either the quantity $\frac{di}{R\,dR}$ is greater at opening than at closing, or the introduction of an impedance modifies the ratio of the open to the closed time.

[Pellat, *Comptes Rendus*, March 20, 1899.

Physiological Effects of Currents.—The study of the effect of currents upon the human economy is connected with one of the least cheerful applications of electrical science. But apart from their therapeutic value, their precise action in the case of accidents should be known, so as to facilitate restorative measures. As the result of some 170 experiments upon various animals, J. L. Prevost and F. Battelli conclude that high tension alternate currents applied to the head chiefly affect the respiration, and that the most valuable restorative lies in artificial respiration. In the case of low-tension currents, the ventricles of the heart are stopped, or are put into fibrillary tremulation, while the auricles continue to work. The remedy lies, curiously enough, in a short application of a high-tension current and in artificial respiration. That the high-tension current is a somewhat heroic remedy is shown by the fact that it stops the auricles while it allows the ventricles to continue beating. It must be applied, moreover, within 15 seconds (in cats and guinea-pigs, at least) after the low-tension shock, and that is not practicable, as a rule. Artificial respiration should always be tried in case of accidents. The authors could not establish any definite *post-mortem* characteristics of death by electricity, except intra-cerebral hemorrhage in case of prolonged applications.

[Prevost and Battelli, *Comptes Rendus*, March 13, 1899.]

Photo-Electricity.—In experiments undertaken for the purpose of investigating the nature of photo-electric currents, the highly sensitive silver halogens are usually employed. They have, however, the disadvantage of being converted into very unstable salts which cannot be satisfactorily isolated. G. C. Schmidt therefore employs the well-known oxide of copper, CuO, which, if it is modified at all, is converted into the lower salt Cu_2O, cuprous oxide. He deposits these salts on platinum foil, and immerses two such plates as electrodes in a solution of caustic soda. One of the electrodes is then illuminated with light of a definite colour, and the effect is studied by means of a galvanometer. Thus the experiment becomes readily accessible to Nernst's theory, which determines the E.M.F. from the solution pressure of the salt and the charge of the ion. But an important source of uncertainty is introduced by the fact that the potential of freshly-prepared layers of CuO rapidly decreases, going down to about half its initial value in 12 hours. When fresh CuO is exposed to red light it becomes positive, whereas it becomes negative under violet light. Hence red light increases the solution pressure of the oxygen. When pure metals are used in solutions of their own salts, under circumstances which exclude secondary effects, no effect is produced upon them by light.

[Schmidt, *Wied. Ann.*, No. 3, 1899.]

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MAGNETIC LEAKAGE IN THE ALTERNATING CURRENT TRANSFORMER.

BY ALEXANDER RUSSELL, M.A.

(Concluded from page 789.)

Calculation of the Magnetic Leakage.—From the results of experiment 16 in the preceding table we get α equal to 9·3deg. by (5), 10·9deg. by (6), 9·4deg. by (7) and 7·3deg. by (11). The first three of these results agree well with one another, but the last seems to show that the observed voltmeter reading on the secondary was too high. We shall take 9·3 as the leakage lag when the secondary current is 51·38 amperes.

Comparison of Observed and Calculated Leakage.

No. of experiment.	3	7	9	12	14	16
Calculated α	1·0	3·25	3·9	5·8	7·6	9·3
Probable α.....	0·5	2·9	4·3	6·2	7·9	9·3

The above values of α were calculated by the sine formula (5).

Calculation of Primary Angle of Lag for given Secondary Currents.

No. of experiment.	3	7	9	12	14	16
ϕ_1 observed	80·8	58·6	49·4	42·0	37·2	34·9
ϕ_1 calcu lated (no leakage) ...	80·8	58·1	47·8	37·3	31·8	27·9
ϕ_1 calculated	80·8	58·7	49·5	42·0	37·2	35·0

The second row has been calculated from the formula given in *The Electrician*, Vol. XXXVIII., p. 725; the third row from the formulæ given above.

Calculation of A_1 when A_2 is given.

No. of experiment.	3	7	9	12	14	16
A_1 observed	1·214	1·442	1·661	2·030	2·392	2·692
A_1 calculated (no leakage) ...	1·207	1·404	1·609	1·967	2·262	2·548
A_1 calculated.....	1·209	1·440	1·678	2·036	2·434	2·747

Comparison of Observed and Calculated Secondary Volts.

No. of experiment.	3	7	9	12	14	16
V_2 observed	102·0	101·7	101·4	100·8	100·1	99·7
V_2 calculated (no leakage) ...	101·9	101·6	101·3	101·0	100·7	100·5
V_2 calculated.....	101·9	101·4	101·0	100·4	99·8	99·2

Comparison of Observed and Calculated Primary Watts.

No. of experiment.	3	7	9	12	14	16
W_1 observed	469	1,804	2,583	3,632	4,571	5,297
W_1 calculated.....	464	1,796	2,615	3,632	4,652	5,401

W_1 has been calculated from $V_1 A_1 \cos \phi_1$, taking the values of A_1 and ϕ_1 calculated above.

Comparison of Observed and Calculated Efficiencies.

No. of experiment.	3	7	9	12	14	16
η observed.....	0·665	0·903	0·937	0·954	0·960	0·969
η_1 calculated (no leakage) ...	0·674	0·911	0·935	0·951	0·955	0·957
η calculated	0·674	0·911	0·935	0·951	0·955	0·957

η_1 has been calculated by the formula

$$\left(1 - \frac{151}{W_1}\right)\left(1 - \frac{16{\cdot}3W_1}{2{,}400^2}\right).$$

This is equivalent to the graphical construction for the efficiency. The last row η has been calculated from the more elaborate formula (12), which takes leakage into account, and we see that, as far as the third figure at least is concerned, up to five-sixths of full load it agrees with the graphical construction.

Calculation of the Efficiencies from the Observations on the Low Tension Side.

No. of experiment.	3	7	9	12	14	16
η observed.....	0·665	0·903	0·937	0·954	0·960	0·969
η_1 calculated (no leakage).....	0·674	0·912	0·936	0·946	0·948	0·951
η calculated	0·674	0·913	0·939	0·952	0·957	0·964

The second row has been calculated by formula (15), the third row taking leakage into account by formula (16).

Graphical Construction for the Primary Watts, &c., for a given Secondary Current.—(1) No magnetic leakage.

We suppose that V_1, W_0, A_0, and n are given. Draw two lines FB and FC at right angles to one another (Fig. 2). Measure off FD equal to $\frac{W_0}{V_1}$, and with centre D and radius equal to A_0 describe a circle cutting FB in B.

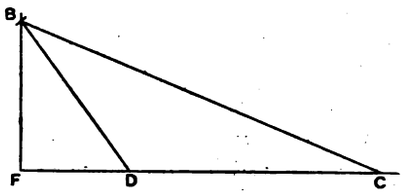

FIG. 2.

Then the angle BDF will equal the primary angle of lag on open circuit. To find A_1, ϕ_1 and W_1 for a given A_2, measure off DC equal to nA_2 where n is the ratio of the secondary to the primary turns and join BC. Then W_1 will equal V_1. FC, BC will equal A_1 and the angle BCF will be ϕ_1. Many interesting trigonometrical relations between the various quantities follow from this simple diagram (Fig. 3), but these may be left as an exercise to the student.

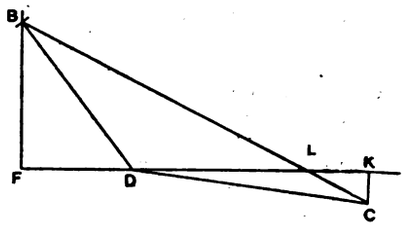

FIG. 3.

2. *Magnetic Leakage Considered.*—Suppose that α_1 is the leakage lag produced by the unit secondary current. The triangle BFD being constructed, as in the preceding case, make the angle KDC equal to $A_2 \alpha_1$ (α suppose) and measure off DC equal to nA_2 where n is the ratio of the effective secondary turns to the primary turns, found experimentally from formula (2). Draw CK perpendicular to FK then,

$$\begin{aligned} FK &= FD + DK, \\ &= A_0 \cos \phi_0 + nA_2 \cos \alpha, \\ &= \frac{W_1}{V_1} \text{ by formula (6).} \end{aligned}$$

Hence $W_1 = FK \,.\, V_1$.

Again $BC \cos BLD = FK,$
$= A_1 \cos \phi_1,$

and $BC \sin BLD = BF + KC,$
$= A_0 \sin \phi_0 + nA_2 \sin \alpha,$
$= A_1 \sin \phi_1$ by (5).

Hence $BC = A_1,$

and $BLF = \phi_1.$

For a given secondary current ϕ_1 is, therefore, greater when there is magnetic leakage. The locus of the point C for different values of W_1 is easily seen to be very nearly a parabola, touching FK at D, and hence the tangent to this locus at C will bisect DK nearly. In drawing the complete diagram this is a useful rule to remember.

Similar simple constructions can be given for the secondary voltage and also for the efficiency. These geometrical theorems are most useful, as by studying them various relations come out which are concealed by the often complicated algebraical expressions. They also suggest various laboratory methods of measuring the losses in the iron core of certain electrical apparatus.

The above method can be very simply applied to studying the air core transformer. The best way to write the differen-

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tial equations in this case is as follows (adopting the usual notation):—

$$e_1 = Ri_1 + L\frac{d}{dt}\left(i_1 + \frac{M}{L}i_2\right).$$

$$-M\frac{d}{dt}\left(i_1 + \frac{M}{L}i_2\right) = Si_2 + \left(N - \frac{M^2}{L}\right)\frac{di_2}{dt}.$$

Written in this way they suggest the diagram shown in Fig. (1). In this case

$$\frac{BC}{BD} = \frac{L}{M}, \quad OC = V_1 \text{ and } OB = RA_1.$$

Numerous relations between the various quantities involved can be got which are independent of the shape of the wave of E.M.F. The tangent of the angle of lag in the secondary circuit always contains $N - \frac{M^2}{L}$ as a factor and hence vanishes when M^2 equals LN. Very simple geometrical constructions can also be given for the air core transformer whether at constant current or at constant voltage.

The constructions given in *The Electrician*, Vol. XXXVIII., p. 725, for "boosters," "pressure reducers," and "compensators" can easily be expanded in the same way so as to take leakage into account.

THE INDUCTION MOTOR.*

BY ERNEST WILSON.

(Continued from page 802).

Deal now with the armature of this motor. The armature being brought to the same position in each experiment by aid of the pulley-block, and the pull in pounds observed on the spring balance, observations were made for different positions of the phase of the primary potential differences E_1 E_2 and currents x_1 x_2; the potential differences between the ends of each of the armature circuits C, D, E (see Fig. 6), and the currents y_1, y_2, y_3, in each armature circuit. The electromotive force of each armature circuit, e_1 e_2 e_3, is given by correcting its potential difference for current into resistance of the armature coil. In this investigation, r_1 r_2 r_3 are respectively the resistances of the armature coils, and are each equal to 0·025 ohm; ρ_1 ρ_2 ρ_3 are the external resistances, in the armature circuits r_1 r_2 r_3, and constitute the independent variable. In any one experiment $\rho_1 = \rho_2 = \rho_3$. By correction for R_1 R_2 (the resistance of the primary circuit) into the instantaneous value of the current, the reactions $m_1 dI_1/dt$ $m_2 dI_2/dt$ have been found, and therefrom dI_1/dt dI_2/dt. An integration of the E.M.F. curves dI_1/dt dI_2/dt e_1/n_1 e_2/n_2 e_3/n_3 gives the average total induction in the coils where $n_1 = n_2 = n_3 = 24$. A small correction must also be applied in the case of the armature coils, since there are three groups of 24 each per half-period. If the distribution per half-period of $(\theta/2)$ along the surface circumferentially were a sine curve, the average total induction per coil would equal 0·93 of the maximum. In our case this coefficient is 0·93 nearly. The integrals of e_1/n_1 e_2/n_2 e_3/n_3 have been increased respectively by multiplying by 1/0·93 in order to deduce the maximum average induction experienced by each coil. Four distinct cases have been dealt with at about the same frequency of 52 periods per second, and with $\sqrt{\text{mean}^2}$ E_1 and E_2 equal to 60 volts. These correspond to values of $\rho_1 = \rho_2 = \rho_3$ equal to ∞ 1·03, 0·133 and 0·012 ohms. The results are given respectively in Tables V., VI., VII. and VIII. Table IX. gives the collected results.

Table V.

Angle in 60ths of a period.	A Circuit. $m_1 dI_1/dt$ Volts.	A Circuit. x_1 Amps.	B Circuit. $m_2 dI_2/dt$ Volts.	B Circuit. x_2 Amps.	$m_1 dI_1/dt x_1 + m_2 dI_2/dt x_2$ Watts.	e_1 Volts.	e_2 Volts.	e_3 Volts.
0	+ 61·4	− 6·68	+ 56·6	+ 9·76	+ 142	+ 14·1	− 24·4	+ 12·9
3	+ 73·9	− 3·08	+ 38·7	+ 11·8	+ 229	+ 8·45	− 24·2	+ 17·6
6	+ 91·6	+ 1·54	+ 9·7	+ 12·5	+ 262	− 0·73	− 18·7	+ 19·6
9	+ 88·9	+ 4·55	− 25·3	+ 11·3	+ 119	− 10·1	− 11·0	+ 20·9
12	+ 68·8	+ 8·22	− 50·2	+ 8·73	+ 127	− 17·4	− 7·9	+ 24·8
15	+ 54·5	+ 11·1	− 61·3	+ 5·72	+ 254	− 20·2	− 2·39	+ 22·6
18	+ 38·1	+ 13·2	− 76·5	+ 2·2	+ 335	− 22·2	+ 2·93	+ 18·7
21	+ 8·6	+ 13·9	− 93·2	− 1·39	+ 250	− 19·6	+ 10·1	+ 9·55
24	− 26·1	+ 12·7	− 87·4	− 4·25	+ 40	− 17·6	+ 17·4	− 0·918
27	− 50·5	+ 9·76	− 68·4	− 7·26	+ 1	− 17·3	+ 24·4	− 8·08
					1,759			

Frequency, 52·2. $\rho_1 = \rho_2 = \rho_3 = \infty$ $\sqrt{\text{mean}^2}$ E_1 and $E_2 = 60$ volts.

Table X.

0	+ 80·5	− 4·20	− 72·2	− 7·08	+ 173	− 17·3	+ 30·6	− 16·4
3	+ 100·9	− 1·44	− 49·3	− 8·34	+ 266	− 10·2	+ 30·1	− 22·1
6	+ 122	+ 1·69	− 7·2	− 8·71	+ 269	+ 2·12	+ 23·4	− 24·3
9	+ 114	+ 3·82	+ 36·4	− 7·84	+ 150	+ 12·5	+ 11·0	− 22·1
12	+ 87	+ 6·21	+ 64·4	− 6·02	+ 152	+ 22·9	+ 8·32	− 29·3
15	+ 71·6	+ 8·28	+ 81·1	− 3·76	+ 288	+ 26·4	+ 3·45	− 28·1
18	+ 47·5	+ 9·84	+ 101·3	− 1·32	+ 333	+ 17·3	− 3·77	− 23·1
21	+ 7·9	+ 10·16	+ 121·6	+ 1·44	+ 255	+ 25·4	− 12·7	− 11·6
24	− 34·9	+ 9·22	+ 112·8	+ 3·32	+ 52	+ 16·9	− 18·4	+ 3·47
27	− 65·9	+ 7·02	+ 87·4	+ 5·27	− 2	+ 20·6	− 27·9	+ 11·2
					1,936			

Frequency = 95·5. $\rho_1 = \rho_2 = \rho_3 = \infty$. $E_1\sqrt{\text{mean}^2} = 80$; $E_2\sqrt{\text{mean}^2} = 80$ volts.

Dealing with Table V. first, in which the armature is on open circuit, the relation between the curves dI_1/dt dI_2/dt and the E.M.F. curves e_1 e_2 e_3 may be found. Each of the $m_1\int\frac{dI_1}{dt}dt$ and $m_2\int\frac{dI_2}{dt}dt$ curves shows a maximum of $27·2\times10^6$ C.G.S. units; the coils on the armature experience each a total change of $7·2\times10^6$ C.G.S. units. We have, therefore, 27·2/75 as the total average maximum per turn due to primary and 7·2/24 as the total average maximum experienced per turn by secondary. Multiplying the former by 1/0·83 and the latter by 1/0·93, we have 0·437 and 0·322. The difference gives 0·115, which is 26·3 per cent. of 0·437. These results are given in Table IX., and also the corresponding ones for the other experiments, in which $\rho_1 = \rho_2 = \rho_3 = 1·03$, 0·15 and 0·012 ohms.

Torque.

Let f = frequency of supply; N = number of poles per revolution of stationary portion; there are two poles per circuit A and B to the period θ; r = radius of armature in cms. Then $2\pi r/N$ = length of circumference per half period in cms.; and $4\pi rf/N$ = velocity of field in cms. per second. Let l = length of armature core in cms. Let e_1, e_2, e_3 = the electromotive forces in volts of each circuit on the armature, and n_1, n_2, n_3 = the turns per circuit. Then $e_1/n_1 l$ = average volts per cm. length of conductor. Let y_1, y_2, y_3 = the current in amperes in the armature circuits. Without analysing the variation of B, the induction per square cm. at the conductor, we may say that during time $N/4\pi rf$ the average $e_1/n_1 l$ = av. $B\times 4\pi rf10^{-8}/N$. The force on the armature at radius r due to current y_1 in the conductor is $By_1/10$ dynes, if y_1 be in amperes; so that the

Table IX.

Extra resistance in armature $\rho_1 = \rho_2 = \rho_3$ in ohms.	Tot. resist. of armature $r_1 + \rho_1 = r_2 + \rho_2 = r_3 + \rho_3$ in ohms.	Torque in lbs. at 3·5 feet radius. Calc.	Obs. abt.	Mean $m_1\frac{dI_1}{dt}x_1 + m_2\frac{dI_2}{dt}x_2$ over a half period in watts.	Mean $e_1y_1 + e_2y_2 + e_3y_3$ over a half period in watts.	Average dissipation due to magnetic hysteresis, eddy currents, and waste field over a half period in watts.	If dissipation due to magnetic hysteresis & eddy currents be assumed zero and reduced to 176 watts, waste field would account for in watts.	For further particulars, see Tables.	Maximum average values of $m_1\int\frac{dI_1}{dt}dt$ and $m_2\int\frac{dI_2}{dt}dt \div 75\times0·83$ in C. G. S. units 10^6.	Maximum average value of $\int e_1dt, \int e_2dt$, and $\int e_3dt \div 24\times0·93$. in C.G.S. units, 10^6.	Difference.	Difference expressed as a percentage of max. av. value of $m_1\int\frac{dI_1}{dt}dt$ and $m_2\int\frac{dI_2}{dt}dt \div 75\times0·83$	Frequency f.	$\sqrt{\text{mean}^2}$ in volts. E_1	E_2	Maximum volts. $m_1\frac{dI_1}{dt}$	$m_2\frac{dI_2}{dt}$	Maximum amperes. x_1	x_2	Alteration in phase from zero on open circuit. (360° = 1 period.) $m_2\frac{dI_2}{dt}$	$m_1\frac{dI_1}{dt}$	x_1	x_2
∞	∞	0	0	176	0	176	0	V.	0·437	0·322	·115	26·3	52·2	60	60	96	94	13·9	12·5	0°	0°	0°	0°
1·03	1·06	1·5	2	2,091	790	1,301	1,125	VI.	0·419	0·319	·100	23·9	52·1	,,	,,	83	88	46·6	41·4	+3·6	+ 2·4	- 18	- 25·2
0·150	0·175	6·72	7	3,723	3,507	216	40	VII.	0·401	0·286	·115	28·7	52·0	,,	,,	74	82	71·8	70·6	+6·0	+ 6·0	- 28·4	- 25·2
0·012	0·037	2·2	2	2,050	1,135	905	729	VIII.	0·367	0·0864	·2806	76·5	52·7	,,	,,	116	120	111	123	- 7·2	- 13·2	- 20·4	- 12·0

Table XIV.

∞	∞	0	0	194	0	194	0	X.	0·309	0·208	·100	32·5	95·5	80	80	122·0	122	10·2	9·8	0°	0°	0°	0°
1·07	1·10	1·2	1¼	1,386	1,112	274	80	XI.	0·315	0·205	·110	34·9	95·0	80	81	114·7	119	20·5	18·5	+4·8	+ 3·6	- 28·2	- 27·6
0·149	0·174	3·2	4	3,771	3,054	717	523	XII.	0·308	0·141	·167	54·2	95·0	78	80	130·0	132	69·3	64·3	+3·0	+ 4·2	- 19·2	- 13·8
0·0095	0·0345	1·2	1	1,756	1,188	568	374	XIII.	0·312	0·065	·247	79·2	95·5	78	80	124·0	161	95·7	86·4	- 1·8	- 6·0	- 8·4	+ 0·6

* Paper read before the Institution of Electrical Engineers, March 9.

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Table XV.

$\rho_1=\rho_2=\rho_3$	Frequency.	Alteration in the ordinate of $\int e$ (for $\rho=\infty$) dt when $y=o$. +signifies increase ordinate. − „ decrease „			
		y_1.	y_2.	y_3.	Average.
		%	%	%	%
1·03	52	+ 7·3	+ 3·85	− 2·7	+ 2·81
0·150	52	+29·4	+11·1	+28·0	+22·8
0·012	52	−44·1	−75·0	−83·0	−67·3
1·07	95	+ 6·0	+25·6	+13·1	+14·9
0·149	95	+62·5	+25·0	+92·3	+59·9
0·0095	95	−47·4	−92·3	−63·8	−67·8

Table XVI.

Angle in 60ths of a period.	Frequency 52.			Frequency 95.		
	$\rho_2=1·03$	$\rho_1=0·15$	$\rho_1=0·012$	$\rho_1=1·07$	$\rho_1=0·149$	$\rho_1=0·0095$
	L in 10^6 C.G.S. units.	L in 10^6 C.G.S. units.	L in 10^6 C.G.S. units.	L in 10^6 C.G.S. units.	L in 10^6 C.G.S. units.	L in 10^6 C.G.S. units.
0	1·03	0·418	0·089	0·58	0·499	0·064
3	...	...	...	...	...	...
6	1·35	0·386	0·077	0·31	0·513	0·036
9	...	...	...	..	...	...
12	1·20	0·289	0·018	1·81	0·798	0·024
14	...	...	0·355	...	...	...
15	...	...	0·400	...	...	...
16	...	...	0·387	1·74	...	..
18	0·92	0·871	0·336	1·75	1·06	0·208
20	..	...	...	1·46	...	0·323
21	...	...	0·198	1·37	...	0·333
24	0·97	0·489	0·126	0·93	0·564	0·127
27	...	...	...	...	...	...

Table XVII.

Angle in 60ths of a period.	Frequency 95. Increase $\int e_1$ (for $\rho=\infty$) dt by 6 per cent.						
	$\rho=\infty$ $\int e_1 dt$	$\rho=\infty$ $1·06\int e_1 dt$	$\rho=1·07$ $\int e_1 dt$	$1·06\int e_1 dt$ $-\int e_1 dt$	$1·06\int e_1 dt$ $-\int e_1 dt$ in 10^6 C.G.S. units.	y_1 in C.G.S. units. *See* Table XI.	L in 10^6 C.G.S. units.
0	+20·2	+21·4	+13·6	+ 7·8	+1·37	+2·36	+0·58
3	...	...	...	...	...	...	...
6	+25·7	+27·2	+25·2	+ 2·0	+0·351	+1·14	+0·308
9	...	...	..	...	...	...	...
12	+18·0	+19·1	+26·5	− 7·4	−1·30	−0·72	+1·81
15	...	...	...	...	...	...	...
16	+ 7·7	+ 8·16	+22·1	−13·9	−2·44	−1·40	+1·74
18	+ 3·7	+ 3·92	+18·8	−14·9	−2·61	−1·49	+1·75
20	0·0	0·0	+15·0	−15·0	−2·63	−1·80	+1·46
21	− 2·0	− 2·12	+13·0	−15·0	−2·63	−1·92	+1·37
24	− 8·9	− 9·43	+ 4·2	−13·63	−2·39	−2·55	+0·93
27	...	...	..	...	...	...	...

Table XVIII.

Frequency.	Extra Resistance in Armature $\rho_1=\rho_2=\rho_3$	Measured Torque in lbs. at 3·5ft. radius.	Volts $\sqrt{\text{mean}^2}$ E_1 E_2	Amperes $\sqrt{\text{mean}^2}$ in A + B Circuits.	See Tables for further particulars.
	ohms.	lbs. ozs.			
34	0·01	2 3	44	99	
„	0·136	4 0	34	39	
„	0·43	1 14	33	15	
„	1·02	0 14	34	Less than 12	
„	2·35	0 8	33	„ 12	
52	0·012	2 0	60	...	VIII., XI.
„	0·15	7 0	60	...	VII., XI.
„	1·03	2 0	60	...	VI., XI.
99	0·01	0 15	60	45	
„	0·136	1 5	60	36	
„	0·43	1 5	60	20	
„	1·02	0 14	60	9	
„	2·35	0 8	60	Less than 6	
95	0·0095	1 0	80	80	XI., XIV.
„	0·149	4 0	81	63	XII., XIV.
„	1·07	1 1	78	...	XIII., XIV.
95·5	0·01	2 0	91	102	
„	0·136	5 0	91	75	
„	0·43	3 4	91	36	
„	1·02	1 6	91	18	
„	2·35	0 9	91	12	

whole force on the armature at this radius due to one circuit $=Bn_1ly_1/10$, and taking B to be the average given by $e_1/n_1l\times N4\pi rf10^{-8}$ we get the whole force $=e_1y_1N/4\pi rf10^{-7}$. At the same epoch the forces due to the other circuits will be $e_2y_2N/4\pi rf10^{-7}$ and $e_3y_3N/4\pi rf10^{-7}$ in this three-phase armature. The average of the total force

$$\frac{N\times10^7}{4\pi rf}\{e_1y_1+e_2y_2+e_3y_3\}$$

over a half period, will be the average force acting at radius r upon the armature. In the ideal motor this force would have no variation. We must divide by 981×454 to reduce to pounds.

It will be well to see if this verifies by actual experiment. The torque has been measured for three values of $\rho_1=\rho_2=\rho_3$, the external resistance in the armature of this motor, namely, 1·03, 0·15, and 0·012 ohm, and found to be about 2, 7, and 21b. respectively at a radius of 3·5ft. Tables VI., VII. and VIII. give the results of the experiments in each case, and Table IX. shows the collected results, from which we see that the calculated values are 1·5, 6 72, and 2 21b. at a radius of 3·5ft. The agreement is as good as one could expect from the rough way in which the torque was measured, owing to the friction of brushes and bearings rendering an exact measurement difficult.

It is interesting to examine the effect of leakage field upon the distribution of power in this motor over a half period in time. The sum of $m_1\int x_1\frac{dI_1}{dt}dt$ and $m_2\int x_2\frac{dI_2}{dt}dt$ over half a period divided by $2f$ is the energy delivered to the motor by the primary circuit irrespective of $x_1^2R_1$ and $x_2^2R_2$ losses, since the potential differences E_1, E_2 have been corrected for x_1R_1 and x_2R_2. Similarly $\int e_1y_1\,dt+\int e_2y_2dt+\int e_3y_3\,dt$ divided by $2f$ is the energy received by the secondary or armature circuits. The difference gives the dissipation of energy due to magnetic hysteresis and induced currents in the iron (and copper if there be any) and that due to stray field. When the machine has open-circuited armature, the average rate of dissipation of energy in watts is 176 (*see* Table V.). Take Table VI., in which the external resistances $\rho_1=\rho_2=\rho_3=1·03$ ohms. The average watts due to leakage and iron losses = 1301. Assuming that 176 watts represent the rate of dissipation of energy in the iron, we have 1,125 watts due to stray field. Take Table VII., in which the external resistances $\rho_1=\rho_2=\rho_3=0·15$ ohm. The average

Table IX. *(continued).*

Phase-difference between.		Maximum volts.			Maximum amperes.			Alteration in phase from zero on open circuit.						Phase-difference between e (for $\rho=\infty$) and y.			Phase-difference between e (for $\rho=ab.\ldots$) and y.			Phase-difference between					
$\frac{dI_1}{dt}$ & x_1	$\frac{dI_2}{dt}$ & x_2	e_1	e_2	e_3	y_1	y_2	y_3	e_1	e_2	e_3	y_1	y_2	y_3	e_1 & y_1	e_2 & y_2	e_3 & y_3	e_1 & y_1	e_2 & y_2	e_3 & y_3	x_1 & y_1	x_1 & y_2	x_1 & y_3	x_2 & y_1	x_2 & y_2	x_2 & y_3
+79·2	+79·2	22·2	24·4	24·8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4·8	69·6	114	94·8	159·6	24
+57·6	+51·6	25·2	24·2	26·9	22·5	22	25	+18	+27·6	+19·2	+13·2	+14·4	+14·4	+13·2	+14·4	+14·4	+ 4·8	+ 12·0	+ 3·0	36	102	146·4	133·2	199·2	63·6
+46·8	+48·0	25·7	20·6	22·5	115	114	112	+42	+49·2	+60	+35·4	+34·8	+57·6	+36	+34·8	+57·6	+ 7·2	+ 15·6	+ 2·4	66	130·8	198	155·4	219·6	106·8
+66·0	+80·4	14·1	7·6	6·2	168	129	105	+22·8	+86·4	+48	+38·4	+40·8	+68·4	+38·4	+40·8	+68·4	−15·6	+ 45·6	− 20·4	63·6	130·8	202·8	145·2	212·4	104·4

Table XIV. *(continued).*

77°·4	78°·0	26·4	30·6	29·3	0	0	0	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	0°	..	...	...	...	...	...
44°·4	46°·8	33·3	27·5	33·1	26·5	24·2	27·6	+24	+39·6	+40·8	+12	+30	+46·2	12°·0	30°·0	46°·8	−12°·0	− 9·6	+ 4·8	...	...	...	...	...	...
55°·2	60°	25·4	21·2	23·6	111	106	105	+69·6	+60·0	+87·0	+39·4	+50	+85·2	54·0	50°·4	80°·4	−15·6	− 9·6	− 2·4	...	...	...	...	...	...
70°·8	84°	19·4	15·6	12·3	159	153	153	+87·6	+103	+80·4	+37·2	+37·4	+71·4	37·2	38°·4	72°·0	+50·4	+115·2	−81·6	...	...	...	...	...	...

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Table VI.—Frequency, 52. $\rho_1=\rho_2=\rho_3=1{\cdot}03$ ohm. $\sqrt{\text{mean}^2}$ E_1 & $E_2=60$ volts.

Angle in 60ths of a period.	A Circuit. $m_1 dI_1/dt$ Volts.	A Circuit. x_1 Amps.	$m_2 dI_2/dt$ Volts.	x_2 Amps.	$m_1 dI_1/dx + m_2 dI_2/dx$ Watts	e_1 Volts.	y_1 Amps.	e_2 Volts.	y_2 Amps.	e_3 Volts.	y_3 Amps.	$c_1y_1 + c_2y_2 + c_3y_3$ Watts.	Dissip't'n of energy due to w'ste f'ld hyster'sis and eddy currents. Watts.
0	+ 57·8	− 5·0	− 59·0	− 41·2	+2141	+ 17·4	+17·3	− 24·2	+21·9	+ 3·33	− 4·22	− 845	+1296
3	+ 78·2	+ 3·6	− 42·2	− 41·4	+2032	+ 13·3	− 12·4	− 23·4	+18·7	+ 7·99	− 7·54	− 663	+1369
6	+ 81·3	+ 15·1	− 17·4	− 36·3	+1862	+ 6·2	− 4·83	− 18·8	+18·4	+14·75	− 14·0	− 582	+1280
9	+ 82·5	+ 33·3	+ 21·4	− 27·0	+2172	− 0·6	+ 3·47	− 17·8	+19·3	+26·9	− 23·2	− 970	+1202
12	+ 70·4	+ 41·6	+ 40·7	− 14·1	+2355	− 11·8	+11·8	− 14·0	+12·8	+26·23	− 25·0	− 974	+1381
15	+ 57·6	+ 44·6	+ 60·2	− 2·2	+2438	− 17·3	+16·3	− 8·0	+ 6·79	+24·0	− 22·9	− 886	+1552
18	+ 40·7	+ 46·6	+ 81·3	+ 4·2	+2241	− 17·0	+15·8	− 4·3	+ 3·47	+20·5	− 19·3	− 680	+1561
21	− 12·9	+ 42·2	+ 87·6	+ 13·9	+1764	− 22·0	+17·8	− 0·6	− 3·32	+12·6	− 15·2	− 582	+1182
24	− 13·6	+ 30·3	+ 82·9	+ 29·2	+2008	− 25·2	+22·5	+ 12·8	− 15·2	+ 7·0	− 7·7	− 816	+1192
27	− 42·0	+ 16·1	+ 69·0	+ 37·3	+1894	− 21·7	+20·4	+ 21·5	− 21·4	+ 0·41	+ 0·75	− 903	+ 997
					20,907							7,901	13,012

Table VII.—Frequency, 52·7. $\rho_1=\rho_2=\rho_3=0{\cdot}15$ ohm. $\sqrt{\text{mean}^2}$ E_1 & $E_2=60$ volts.

0	+ 58·7	− 2·0	+ 56·9	+70·6	+3903	+21·6	− 114	− 14·1	+ 90·4	− 3·10	+24·9	+ 3839	+ 64
3	+ 69·3	+ 10·9	+ 41·7	+69·8	+3665	+18·8	− 103	− 16·4	+ 98·3	− 1·10	+ 7·35	− 3558	+ 107
6	+ 71·9	+ 31·5	+ 16·0	+60·5	+3228	+13·3	− 77·4	− 20·2	+110	+ 3·39	− 25·4	− 3106	+ 122
9	+ 73·9	+ 54·9	− 10·7	+41·2	+3619	+ 6·8	− 40·1	− 20·6	+114	+11·9	− 72·9	− 3491	+ 128
12	+ 67·7	+ 67·8	− 51·2	+20·6	+3535	+ 3·54	+ 5·08	− 14·1	+102	+22·5	− 102	− 3712	− 177
15	+ 57·4	+ 71·8	− 67·8	+ 3·2	+3903	− 5·83	+31·1	− 15·0	+ 83·1	+19·2	− 111	− 3561	+ 342
18	+ 46·7	+ 71·0	− 73·0	− 8·47	+3938	− 10·9	+48·0	− 14·6	+ 68·9	+16·8	− 112	− 3413	+ 525
21	+ 18·7	+ 60·5	− 76·6	− 33·9	+3730	− 20·3	+88·2	− 9·06	+ 20·9	+13·6	− 106	− 3419	+ 311
24	− 10·7	+ 44·4	+ 82·0	− 52·1	+3795	− 25·7	+107	− 3·16	− 21·5	+ 8·8	− 87·6	− 3453	+ 342
27	− 25·5	+ 23·8	− 70·4	− 64·2	+3913	− 23·6	+115	− 7·40	− 65·0	+ 6·11	− 53·7	− 3519	+ 394
					37,229							35,071	2,335
													177
													2,158

Table VIII.—Frequency, 52·7. $\rho_1=\rho_2=\rho_3=\cdot012$ ohm. $\sqrt{\text{mean}^2}$ E_1 & $E_2=60$ volts.

0	+ 51·7	−15·12	− 31·9	−123·4	+3158	+10·40	−144·0	+ 1·30	+ 99·2	+ 3·74	+ 35·4	−1234·8	+1923
3	+116·5	+11·06	− 19·0	−122·6	+3620	+ 6·26	−142·6	− 2·98	+108·0	− 0·64	+ 39·4	−1239·2	+2381
6	+ 79·1	+ 33·2	+ 12·9	−114·0	+1160	+ 2·26	−109·4	− 6·08	+126·6	− 1·52	− 12·0	−1000·8	+ 159
9	+ 58·9	+ 65·6	+ 28·7	− 93·6	+1170	+ 0·82	− 61·4	− 6·24	+128·6	+ 0·48	− 58·6	− 882·4	+ 288
12	+ 39·6	+ 97·0	+ 44·1	− 45·0	+1860	− 1·96	− 3·6	− 6·30	+110·6	+ 0·92	− 98·0	− 778·8	+1081
15	+ 38·6	+ 97·8	+ 73·2	− 21·2	+2220	− 0·48	+ 23·4	− 0·80	+103·4	+ 5·28	−105·4	− 650·0	+1570
18	+ 16·4	+110·6	+119·8	0	+1810	− 3·76	+ 56·6	− 3·44	+ 58·6	+ 2·56	− 98·0	− 665·2	+1145
21	− 2·2	+109·0	+ 61·1	+ 34·0	+1840	−11·50	+124·0	− 7·60	+ 32·0	− 3·50	− 86·0	−1366·4	+ 474
24	− 27·7	+ 78·2	+ 56·4	+ 69·8	+1770	−14·12	+163·4	− 7·34	− 16·4	− 5·28	− 72·6	−1804·4	− 34
27	− 41·1	+ 43·4	+ 37·0	+100·4	+1890	−13·16	+168·0	− 3·80	− 80·0	− 6·20	− 29·4	−1725·6	+ 64
					20,498							11,347·6	9,051

Table XI.—Frequency, 95. $\rho_1=\rho_2=\rho_3=1{\cdot}07$ ohms; $E_1\sqrt{\text{mean}^2}=80$; $E_2\sqrt{\text{mean}^2}=81$ volts.

0	+ 81·7	+ 0·25	− 77·5	−18·5	+1455	− 25·1	+ 23·6	+ 27·5	− 24·2	− 0·2	+ 1·33	− 1258	+ 196
3	+109·9	+ 2·65	− 54·6	−18·4	+1296	− 19·8	+ 19·4	+ 26·7	− 22·1	− 1·2	+ 2·95	− 977	+ 319
6	+114·7	+ 7·69	− 15·9	−15·1	+1122	− 11·7	+ 11·4	+ 24·7	− 21·4	− 9·6	+10·8	− 766	+ 356
9	+109·3	+16·9	+27·98	− 9·95	+1569	− 0·7	− 13·9	+ 25·1	− 23·9	− 27·2	+24·5	− 1256	+ 313
12	+ 93·2	+19·9	+ 61·9	− 4·66	+1567	+ 4·5	− 7·2	+ 20·5	− 20·8	− 33·1	+27·6	−1371	+ 195
15	+ 78·4	+20·5	+ 84·6	+ 0·13	+1618	+ 15·2	− 13·9	+ 15·9	− 14·0	− 29·8	+27·4	− 1251	+ 367
18	+ 56·1	+19·8	+110·9	+ 2·52	+1390	+ 16·6	− 14·9	+ 9·5	− 7·5	− 26·3	+24·0	− 949	+ 441
21	+ 15·2	+16·8	+118·7	+ 7·06	+1093	+ 23·8	− 19·2	+ 4·6	− 0·59	− 17·3	+18·7	− 784	+ 310
24	− 22·4	+11·3	+112·5	+14·0	+1311	+ 33·3	− 25·5	− 5·7	+10·6	− 11·1	+14·7	− 1072	+ 238
27	− 57·4	− 3·91	+ 93·9	+17·8	+1447	+ 30·1	− 26·5	− 22·4	+21·5	− 4·0	+ 3·83	− 1295	+ 151
					13,867							10,981	2,886

Table XII.—Frequency, 95. $\rho_1=\rho_2=\rho_3=0{\cdot}149$ ohm. $E_1\sqrt{\text{mean}^2}=78$. $E_2\sqrt{\text{mean}^2}=80$ volts.

0	+ 75·9	− 3·45	− 72·6	−61·7	+4217	+22·8	− 108	− 5·18	+ 67·9	− 2·46	+ 42·1	−3056	+1161
3	+129·8	+ 4·7	− 54·4	−64·3	+4108	+19·6	− 111	−11·0	+ 81·2	− 3·0	+ 30·7	−3357	+ 751
6	+119	+23·2	− 31·1	−58·0	+3520	+14·5	− 96·1	−16·6	+ 95·6	− 3·3	0	−3254	+ 266
9	+ 97	+45·1	+ 19·1	−42·9	+3556	+ 8·9	− 66·9	−18·0	+106·0	+ 3·54	− 39·6	−2985	+ 571
12	+ 83·2	+61·1	+ 50·4	−23·2	+3915	+ 1·8	− 22·8	−17·6	+103·0	+10·68	− 78·8	−3013	+ 902
15	+ 77	+67·4	+ 97·1	− 7·2	+4490	+ 5·8	+ 6·44	− 7·06	+ 95·6	+23·6	− 98·1	−3232	+1258
18	+ 57·3	+69·3	+131·9	+ 2·5	+4302	− 3·85	+ 23·8	−12·6	+ 86·7	+18·26	− 105	−3332	+ 970
21	+ 21·2	+62·4	+104·4	+16·6	+3056	− 13·1	+ 44·1	−15·2	+ 59·9	+11·35	− 101	−2748	+ 308
24	− 24·6	+43·6	+104·4	+40·7	+3177	− 22·9	+ 84·2	−10·5	+ 6·93	+ 6·8	− 90·6	−2618	+ 559
27	− 46·2	+24·4	+ 85·3	+52·7	+3368	− 25·4	+ 99·6	− 4·39	− 28·2	+ 4·49	− 71·3	−2950	+ 418
					37,709							30,544	7,165

Table XIII.—Frequency, 95·5. $\rho_1=\rho_2=\rho_3=0{\cdot}0095$ ohm. $E_1\sqrt{\text{mean}^2}=78$. $E_2\sqrt{\text{mean}^2}=80$ volts.

0	+73 53	− 25·1	− 52·2	− 74·6	+2049	− 14·67	+159	− 4·50	− 137·5	− 7·78	− 37·5	− 1419	+ 630
3	+123·8	− 0·81	− 32·9	− 86·4	+2740	− 10·88	+153	− 0·55	− 147	− 4·78	− 15·6	− 1509	+1231
6	+112·2	+ 15·8	+ 6·8	− 83·9	+1202	− 5·21	+107·5	+ 3·74	− 153	− 1·84	+ 6·25	− 1143	+ 59
9	+114	+ 41·0	+ 52·7	− 72·6	+ 848	+ 5·92	+ 68·7	+15·6	− 144	+12·25	+ 50	− 1231	− 383
12	+ 72·2	+ 68·1	+ 64·9	− 49·1	+1733	+ 2·82	− 9·37	+ 7·37	− 147	− 1·73	+122	− 1317	+ 416
15	+ 60·6	+ 84·8	+ 77·6	− 23·9	+3284	+ 3·76	− 50·0	+ 6·22	− 125	− 3·31	+153	− 1472	+1812
18	+ 40·6	+ 95·7	+111·2	− 6·08	+3210	− 4·53	− 56·2	− 2·63	− 103	− 10·94	+153	− 1144	+2066
21	+ 1·63	+ 92·5	+160·1	+ 5·68	+1064	+ 4·27	− 53·1	+ 4·61	− 59·4	− 1·83	+134	− 746	+ 318
24	− 38·04	+ 74·2	+ 90·6	+ 34·9	+ 431	+15·4	− 147	+ 8·41	+ 53·1	+ 6·54	+106	− 1121	− 690
27	− 86·2	+ 49·5	+ 90·5	+ 59·2	+1092	+19·4	− 137·5	+11·94	+ 71·9	+12·27	+ 84·4	− 776	+ 316
					17,560							11,880	568

rate of dissipation of energy is equal to 216 watts, leaving very little for waste field. In this experiment the magnitudes are great, and the difference we are considering is small. A small error in the value of ϵ ther magnitude will affect this difference seriously, and it has not been measured as a direct quantity. We may say that the dissipation of energy by waste field in this experiment is comparatively small if we assume that 176 watts are dissipated in the iron. Coming now to the last Table VIII., we see that iron losses and leakage account for 905 watts, leaving 729 for waste field, if we assume 176 for the iron losses. The variation of torque over a half period is shown by the figures in Tables VI., VII., and VIII.; in Table VI. the maximum and minimum values deviate from the mean by 23·3 and 2·63 per cent. In Table VII., these per centage figures are 9·5 and 11·4; and in Table VIII. they are 58·8 and 43. With a pure rotating field the torque should be constant.

Table IX. shows collected results for each of the four experiments described. The phase differences have been taken from the curves after plotting on squared paper. We notice, firstly, as a numerical quantity the leakage as between the maximum average values of the primary and secondary per half period amounts to 26·3, 23·9, 28·7 and 76·5 per cent. in the four cases. With regard to phase differences we notice that with 0·15 ohm in each armature circuit the difference between $m_1\ dI_1/dt$ and x_1 as also $m_2\ dI_2/dt$ and x_2 has its minimum value of 47°·4 (360° = 1 period). Taking the phase with ∞ in the armature as an origin, we see that $m_1\ dI_1/dt$ and $m_2\ dI_2/dt$ experience little change; but e_1 e_2 e_3 are much altered, the signs however are not altered. The phase of x_1 and x_2 has maximum diminution with 0·15 ohm; the phase of y_1 y_2 y_3 are much increased between ∞ and 0·15 ohm, but have not such a great increase between 0·15 and 0·012 ohm. The phase difference between x_1 and y_1 y_2 y_3 has a maximum value for 0·15 ohm. As is well known, the conclusion is that unlike the direct current motor an induction motor gives maximum starting torque for a particular external resistance in its armature, below or above which the torque decreases. The power factor is a maximum, since phase difference between applied potential difference and current is a minimum with maximum torque.

In applying an induction motor for the propulsion of a tramcar, for example, the controller should be so arranged that at starting the driver cannot exceed the position for maximum torque. With direct currents it happens that a careless driver puts over the controller too far at starting, with the result that the car jumps forward. With an induction motor such use of the controller would result in an abnormal current from the line, but practically no starting torque.

To give a complete account of this motor it would be necessary to observe curves for variation of frequency and potential differences, E_1 E_2, and position of armature with respect to field. The preceding curves refer to a frequency 52 and $\sqrt{\text{mean}^2}$ E_1 and $E_2=60$ volts. A similar set of curves

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have been obtained at frequency 95 and $\sqrt{\text{mean}^2}=80$ volts, the position of armature with respect to field being unaltered. The results of these tests are given in Tables X., XI., XII. and XIII. It will be seen that the same character of result is obtained, namely, that as the independent variables $\rho_1=\rho_2=\rho_3$ are given values between ∞ and 0, the torque rises to a maximum at about $\rho_1=\rho_2=\rho_3=0{\cdot}15$ ohm, and then diminishes. These tests, as well as those at frequency 52, will be specially referred to in the next section on "Armature Reaction." Table XVIII. gives a few other tests at other frequencies for which no curves have been taken.

(To be concluded.)

WIRELESS TELEGRAPHY.

We reprint below an interesting letter from the pen of Prof. J. A. Fleming, which appeared in *The Times* of Monday last, the 3rd inst. The letter deals with recent developments in wireless telegraphy on the Marconi system—the only system, by the way, that has yet attained success on a commercial scale:—

During the last few days I have been permitted to make a close examination of the apparatus and methods being employed by Signor Marconi in his remarkable telegraphic experiments between South Foreland and Boulogne, and at the South Foreland lighthouse have been allowed by the inventor to make experiments and transmit messages from the station there established both to France and to the lightship on the Goodwin Sands, which is equipped for sending and receiving ether wave signals. Throughout the period of my visit messages, signals, congratulations and jokes were freely exchanged between the operators sitting on either side of the Channel, and automatically printed down in telegraphic code signals on the ordinary paper slip at the rate of 12 to 18 words a minute. Not once was there the slightest difficulty or delay in obtaining an instant reply to a signal sent. No familiarity with the subject removes the feeling of vague wonder with which one sees a telegraphic instrument merely connected with a length of 150ft. of copper wire run up the side of a flagstaff begin to draw its message out of space and print down in dot and dash on the paper tape the intelligence ferried across 30 miles of water by the mysterious ether.

The public have already been placed in possession by *The Times* and other agencies of a general description of the apparatus employed by Signor Marconi, and there is no need, therefore, to enter into technical details. Within the last few days also various scientific men have been invited to give the public the guidance of their opinions on the novelty and utility of these demonstrations. These criticisms have for the most part not been of a very helpful character. The general public are not much concerned with questions of priority or with the claims or suggestions of rival experimentalists, but they are interested in ascertaining the serious possibilities of that which has been actually achieved. Signor Marconi has never hesitated to acknowledge that he has built upon the foundations laid by others, but a vast gulf separates laboratory experiments, however ingenious, from practical large scale demonstrations conducted with all that regularity and freedom from failure which is the absolute condition of their public utility.

I cannot help thinking that the time has arrived for a little more generous appreciation by his scientific contemporaries of the fact that Signor Marconi has by minute attention to detail, and by the important addition of the long vertical air wire, translated one method of space telegraphy out of the region of uncertain delicate laboratory experiments and placed it on the same footing as regards certainty of action and ease of manipulation, so far as present results show, as any of the other methods of electric communication employing a continuous wire between the two places. This is no small achievement. The apparatus, moreover, is ridiculously simple and not costly. With the exception of the flagstaff and 150ft. of vertical wire at each end, he can place on a small kitchen table the appliances, costing not more than £100 in all, for communicating across 30 or even 100 miles of channel. With the same simple means he has placed a lightship on the Goodwins in instant communication, day and night with the South Foreland lighthouse. A touch on a key on board the lightship suffices to ring an electric bell in the room at South Foreland, 12 miles away, with the same ease and certainty with which one can summon the servant to one's bedroom at an hotel. An attendant now sleeps hard by the instruments at South Foreland. If at any moment he is awakened by the bell rung from the lightship he is able to ring up in return the Ramsgate lifeboat, and, if need be, direct it to the spot where its services are required, within a few seconds of the arrival of the call for help. In the presence of the enormous practical importance of this feat alone, and of the certainty with which communication can now be established between ship and shore without costly cable or wire, the scientific criticisms which have been launched by other inventors against Signor Marconi's methods have failed altogether in their appreciation of the practical significance of the results he has brought about.

The public, however, are not in the least interested in learning the exact meed of merit to be apportioned to various investigators in the upbuilding of this result. They do, however, want to know whether the new method of communication across the Channel established by the expenditure of a few hundred pounds will take the place to any considerable extent of submarine cables which have cost many thousands of pounds to lay and equip. They do also desire to learn what reasons, if any, will prevent every lighthouse and lightship round our coasts from being forthwith furnished with the necessary apparatus for placing it in instantaneous and secure connection with the mainland. They also hope to hear that the methods can be applied to enable ships to be able in addition to communicate instantly in case of need with shore stations. To understand how far these things can be done, and to appreciate the necessary or present limitations of the method, it is requisite to explain that each vertical wire or rod connected to a Marconi receiving or sending apparatus has a certain "sphere of influence." Signor Marconi has proved by experiment up to certain limits that the distance to which effective signalling extends varies as the square of the height of the rod. A wire 20ft. high carries the effective signal one mile, 40ft. high four miles, 80ft. 16 miles, and so on. Up to the present time he has not yet discovered any method of shielding any particular rod so as to render it responsive only to signals coming from one station and not from all others within its sphere of influence. In spite, however, of what has been said, there is no inherent impossibility in attaining this desired result. At present all signals sent from the South Foreland to France affect the receiver on board the Goodwin lightship. But this offers no difficulty. In an ordinary electric bell system in a hotel the servant recognises the room from which the signal comes by means of a simple apparatus called an indicator, and a very similar arrangement can be applied to distinguish the origin of an ether wave signal when several instruments are at work in a common region. Subsequent inventions, as also perhaps the promulgation of some necessary Board of Trade regulations for the use of the ether, will prevent official ether wave receivers from being disturbed by vagrant electric waves sent out by unauthorised persons in their neighbourhood. The practical upshot, however, of the matter is that at present if more than two stations are not established within certain regions these stations pair and pair can communicate with each other freely and regularly by means of ether wave signals sent out and received by long vertical rods or wires. No state of the atmosphere, and neither darkness nor storm, interrupts, so far as yet found, the freedom of communication.

Up to the present time none of the other systems of wireless telegraphy employing electric or magnetic agencies have been able to accomplish the same results over equal distances. Without denying that much remains yet to be attained, or that the same may not be affected in other ways, it is impossible for any one to witness the South Foreland and Boulogne experiments without coming to the conclusion that neither captious criticism nor official lethargy should stand in the way of additional opportunities being afforded for a further extension of practical experiments. Wireless telegraphy will not take the place of telegraphy with wires. Each has a special field of operations of its own, but the public have a right to ask that the fullest advantage shall be taken of that particular service which ether wave telegraphy can now render in promoting the greater safety of those at sea, and that, in view of our enormous maritime interests, this country shall not permit itself to be outraced by others in the peaceful contest to apply the outcome of scientific investigations and discoveries in every possible direction to the service of those who are obliged to face the perils of the sea. If scientific research has forged a fresh weapon with which in turn to fight Nature "red in tooth and claw," all other questions fade into insignificance in comparision with the inquiry how we can take the utmost advantage of this addition to our resources.

BOOKS RECEIVED.

"*Journal* of the Institution of Electrical Engineers." No. 138, Vol. XXVIII. Edited by W. G. McMillan. (London: E. and F. N. Spon.) Price 4s.

"*Proceedings* of the Royal Society." No. 410, Vol. LXIV. (London: Harrison and Sons.) Price 2s.

"*Proceedings* of the Royal Society of Edinburgh." No. 3, Vol. XXII.

"*Transactions* of the North-East Coast Institution of Engineers and Shipbuilders." Parts 3, 4 and 5, Vol. XV. (London: Andrew Reid and Co.)

"Annual (1898-1899) Catalogue of the Massachusetts Institute of Technology." (Boston: Rockwell and Churchill Press.)

"Professional Papers of the Corps of the Royal Engineers." Paper 6, Vol. I. Foreign Translation Series. Translated by Capt. R. F. Edwards, R.E. (Chatham: W. and J. Mackay and Co.) Price 1s.

"Une Excursion Électrotechnique en Suisse par les Élèves de l'École Supérieure d'Electricité," with a preface by P. Janet. (Paris: Gauthier-Villars.)

"La Tracción Eléctrica Lo Que Ha Sido Lo Que Es y Lo Que Puede Ser." By Enrique Hauser. Reprint from "La Revista Minera Metalurgica y De Ingenieria." (Madrid: E. Teodoro.)

"Materialistisch-hypothetische Sätze und Erklärung des Wesens und der Kraftausserungen des Elektrischen Fluidums." By F. Ph. Stögermayr. Two vols. (Leipzig: A. Hartleben.) Price 3 marks each.

"Dynamomaschinen für Gleich-und Wechselstrom." By Gisbert Kapp. Third Edition, revised and enlarged. (Berlin: Julius Springer.) Price 12 marks.

"Science Abstracts." No. 15, March, 1899. Issued under the direction of the Institution of Electrical Engineers and the Physical Society of London. (London: E. and F. N. Spon.) Price 2s.

"Electrical Installation Rules." Published by the Yorkshire Insurance Co. 1899 edition.

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ELECTRICITY WORKS ACCOUNTS.

Worcester Municipal Electric Supply Works.

It is with pleasure that we are able to show, in our analysis of last year's accounts of the Worcester electric lighting undertaking, such a substantial improvement over the already very satisfactory figures for the costs of 1897. Started on Oct. 11, 1894, the year 1898 represented the fourth completed year of working. During the year, £7,104 has been expended on capital account, raising the total expenditure to £74,397, or £149 per kilowatt of generating capacity of plant installed. Owing to the non-completion of the new engine and alternator, the connecting of new consumers was not encouraged during the latter part of the year owing to the overloaded state of the station and the absence of reserve plant. However, 80 additional consumers raised the total to 355, and the equivalent number of 8 c.p. lamps from 24,146 to 27,783—an increase of 15 per cent. With an output of 474,344 units sold, the revenue was £7,154—an average from all sources of 3·62d. per unit. The average price obtained for supply was only 2·845d. per unit—a price on which consumers of electricity in Worcester are to be congratulated. As regards the costs, notwithstanding that, in consequence of the coal strike, 123 tons of coal were paid for at from 24s. to 25s. 6d. per ton, as against the contract price of 14s. 6d., the fuel costs have dropped from 0·742d. to 0·614d. per unit. Wages, and especially repairs and maintenance costs at the station, have also been reduced. On the other hand, distributing costs and management charges have risen somewhat. The net result has been that the total costs have been reduced by nearly 0·3d., and now stand at barely 2d. per unit, a figure which is well below that of the average of municipal stations of similar output.

In spite of the low revenue, the ratio of the costs to the revenue comes out at 55·1 per cent. in 1898, as compared with 65 per cent. in 1897. For these satisfactory results great credit is due to Mr. E. T. Ruthven-Murray, who was engineer at Worcester until December 31st last.

The working profit for the year was £3,210, or 4·53 per cent. of the mean capital. After a payment of £1,725 to the reserve fund and £1,946 as interest on loans, the deficit was £460.

It should be noted that there were 10 days in the year when water power was completely unavailable, owing either to flood or drought, as against 25 days in 1896.

The following table gives the number of units generated, accounted for, and sold, which were generated by steam and by water power in 1897 and in 1898 :—

Year.	Total units.	Total B. T. U.	Steam B. T. U.	Per cent.	Water B. T. U.	Per cent.
1897	Generated	559,275	298,610	53·40	260,665	46·60
	Accounted for	434,425	242,757	55·88	191,668	44·12
	Sold	429,270	240,178	55·94	189,092	44·06
1898	Generated	610,492	283,072	46·36	327,420	53·64
	Accounted for	480,524	224,301	46·68	256,223	53·32
	Sold	474,344	222,241	46·85	252,103	53·15

Another table is also appended showing the more interesting figures for the four years during which the undertaking has been working :—

Year.	No. of consumers	Equiv. 8 c.p. lamp connection.	Output units sold.	Revenue total.	Total costs.	Deficit	Total costs per unit.
1895	181	13,522	246,912	£3,254	£3,061	£1,977	2·975d.
1896	241	21,958	333,644	4,758	3,155	1,616	2·270d.
1897	291	24,712	429,270	6,292	4,097	1,475	2·290d.
1898	382	28,496	474,344	7,154	3,944	460	1·996d.

Brighton and Rottingdean Seashore Electric Tramroad Co.

The extraordinary conditions under which this line is worked invest it with an interest more than sufficient to justify our preparing an analysis of the accounts for the year 1898. It will be remembered that the line was opened in November, 1896, and is constructed on the overhead trolley system (supplied at 550 volts pressure). The track has an 18ft. gauge and is laid along the foreshore between the terminus of Mr. Volk's little line at Brighton and Rottingdean. There is an intermediate station at Ovingdean. The level of the track is slightly above low water level, but is submerged to a depth of about 14ft. at high tide. One car only is run, and this measures 50ft. over all by 22ft. wide, weighs 40 tons, and is capable of accommodating 150 passengers at a height of about 24ft. above the rails. The power station is situated at the Brighton end of the line, and current is taken from the Corporation mains at 230 volts and transformed up to the line pressure of 550 by a 60 kilowatt motor and generator set. Accumulators are also installed in the power house for regulation purposes.

At Dec. 31st last the authorised total capital stood at £35,000, out of which £24,140 had been paid up as share capital, and £5,000 had been borrowed. At the same date the expended capital had amounted to £35,792 or at the rate of £11,931 per mile of railway.

The car-mileage for the latter half year of 1898 was 2,539, and the number of passengers carried 67,422, as compared with 2,508 car-miles and 45,106 passengers in the first half of the year. In this connection it may be interesting to note that the car-mileage and the number of passengers carried during the half-year ended December 31, 1897, was respectively 2,601 and 44,282.

The revenue earned during the last completed half-year was £1,679 or 13s. 2¾d. per car-mile. To this the revenue, at 9s. 3½d., bears a ratio of 70·3 per cent. With a revenue per passenger of barely 6d., this is quite a surprising result under the conditions. Even more remarkable are the figures representing the locomotive power costs, which in the first half of 1898 was 2s. 5½d., and in the latter half 3s. 5½d., or a mean for the year of 2s. 11d. per car-mile, considering that traffic is carried on in a mean depth of 7ft. of water and that the car capacity is 150 passengers.

The gale in the latter end of 1896 was a serious set-back to the Company through the loss of capital experienced, and we are informed that, with only one car running, the facilities for dealing with the traffic in the summer months is quite inadequate, and passengers have to be refused. We are also told that since the late reduction in the charge for power to 1d. per unit after 7d. for the first hour daily, the "locomotive power" item is and will be no more than 1s. 5d. per car-mile. If this is so, there seems every reason to expect that the line will become a financial success, and we shall look forward with interest to the publication of the accounts for the next period.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared :—

Aberdeen (Municipal)	1899	Jan. 6	
Ayr (Municipal)	1898	Nov. 11	
Bedford (Municipal)	,,	Mar. 4	
Belfast (Municipal)	,,	Sept. 23	
Birmingham (Company)	,,	Dec. 16	
Blackpool (Municipal)	,,	Oct. 7	
Bournemouth (Company)	,,	June 3	
Bolton (Municipal)	,,	Dec. 9	
Bradford (Municipal)	,,	May 20	
Brighton (Municipal)	,,	May 6	
Bristol (Municipal)	,,	July 29	
Burnley (Municipal)	,,	Sept. 16	
Burton-upon-Trent (Mun.)	,,	April 15	
Bury (Municipal)	,,	Nov. 25	
Cambridge (Company)	1899	Mar. 10	
Cardiff (Municipal)	,,	Jan. 6	
Charing Cross (Company)	,,	Mar. 17	
Chelsea (Company)	,,	Mar. 31	
Cheltenham (Municipal)	1898	Oct. 7	
Chester (Municipal)	,,	Oct. 14	
Clerkenwell (Company)	,,	Mar. 18	
Derby (Municipal)	,,	Dec. 9	
Dewsbury (Municipal)	,,	Nov. 25	
Dover (Company)	,,	Mar. 11	
Dundee (Municipal)	,,	Nov. 4	
Eastbourne (Company)	,,	July 22	
Edinburgh (Municipal)	,,	Oct. 14	
Exeter (Municipal)	,,	Aug. 5	
Glasgow (Municipal)	,,	Aug. 12	
Guildford (Company)	,,	May 13	
Halifax (Municipal)	,,	Nov. 18	
Hammersmith (Vestry)	,,	June 10	
Hampstead (Municipal)	,,	Sept. 9	
Hanley (Municipal)	,,	April 8	
Harrogate (Municipal)	,,	Dec. 30	
Harrow (Company)	,,	Sept. 9	
Hast'gs & St. Leonard's (Co.)	,,	April 29	
H'use-to-H'use Co. (K'ns'gt'n)	1899	Mar. 31	
Hove (Company)	,,	Mar. 10	
Huddersfield (Municipal)	1898	Mar. 25	
Islington (Vestry)	,,	June 24	
Kensl'gton & Knightsbr' (Co.)	'99	Mar. 3	
Kingston-upon-Hull (Mun.)	1898	Aug. 19	
Kingston-on-Thames (Mun.)	,,	Mar. 25	
Lancaster (Municipal)	,,	Oct. 21	
Leeds (Company)	1899	Mar. 3	
Leicester (Municipal)	,,	Jan. 20	
Leyton (Municipal)	1898	Sept. 23	
Liverpool (Municipal)	,,	Aug. 12	
Manchester (Municipal)	,,	July 29	
Newcastle and District (Co)	,,	Dec. 2	
Newcastle-upon-Tyne (Co.)	,,	April 29	
Northampton (Company)	,,	April 15	
Norwich (Company)	,,	Dec. 2	
Notting Hill (Company)	1899	Mar. 17	
Nottingham (Municipal)	1898	Oct. 28	
Oldham (Municipal)	,,	Nov. 18	
Oxford (Company)	,,	April 1	
Portsmouth (Municipal)	,,	Nov. 4	
Preston (Company)	,,	Oct. 28	
Reading (Company)	,,	Sept. 16	
Richmond (Company)	,,	Mar. 4	
Scarborough (Company)	,,	April 1	
St. James' & Pall Mall (Co.)	1899	Feb. 24	
St. Pancras (Vestry)	1898	May 13	
Sheffield (Company)	,,	Dec. 16	
Shoreditch (Vestry)	,,	May 27	
Southampton (Municipal)	,,	June 3	
Southport (Municipal)	,,	Dec. 23	
Stafford (Municipal)	,,	Oct. 21	
Sunderland (Municipal)	,,	Aug. 19	
Taunton (Municipal)	,,	Aug. 5	
Tunbridge Wells (Mun.)	,,	July 22	
Walsall (Municipal)	,,	Nov. 11	
Wandsworth (Company)	,,	Mar. 18	
Westminster (Company)	1899	Feb. 24	
Whitehaven (Municipal)	1898	Dec. 23	
Windsor (Company)	,,	Dec. 30	
Wolverhampton (Municipal)	,,	July 15	
Woolwich (Company)	1899	Jan. 13	
Worcester (Municipal)	1898	May 13	
Yarmouth (Municipal	,,	June 17	

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WORCESTER.

Undertaking Worked by	Corporation of Worcester.
Date of Commencement of Supply	October 11, 1894.
System of Supply	Alternate-current transformers in sub-stations and houses.
Chief Engineer	C. J. Sutherland.

YEAR ENDED	DEC. 31, 1897.	DEC. 31, 1898.
QUANTITIES—		
Units generated	559,275	610,492
„ SOLD (TOTAL)	429,270	474,344
„ sold to consumers	325,130*	365,944*
„ sold for public lighting, &c.	104,140	108,400
„ used on works	5,155	6,180
UNITS SOLD per 8 c.p. LAMP CAPACITY	25·9	28·8
Maximum supply demanded	740 kilowatts	854 kilowatts
Number of public lamps	55 arc, 5 incan.[a]	56 arc, 5 incan.[a]
Number of consumers	275	355
Connections to mains in 8-c.p. lamps	24,146	27,783
CAPACITY OF PLANT IN 8-c.p. LAMPS	16,600	16,600
CAPACITY OF PLANT IN KILOWATTS	500	500

CAPITAL—	Total.	per kw. capacity.	Total.	Per kilowatt capacity.
AUTHORISED (TOTAL)	£71,738	£143	£71,738	£143
Share	—	—	—	—
Loan (including Debenture charges)	71,738	143	71,738	143
RECEIVED (TOTAL)	[b]62,569	125	63,140[b]	126
Share	—	—	—	—
Loan (including Debenture charges)	61,748	124	61,747	124
AUTHORISED, NOT RECEIVED (TOTAL)	9,990	20	9,990	20
Share (unissued)	—	—	—	—
Share (uncalled)	—	—	—	—
Loan (including Debentures)	9,990	20	9,990	20
REPAID (TOTAL)	—	—	—	—
RESERVE OR SINKING FUND	4,271	8·55	6,109	12·2
DEPRECIATION FUND	—	—	—	—
EXPENDED (TOTAL)	67,293	135	74,397	149
Lands and buildings	25,991	52·0	26,242	52·5
Plant	} 40,274	80·6	47,124	94·2
Mains				
Miscellaneous	1,029	2·06	1,031	2·06
BALANCE OF CAPITAL ACCOUNT	[c]−4,725	−9·46	−11,257[c]	−22·5

REVENUE—	Total.	Per unit sold.	Total.	Per unit sold.
TOTAL	£6 292	3·520d.	£7,154	3·620d.
Revenue from supply	4,683	2·620d.	5,620	2·845d.
„ meters, &c.	192	0·107d.	166	0·084d.
„ public lighting	1,266	0·708d.	1,281	0·649d.
„ sale of lamps, &c.	—	—	4	0·002d.
„ miscellaneous sources	151	0·085d.	84	0·043d.
EXPENDITURE—				
TOTAL COSTS	£4,097	2·290d.	£3,944	1·996d.
WORKS COSTS	3,447	1·930d.	3,062	1·550d.
Generation of Electricity	*3,043*	*1·700d.*	*2,574*	*1·304d.*
Fuel (including cartage, &c.)	1,328	0·742d.	1,212	0·614d.
Oil, waste, water, stores	145	0·082d.	212	0·107d.
Wages at station	957	0·535d.	953	0·482d.
Repairs & maintenance at Station	613	0·353d.	197	0·100d.
Distribution of Electricity	*62*	*0·035d.*	82	*0·042d.*
Wages, &c.	52	0·029d.	40	0·020d.
Repairs, renewals of mains, &c.	10	0·005d.	42	0·021d.
Public Lighting	*342*	*0·191d.*	*407*	*0·206d.*
Attendance	} 342	0·191d.	407	0·206d.
Renewals				
MANAGEMENT CHARGES, &c.	651	0·364d.	882	0·447d.
Royalties	—	—	—	—
Rent, rates, taxes	*87*	*0·048d.*	*80*	*0·041d.*
Management	*564*	*0·315d.*	*802*	*0·406d.*
Salaries	362	0·202d.	477	0·242d.
Stationery, &c.	57	0·032d.	·43	0·022d.
Establishment charges	47	0·026d.	34	0·017d.
Law charges, &c.	98[d]	0·055d.	248[g]	0·126d.

FINANCIAL RESULTS—	Total.	% to mean cap. exp'd.	Total.	% to mean cap.exp'nded
WORKING PROFIT FOR YEAR	£2,195	3·43%	£3,210	4·53%
Carried to Depreciation Fund	—	—	—	—
Carried to Res. or Sinking Fund	1,724	2·69%	1,725	2·44%
Net int. on loans (incl. Deb. charges)	1,946	3·04%	1,946	2·75%
BALANCE FROM LAST ACCOUNT	nil	—	nil	—
Do. AVAILABLE for DISTRIBUTION, &c	—	—	—	—
Deficit	*1,475[h]*	*2·30%*	*460*	*0·650%*
ORDINARY DIVIDEND PAID	—	—	—	—
% of TOTAL COSTS to GROSS REVENUE	65%		55·1%	
Expenditure per kilowatt capacity	£8. 3s. 7d.		£7. 17s. 10d.	
REVENUE PER KILOWATT CAPACITY	£12. 11d. 5d.		£14. 6s. 0d.	
Expenditure per 8-c.p. lamp capacity	4s. 11d.		4s. 9d.	
REVENUE PER 8-C.P. CAPACITY	7s. 7d.		8s. 7½d.	
REVENUE PER 8-C.P. CONNECTED	5s. 2½d.		5s. 1½d.	
Price charged for lighting, per unit	} 6d. to 2½d.[e]		6d. to 2½d.[e]	
„ for power, per unit				
„ for public lighting	£22. 12s. 0d.[f]		£22. 9s. 3d.	

WORCESTER.—REMARKS—* Includes 104,080 units taken by waterworks motors in 1897 and 96,114 in 1898. *a* The arcs are 500 watt and the incandescents 112 watt lamps. *b* Includes £1,871 premiums on stock, £116 on sale of boilers, etc., and £506 from General District Fund for preliminary expenses in 1897 and 1898, also in 1898, £535 from General District Fund (commission). *c* Over-expended. *d* Included £19 to insurance. *e* 6d. for first hour, 2½d. after. *f* Taking an equivalent of 56 arcs in 1897 and 57 in 1898. *g* Includes £36 to law expenses, £21 to insurance, £13 to Free Wiring Co. and £178 to "lamps." *h* Met by General District Fund.

BRIGHTON AND ROTTINGDEAN SEASHORE ELECTRIC TRAMROAD CO.

Worked by	The Brighton and Rottingdean Seashore [Electric Tramroad Co.
Date of Commencement of Working	November, 1896.
System	Overhead trolley at 550 volts.
Chief Engineer	Magnus Volk.

Half-year ended	June 30, 1898.	December 31, 1898.
QUANTITIES.		
Train mileage	*2,508*	*2,539*
Passengers Carried	45,106	67,422
Length of railway authorised	3 ml.	3 ml.
Length of railway constructed	3 ml.	3 ml.
Length of Railway Worked	3 ml.	3 ml.
Length of railway under construction	nil	nil
Rolling stock, number of cars	} 1*	1*
„ number of locos.		
CAPITAL.		
Authorised (Total)	£35,000	£35,000
Authorised (share)	28,000	28,000
Authorised (loan)	7,000	7,000
Received (Total)	28,139	29,140
Received (share)	23,139	24,140
Received (loan)	5,000	5,000

	Total.	Per mile of working railway.	Total.	Per mile of working railway.
Expended (Total)	£34,933	£11,644	£35,792	£11,931
On line open for traffic	—	—	—	—
On line in course of construction	—	—	—	—
On working stock, including power station	—	—	—	—
Balance of Capital Account	−6,794[i]	−2,265	−6,652[i]	−2,217
Renewal Fund	—	—	—	—
Contingent Fund	—	—	—	—

REVENUE.	Total.	Per train mile.	Total.	Per train mile.
Total	£1,092	8·71s.	£1,679	13·23s.
Passenger traffic	1,088	8·67s.	1,664	13·10s.
Parcels, rents, transfer fees, &c.	4	0·032s.	16	0·126s.
EXPENDITURE.				
Total	£1,006	8·015s.	£1,180	9·300s.
Maintenance of way, works, & stations (less depreciation)	*113*	*0·900s.*	*114*	*0·898s.*
Maintenance of way	} 113	0·900s.	114	0·898s.
Repairs of structure, stations, &c.				
Locomotive power	*309*	*2·46s.*	*437[e]*	*3·44s.*
Coal and coke	129	1·028s.	142	1·12s.
Wages at power station	165	1·314s.	78	0·614s.
Oil and stores	} 15[a]	0·120s.	10[d]	0·079s.
Repairs and renewals				
Repairs and renewals of cars	*36[b]*	*0·287s.*	*176[f]*	*1·39s.*
Traffic expenses	*181*	*1·44s.*	*128*	*1·01s.*
Salaries and wages	140	1·12s.	110	0·866s.
Other charges	41	0·327s.	18	0·142s.
General charges	*277*	*2·21s.*	*221*	*1·740s.*
Directors	100	0·797s.	100	0·788s.
Salaries of Secretary, General Manager, and Clerks	177	1·41s.	121	0·953s.
Other charges				
Rent, rates, taxes, &c.	*41*	*0·327s.*	*36*	*0·284s.*
Miscellaneous items	*49[c]*	*0·391s.*	*69[g]*	*0·544s.*

FINANCIAL RESULTS.	Total.	Per cent. to mean capital expended.	Total.	Per cent. to mean capital expended.
Working Profit for Half-year	£86	0·250%	£499	1·410%
Sum carried to depreciation fund	—	—	—	—
Net interest on loans	223	0·648%	361	1·02%
Balance from last half-year's account	−41	−0·119%	−178	−0·503%
Balance Available for Dividend	−178[h]	−0·517%	−39[h]	−0·110%
Ordinary Dividend paid at per cent. per annum	nil	—	nil	—
Percentage of total expenditure to revenue	92%	—	70·3%	—
Revenue per Mile of Working Railway	£364	—	£560	—
Expenditure per mile of working railway	£335	—	£393	—
Revenue per Passenger	5·81d.	—	5·98d.	—

BRIGHTON AND ROTTINGDEAN SEASHORE ELECTRIC TRAMROAD CO.—REMARKS—* One motor car only. *a* Includes oil £4, and "miscellaneous" £11. *b* Being amount under designation of "rolling stock." *c* Includes £43 to insurances and £6 to auditing. *d* To "miscellaneous." *e* Includes £207 to item "electricity." *f* This includes £140 to materials and £36 wages on account of "maintenance, rolling stock." *g* Includes £63 to insurance and £6 to auditing. *h* Being deficits. *i* Over-expended.

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INDUCTION MOTOR PROSPECTS.

The Paper, entitled "The Induction Motor," recently read before the Institution of Electrical Engineers, was, we think, somewhat misnamed. It should rather have been headed "The Starting of an Induction Motor," for, with the exception of a few general remarks at the commencement, it dealt exclusively with the tests made by the author on the behaviour when starting of a certain 15 H.P. motor temporarily in his possession. And interested though we were in the investigation of the properties of this machine, we confess that we should have been yet more interested in a Paper dealing more comprehensively with the whole question of the induction motor. Further, it is a pity that the machine experimented on was not a more representative one. The author tested it as a two-phase motor, though, as he stated, it was primarily designed to run as a single-phase; and in the best modern Continental and American practice a two or three-phase motor of like rating would be considerably more compact and run with a considerably smaller air gap, and consequently with much reduced leakage, which would in turn result in higher torque, power factor and efficiency.

But the fact that such a Paper has been read before the premier association of English electrical engineers, together with many no less significant indications of the mind of the practical engineering world, show that the induction motor is gradually coming to the front in this country as it has already done abroad, and it is safe to prophesy that, in the course of the next few years, many hundreds of motors of this class will be brought into service among us. The advantages of the polyphase system can no longer be overlooked in an age in which commercial competition is so keen that every improvement that makes for greater convenience and the reduction of labour has to be adopted if a business is to survive. It is true that in this country we have hitherto generally associated multiphase work with the use of abnormally high potential, and, with a lament for the scarcity of our waterfalls, have allowed the subject to fade from our thoughts; but day by day it is being made clearer that the advantages of the induction motor are no less marked in cases where a low potential

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would naturally be employed. We are now speaking of bi- or tri-phase induction motors, and not of the single-phase motor, which though no doubt extremely serviceable in certain cases, yet, on the whole, lacks just those qualities of simplicity and hardiness which give the polyphase motor its pre-eminence. As compared with its continuous-current rival, the multiphase induction motor can be made at least as light, and certainly more compact, and, as there is no commutator, and in the smaller sizes no rubbing contacts whatever, it can be left quietly running in dark and unhealthy corners for weeks with no further attention than an occasional oiling and blowing free from dust. It can start itself on full load, regulate itself; in fact, look after itself entirely. In short, it may be regarded as nothing more than a metal case giving forth rotary energy. Further, it can be constructed to give as much as four or five times its full load torque at starting—an important consideration in crane or hoist work—and will, as a rule, stand an overload that would ruin the commutator of the best continuous-current motor; though, of course, such an overload must not be applied continuously, or overheating will result, as with the continuous-current motor. It is true that motors with unusually large starting torque lose somewhat in efficiency, and that the induction motor, as a whole, labours under the disadvantage of having a power factor less than unity (varying from about 90 per cent. at full load to about 60 per cent. at quarter-load), and, further, that the starting current is, say, two or three times the full load current when no variable resistance is arranged for in the rotor circuit, but these drawbacks are far more than compensated for by the advantages above mentioned. This is particularly the case with small motors, say, up to 10 or 12 H.P., where efficiency in power is of small moment as compared with ultimate efficiency in the matter of convenience. Moreover, by the addition of three rubbing contact rings on the rotor, and a suitable external resistance (such as is generally provided with motors of about 10 H.P. and upwards), the efficiency can be made quite as high as that of the corresponding continuous-current motor, and at the same time the starting current can be brought down so as not to exceed the normal full-load current while the torque is but little less than at full load. Also, by keeping the resistance in circuit and altering it while the motor is running, the speed of rotation can be varied to any desired extent, though, of course, with varied efficiency. Much has been said concerning the wastefulness of this arrangement, and the continuous-current motor has been lauded in contrast, but in how many cases in practice do we find that a stationary shunt or series continuous-current motor is regulated by alteration of the field ampere turns? Not more than in perhaps nine or ten out of a hundred; whatever regulation is required being, as a rule, obtained in exactly the same way as in the induction motor, *i.e.*, by the insertion of resistance in series with the armature. Surely, then, the advantage lies with the induction motor, which requires no automatic device to protect its armature against interruption in the supply, nor any automatic circuit breaker to guard a commutator against overload. And it should be remarked that in those comparatively few cases in which the regulation of a continuous-current motor is effected by alteration of the field ampere turns, this means that the magnets and field windings are heavier, and the machine consequently costlier than would otherwise be the case. But as often as not it is constant, and not variable, speed that is required; and here the induction motor once more scores over its opponent, for the only factor upon which its speed depends (apart from alteration of the resistance of the rotor circuit) is the frequency, which may be kept as invariable as is desired in the generating station; while, in the case of the continuous-current motor, the voltage, the load, and (in the case of a shunt machine) the temperature, of its field coils, all produce variations. It is, of course, true that the induction motor does not run quite in synchronism with the revolving field of the stator, but the slip is exceedingly small, being only about 2 per cent. at full load in a 50 or 100 H.P. motor, and but 7 per cent. in one of 2 H.P., and proportionally less at smaller loads. The pressure of supply in a polyphase system should, however, be kept as constant as possible, since the power of an induction motor varies as the square of the impressed E.M.F., and if that E.M.F. falls to any considerable extent the point of maximum torque may be but little beyond the working torque, with the result that should the load be increased the motor may suddenly pull up.

Yet there is one class of work for which the two or three-phase motor does not seem, at least at present, to be adapted, namely, for the propulsion of tramcars in an urban district where frequent changes of speed are necessary. For railways or tram lines in the country, where full speed may be maintained over long distances at a time, and where there are but few crossings, such motors are extremely suitable, not only on account of the high potential which can be employed in the transmission line, but also because of the simplicity of construction of the motors themselves. But in crowded town traffic the case is otherwise, and it is far more economical in power to employ on each car two continuous-current series-wound motors, the speeds of which are regulated by a series parallel controller. In addition to this, the continuous-current system has the advantage of requiring but a single-trolley wire, as against the two required by the polyphase, which lead to considerable complication and trouble when the crossings are numerous; even allowing for the fact that a polyphase motor will work as a single phase if once started, and that, consequently, where the lines meet, but a single trolley need be employed. There is the further objection to the polyphase trolley-wire system, that it has great inductive effects in neighbouring wires which, of course, are numerous within the limits of a town or city.

REVIEWS.

Electricity in Town and Country Houses. By PERCY E. SCRUTTON. (London: Archibald Constable and Co. 1898.)

Assuming that there is a legitimate function for books of this class, the work under present notice stands criticism perhaps better than most of such works. Some of the chapters —notably the last two or three—are somewhat loosely written, with the result that to the uninitiated, for whom the book is intended, many statements are apt to convey an erroneous impression. There is also here and there, where such is attempted, incompleteness of discussion of practical details. The author has, on the whole, very fairly suceeded in his object as defined in the opening sentence of the first chapter, which "is to put before the reader in a popular form the many uses to which electricity can be put in his house . . . and the cost which the use of it entails."

Dictionaire Technique Français-Anglais des Outils et Ustensiles Employés dans lès Métiers Manuels, La Petite Industrie le Ménage, &c. By A. S. Lovendal. (Paris: Boyveau et Chevillet, 1899.)

This is not a dictionary, but a vocabulary of tools used in various trades, and it has, therefore, limited application. The words are arranged under about 50 headings, and only in a few instances alphabetically. A draw-vice (mâchoire à tendre) is called an "electrician's stretching jaw," and, with unexpected humour, the next entry is electrician's twisting jaw —mâchoire *à tordre*.

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THE HISSING OF THE ELECTRIC ARC.*

BY MRS. AYRTON.

(Concluded from page 794.)

We now pass from the consideration of the electrical measurements of the arc to the appearance of the crater, arc, and carbons. Every alteration of the current and of the distance between the carbons naturally produces a corresponding modification of all parts of the arc, but until the value of the current attains a certain magnitude, which depends only on the length of the arc with a given pair of carbons, this change is one of degree merely, and not of character. A greater current simply produces a large crater, a larger arc, and longer points to the carbons. When the special current is reached, however, a change which is no longer merely one of degree, takes place in the crater. Instead of presenting a uniformly bright surface to the eye, this becomes partly covered with what appear to be alternately bright and dark bands in one or more sets of concentric circles, moving round different centres in opposite directions. The directions of rotation and the entire positions of the images change continually, and the motion grows faster and faster as the current is increased. It is impossible that these figures, which do not move too fast to be clearly seen by the eye in an image of the arc magnified only 10 times, should have escaped the observation of all those who have made a study of the arc, and yet, after a careful search, I can find no mention of them anywhere. When the current is so much increased that the motion becomes too fast for the eye to detect, the arc begins to hum, and then, as Mr. Trotter † first showed in 1894, it rotates at the rate of from 50 to 450 revolutions per second. These rapid revolutions, which the unaided eye is incapable of observing, he discovered by the use of a disc having alternate arms and spaces, and kept in rapid rotation ; but, in his account of his observations, he makes no reference to the relatively slow rotations which *precede* the hum. In fact, the rotations observed by Mr. Trotter appear to begin just where those I have been describing become too quick for the eye to see unaided, and end just as the arc begins to hiss, for he mentions that at 450 revolutions per second the arc breaks into a hiss. As soon as hissing begins, the whole appearance of the crater changes again ; a sort of cloud seems to draw in round a part of it, moving from the outer edge inwards, and varying continually in shape and position. Sometimes but one bright spot is left, sometimes several, but always the surface is divided into bright and dull parts, giving it a mottled appearance, as is slightly indicated in (*b*) Fig. 4. If, then, the current be diminished, so that the arc becomes silent again, the whole surface of the crater grows dark for an instant, then brightens in spots and finally becomes bright again all over.

The vaporous arc itself undergoes fewer modifications ; it preserves the ordinary characteristics of the silent arc while dancing circles hold possession of the crater, but, when humming begins, a green light is seen to issue from the crater, and with hissing this becomes enlarged and intensified, till the whole centre of the purple core is occupied by a brilliant greenish-blue light, as is indicated in Fig. 5. The *shape* of the arc now alters also. While it is silent or humming, no great difference can be observed in its form. With solid carbons it is rounded or pear-shaped according to its length, and has an appearance of great stability. But as soon as hissing occurs, the arc seems to suddenly dart out from between the carbons and to become flattened out, as if under the influence of a centrifugal force acting at right angles to the common axis of the two carbons. In Fig. 5 this flattened appearance is well marked, as it is also in (*d*) Fig. 6 ; and, indeed, these figures show that every part of the vaporous arc itself is involved in this flattening—the purple core, the shadow round it, and the green aureole—as if they were all revolving with great rapidity round a common axis. And what more likely than that this is the case, since, as has already been mentioned, the arc is revolving at the rate of 450 revolutions per second *at the moment that it starts hissing*. As regards the carbons themselves, the only important modification of the *negative* carbon that appears to be due to hissing is the formation of the well-known "mushroom" at the end of that carbon with a *short* hissing arc. This mushroom, of which a good example is seen in Fig. 5, is well named, not only because of its shape, but also because of the rapidity of its growth, which is so great that while it is forming the carbons often have to be *separated*, instead of being *brought together*, to keep the length of the arc constant.

And now we come to the most important of all the changes that take place when the arc begins to hiss, viz., the alteration in the shape of the *positive* carbon. During the course of his 1889 experiments, Luggin ‡ observed that the arc hissed when the crater filled the whole of the end of the positive carbon. He was thus the first to call attention to the fact that there was a direct connection between hissing and the relation between the area of the crater and the cross-section of the tip of the positive carbon. My own observations in 1893 led to a conclusion somewhat similar to Luggin's, but yet differing in an important particular. It seemed to me that with hissing arcs the crater always *more* than covered the end of the positive carbon—that it overflowed, as it were, along the side. How far this is true will be seen from an examination of Figs. 4, 5, 6, and 7, which show the shaping of the carbons under various conditions with silent and hissing arcs. These figures have all been made from tracings of the images of actual normal arcs, burning between carbons of various sizes. For Fig. 4 the diameters of the carbons were the same, but the currents and lengths of arc were different. Fig. 5 is the image of a short hissing arc. For Fig. 6 the positive carbons were all of the same size, and the arcs of the same length, but the current had four different values, while for

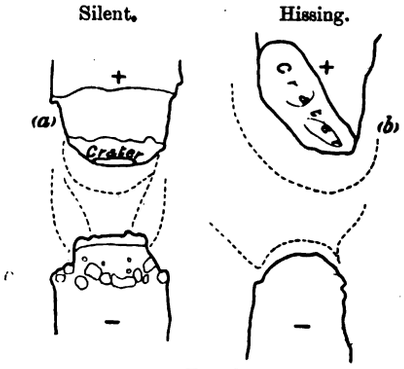

Fig. 4.

Carbons: Positive, 9mm. cored ; Negative, 8mm. solid.
Length of Arc: (*a*) 5mm. ; (*b*) 8mm. Current: (*a*) 3·5 amperes ; (*b*) 34 amperes.

Fig. 7 the current and the length of the arc were the same for both (*a*) and (*b*), but the diameter of one of the positive carbons was twice that of the other. The figures were carefully chosen with special reference to the shaping of the positive carbons. For with normal arcs the shape of the end of a positive carbon, even taken quite apart from that of the negative carbon and of the vaporous arc itself is capable of revealing almost the whole of the conditions under which the arc was burning when it was formed. It is possible, for instance, with a normal arc, to tell, from a mere drawing of the outline of the positive carbon and of its crater, whether the arc with which it was formed had been open or enclosed, short or long, silent or hissing, burning with a large or

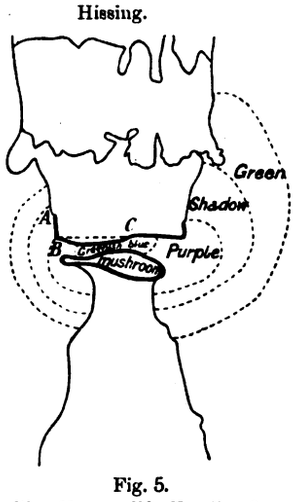

Fig. 5.

Carbons: Positive, 11mm. solid ; Negative, 9mm. solid.
Length of Arc, 1·5mm. Current, 28·5 amperes.

with a small current for the size of the carbon. Take, for example, Fig. 4, and note the difference in the shape of the positive carbon with a current of 3·5 amperes as in (*a*), and with one of 34 amperes, as in (*b*). In the first case the tip of the positive carbon is rounded, so that the crater lies in its smallest cross-section ; in the second, the tip would be practically cylindrical for some distance, but that the crater has burnt away a part of the cylinder, making the tip look as if it had been sheared off obliquely. Comparing now the tips of the positive carbons when the arc is silent and when it is hissing in all the four figures, 4, 5, 6, 7, we find the same difference. With all the silent arcs the tips are more or less rounded, and the crater lies in its smallest cross-section, and consequently is less in area than any but the smallest cross-section. With all the hissing arcs, on the other

* Paper read before the Institution of Electrical Engineers, March 23rd.
† *Proc. Roy. Soc.*, 1894, Vol. LVI., p. 262.
‡ *Wien Sitzungsberichte*, 1889, Vol. XCVIII., p. 1,192.

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hand, the tip of the positive carbon is practically cylindrical for a short distance at least, or would be, but that it is sheared away by the crater; consequently, the area of the crater is *greater* than the smallest cross-section of the tip, or, indeed, than the cross-section of the tip for some little distance along its length.

We have now arrived at the real, the *crucial*, distinction between a silent and a hissing arc. When the crater occupies the *end* of the positive carbon only, the arc is *silent;* when it not only covers the end, but also extends up the *side*, the arc *hisses*. Hence, the arc must be at the *hissing point* when the smallest increase in the area of the crater will make it begin to cover the *side* of the positive carbon, and this can only be when the tip of that carbon has very nearly the same cross-section for some little distance from its end —in other words, when its sides are nearly vertical. I shall now proceed to show that the extension of the crater up the side of the positive carbon is not the *effect* but the *cause* of hissing; that, in fact, *hissing is produced by the crater becoming too large to occupy the end only of the positive carbon, and by its, therefore, extending up its side.* This seems an absurdly simple and inadequate cause to produce such complicated phenomena as those belonging to the hissing arc, but it is the true one nevertheless. Before I proceed to prove this, I will show how the laws for the largest silent currents with normal arcs, which have been already obtained from the electrical measurements, may be deduced on the above hypothesis from Figs. 6 and 7. In Fig. 6 we have a series of four normal arcs of the same length, burning between solid carbons of the same

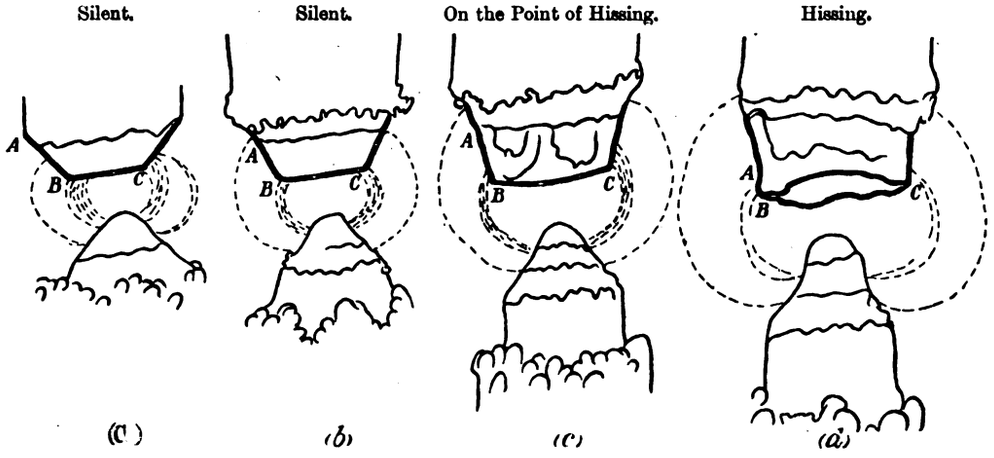

FIG. 6.

Carbons: Positive, 11mm. solid; Negative, 9mm. solid. Length of Arc, 2mm. Current: (*a*) 6 amperes; (*b*) 12 amperes; (*c*) 20 amperes; (*d*) 30 amperes.

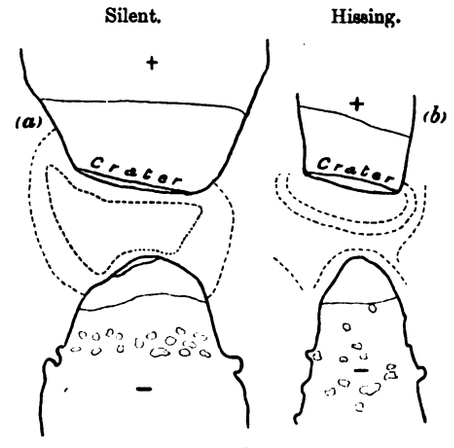

FIG. 7.

Carbons: (*a*) Positive, 18mm. cored; Negative, 15mm. solid.
(*b*) Positive, 9mm. cored; Negative, 8mm. solid.
Length of Arc, 5mm. Current, 25 amperes.

diameter, but in (*a*) the current is 6 amperes, in (*b*) 12, in (*c*) 20, and in (*d*) 30 amperes. The bluntness of the tip of the positive carbon may be measured by the obtuseness of the angle A B C. In (*a*) the tip is very blunt, and the area of the crater is certainly less than any but the smallest cross-section of that tip; therefore the arc is certainly silent. In (*b*) the tip is less blunt, but the arc is still evidently silent; in (*c*) the angle A B C is much more nearly a right angle, and it is plain that a very small increase in the area of the crater would cause it to burn up the side of the tip, therefore the arc is near the hissing point. In (*d*) the angle A B C is practically a right angle, the tip of the positive carbon is cylindrical, and the crater has evidently burnt partly up its side. Thus, keeping the length of the arc constant and gradually increasing the current must gradually bring us to a hissing point. Next, I have shown elsewhere* that with a constant current the end of the positive carbon becomes rounder and blunter, and occupies a larger portion of the entire cross-section of the carbon rod the more the carbons are separated. Hence, the longer the arc the greater must be the area of the crater, and consequently the greater must be the current, before the crater extends up the side of the positive carbon. Consequently, the longer the arc, the greater is the largest silent current. Thirdly, it follows that when the current and the length of the arc have been increased to such an extent that the tip of the positive carbon occupies the whole cross-section of the carbon rod itself no further increase in the size of the crater is possible without a part of it extending up the side of the positive carbon. Hence the largest silent current for a positive carbon of a particular diameter cannot exceed a particular value, however long the arc may be made. And lastly, similar reasoning used in conjunction with Fig. 7 tells us that the thicker the positive carbon the greater must be the largest silent current for a particular length of arc, which was one of the results deduced from the curves in Figs. 2 and 3. Consequently, the fact that

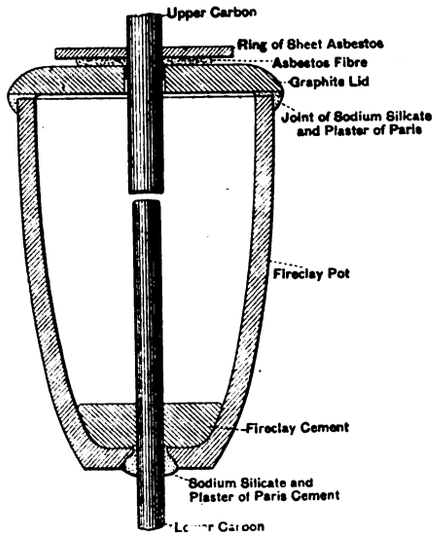

FIG. 8.

hissing occurs when the crater covers more than the end surface of the positive carbon and extends up its side, combined with our knowledge of the way in which the positive carbon shapes itself in practice, is sufficient to enable us to deduce *all* the laws already given which govern the largest current that will flow silently with the *normal* arc under given conditions. It is also now obvious why, when the arc is *not* normal, it may be made to hiss with small currents or be silent with quite large ones. For suppose, for instance, the end of the positive carbon were filed to a long, fine point,

* *The Electrician*, 1895, Vol. XXXIV., p. 614.

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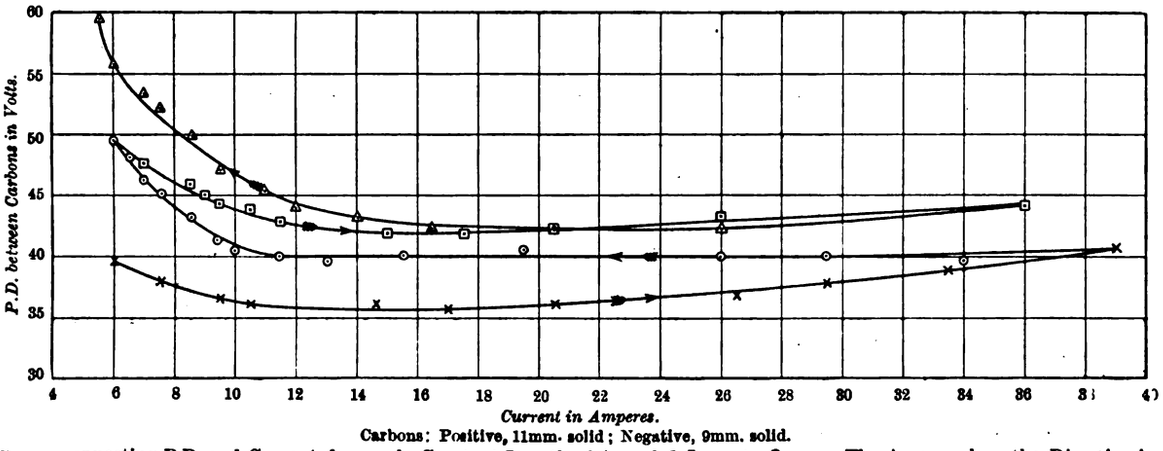
then a very small current would make a crater large enough to extend up the side of the point, and produce a hissing arc. Whereas, on the contrary, if the end were filed flat, so as to have as large a cross-section as possible, quite a considerable current could flow silently even with a short arc, for in that case it would require the current to be great for the crater to be large enough to fill up the whole of the end of the positive carbon.

We come now to the question, why should the arc hiss when the crater burns up the side of the positive carbon—what happens then has not happened previously? In pondering over this question, the possibility occurred to me that, as long as the crater occupied only the end surface of the positive carbon, it might be protected from direct contact with the air by the carbon vapour surrounding it, but that, when the crater overlapped the side, the air could penetrate to it immediately, thus causing a part at least of its surface to *burn* instead of volatilising. Many circumstances at once seemed to combine to show that this was the true explanation. The dancing circles I had observed, and Mr. Trotter's stroboscopic images, how were they caused but by draughts getting into the arc? Then the humming noise, which I long ago described as sounding like the wind blowing through a crack, was not this probably caused by the air rushing through a slight breach in the crater already getting near to the critical size? This air, pouring in faster and faster as the breach widened, would cause the arc to rotate faster and faster, sometimes in one direction, sometimes in another, according as the draught was blown from one side or the other. Then finally the air would actually reach the crater, burn in contact with it, and the P.D. would fall and the arc would hiss. In the open arc, whether silent or hissing, the outer envelope of the vaporous portion is always bright green. With the hissing arc the light issuing from the *crater* is also bright green, or greenish blue. What so likely as that the two green lights should have a common origin, viz., the combination of carbon with air? For the outer green light is seen just at the junction of the carbons and carbon vapour with the air, and the inner one only appears when air can get direct to the crater. Again, why does the arc always hiss when it is first struck? Is it not because a certain amount of air must always cling to both carbons when they are cold, so that when the crater is first made its surface must combine with this air? The cloud that draws in round the crater when hissing begins would be a dulness caused by the air cooling the part of the crater with which it first came into contact, the bright spots being at the part where the crater and air were actually burning together. In fact, everything seemed to point to the direct contact of crater and air as being the cause, perhaps not of the hissing *sound*, but of the diminution in the P.D. betwen the two carbons, which is the hissing phenomenon.

One easy and obvious method of testing this theory immediately presented itself. If air were the cause of the hissing phenomena, exclude the air and there would be no sudden diminution of the P.D. between the carbons, however great a current might be used. Accordingly I tried maintaining arcs of different lengths in an enclosed vessel, and increasing the current up to some 40 amperes. *No* sudden diminution of the P.D. could be observed with any of the currents or lengths of arc employed, although when the same carbons were used to produce *open* arcs, the sudden diminution of 10 volts in the P.D. between the carbons occurred with a current as low as 14 amperes for a 1mm. arc. Indeed, so far from there being any sudden diminution in the P.D. when the current through an *enclosed* arc is raised to higher and higher values, the P.D. appears to slightly increase for large currents. It was, of course, impossible, in these experiments, to avail myself of an ordinary enclosed arc lamp, since a current of only some 5 or 8 amperes is all that is used with such a lamp, whereas to test my theory it was necessary to employ currents up to 40 amperes, although my carbons were of smaller diameter than those fitted in ordinary commercial enclosed arc lamps. Accordingly I constructed little electric furnaces, some made out of fire-clay crucibles with lids of graphite sealed on, as in Fig. 8; some moulded out of fire-clay with mica windows inserted, so that the image of the arc could be projected on to a screen and its length kept constant; some constructed of iron lined with asbestos. Some had tubes inserted in them through which the air could be admitted when required, &c. It was found that when the vessel was entirely enclosed, the pressure in it was so great, on the arc being first started, that occasionally the lid was blown off. Consequently the space between the positive carbon and the asbestos ring was left open till the arc was well started, and then was tightly closed. This sudden increase of pressure probably took place when the carbons were first *brought into contact*, for Mr. Seaton,* while conducting some experiments for Messrs. De la Rue and Müller, in 1879, observed that when the arc was completely enclosed the increase of pressure when the carbons were first brought into contact was far greater than could be accounted for by the rise of temperature of the gas in the vessel, and that the pressure fell, the moment the carbons were separated, almost to what it had been before contact was made. This fact was confirmed by some experiments made by Stenger,† in 1885. This first great rise of pressure may, of course, be partly caused by the gases occluded in the carbons being expelled on the current being started, but a complete investigation of this phenomenon has not, as far as I am aware, yet been made. Some curves connecting the P.D. between the carbons with the current when the arc was completely enclosed in the crucible (Fig. 8) are given in Fig. 9. The carbons were solid, the positive being 11mm. and the negative 9mm. in diameter, similar to those used with the open arc experiments (Fig. 1). As this crucible—the first one made—had no window, the length of the arc could not be kept quite constant, but the distance by which the carbons were separated was noted at the beginning of the experiment, and they were then allowed to burn away without being moved till the end, when the distance the positive carbon had to be moved in order to bring it tightly against the negative was noted. Measured in this way, the length of the arc was 1·5mm. at the beginning and 2mm. at the end of the experiment. The current was started at 6 amperes, and gradually increased to 39 amperes; then as gradually diminished to 6 amperes again, increased to 36 amperes, and diminished to 5 amperes, when the arc was extinguished. The P.D. between the carbons for a given current seems to have increased as the length of time during which the arc had been burning increased; this was undoubtedly partly due to the lengthening of the arc, but was probably also partly due to the whole of the air in the crucible having been gradually burnt up or driven out through the slag wool and the asbestos ring by the pressure of the carbon vapour. Many other sets of curves were obtained, but all with the same result, viz., that, when once the crucible had been freed from air, no sudden diminution in the P.D. could be observed on increasing the current far beyond the value at which this diminution occurred on lifting up the lid and allowing the air to have access to the arc.



Carbons: Positive, 11mm. solid; Negative, 9mm. solid.

FIG. 9.—Curves connecting P.D. and Current for nearly Constant Length of Arc of 1·5mm. to 2mm. The Arrows show the Direction in which the Current was varied.

The next thing to do was to try if an open arc could be made to hiss and the P.D. to suddenly diminish by blowing air at the crater when the current was so small that the crator remained well at the end of the positive carbon—in fact, to bring the air in contact with

* *Philosophical Transactions*, 1879, p. 159.

† *Wiedemann's Annalen*, 1885, Vol. XXV., p. 31.

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the crater artificially when a much smaller current was flowing than would usually produce hissing. I first tried inserting a carbon tube in the arc and blowing through it, but this almost invariably blew the arc out. Then Mr. Phillips, one of Prof. Ayrton's assistants at the Central Technical College, suggested using a tubular positive carbon and blowing the air down it. This plan answered admirably, for when a current of 10 amperes was flowing with an arc of about 3mm., so that the arc was quite silent, each puff of air blown down through the positive carbon was followed by a hiss and the characteristic diminution of the P.D. between the carbons. With a current of 6 amperes, however, I could get no hiss, but simply blew the arc out each time, probably because, with such a small current, the arc was cooled sufficiently to be extinguished before the action could take place. Oxygen was next tried, still with the open arc, and again each puff produced a hiss and diminution of the P.D., the latter being exactly the same in amount as when air was used, namely, about 10 volts. As my idea was that the diminution of the P.D. was due to the chemical combination of air with carbon at the temperature of the crater, the fact of oxygen producing the same diminution of the P.D. as air seemed to show that nitrogen would produce no effect, and that all the effect produced by air was due to the oxygen in it. Accordingly I tried blowing nitrogen down the positive carbon of an open arc, and found that *no* change in the P.D. followed if the nitrogen was blown through gently, but that, beyond a certain pressure, the arc was blown to one side, and thus lengthened, so that the P.D. *rose*, and, if the pressure continued, the arc went out. This experiment proved two things—firstly, that it is the *oxygen* in the air that causes the diminution in the P.D. with hissing; secondly, that this diminution in the P.D. is not due to cooling, for nitrogen would cool the arc as effectually as oxygen or air. To make assurance doubly sure on this point, carbon dioxide was blown down the tubular positive carbon, with the same result as when nitrogen was used, viz., no change was produced in the P.D. between the carbons unless the pressure of the gaseous stream were large enough to blow the arc on one side, and then an increase and not a diminution in the P.D. was observed. If, however, the current was *very near* the value that made an open arc of the particular length used start hissing, blowing either nitrogen or carbon dioxide through the positive carbon sometimes started hissing; but this was due, *not* to any direct action of the stream of gas on the carbon, but to the arc being deflected by the gaseous stream and burning obliquely up the side of the carbon, and thus allowing the air to come into contact with the crater. The proof of this was that this diminution in the P.D. had the same value as if air had been employed, and that the hissing phenomena did not disappear on stopping the stream of nitrogen or of carbon dioxide. This was not the case with hydrogen, however. When that gas was blown down the positive carbon in the open air, the arc would start hissing if the current were large enough, *and stop hissing the moment the hydrogen was shut off*. Not only this, but the diminution in the P.D. had a different value from that produced by air, being only about 6·5 volts instead of 10 volts. Table IV. gives the current and the P.D. between the carbons just before the hydrogen was turned on, just after it was turned on, just before it was turned off, and just after it was turned off.

Table IV.—*Effect of Blowing Hydrogen down a Tubular Positive Carbon.*

Carbons: Positive, 11mm. tubed; Negative, 9mm. solid; length of arc, about 3mm.

P.D. between carbons in volts.				Current in amperes.
Before H. was turned on.	After H. was turned on.	Before H. was turned off.	After H was turned off.	
52·0	46	46	53·0	14
52·0	45	47	52·0	12
52·0	45	45	52·2	12
52·5	46	46	53·0	12
52·0	45	46	52·0	9

Thus, the mean diminution of P.D. accompanying the hissing caused by hydrogen being sent down the positive carbon of an arc burning in the air was about 6 6 volts, or about 3½ volts lower than when the hissing was caused by air alone.

In order to exclude all possibility of doubt as to the effect of the various gases, I repeated the experiments with the arc entirely enclosed, so that the only gases that could reach it were those blown down the tubular positive carbon. The current was distinctly below the hissing point, being only 10 or 11 amperes, and the arc was from 2mm. to 3mm. long. When air was blown down the positive carbon, each puff lowered the P.D. by about 10 volts, and the moment the puff ceased the P.D. rose again. Next, oxygen was tried, with the same result. Thirdly, nitrogen with *no* result, or with the result that the arc was blown out if the pressure was too great. Carbon dioxide had the same effect as nitrogen, and lastly hydrogen was tried. This gas, however, gave a totally different result with the enclosed arc from that already obtained with the open arc. For whereas, as has been previously stated, hydrogen produced a distinct hissing of its own when blown down the positive carbon in the *open air*, it produced *none* when used in the same way with the *enclosed* arc.

To prove that, in order to produce the sudden diminution of P.D. under discussion it was necessary for the active gas to actually touch the crater, a tubular *negative* carbon was used, and each gas was blown up through it in turn, gently enough not to force the gas directly against the crater. In *no* case was there any sudden diminution of the P.D., whatever was the gas blown through the negative carbon, and whether the arc was open or enclosed. On the contrary, there was generally a small increase, probably due to the lengthening of the arc by its being blown on one side. If oxygen or air were blown *very hard* up the negative carbon, they would either produce hissing, or blow the arc out, or both; for in that case some of the gas got to the crater uncombined with the carbon vapour, and acted exactly as if it had been blown down the tubular positive carbon. The case, then, stands thus:—(1) When the arc begins to hiss in the ordinary way, the P.D. between the carbons diminishes by about 10 volts. (2) If the air is excluded from the arc, this diminution of the P.D. does not take place, even when the current is nearly three times as great as would cause hissing in the air. (3) If, however, while the air is excluded, puffs of air are sent against the crater, the diminution of the P.D. *does* occur, even with currents much *smaller* than would cause hissing in the air. (4) If, instead of air, *oxygen* is sent against the crater, the P.D. is diminished to exactly the same extent as when air is used. (5) If, on the other hand, *nitrogen* is sent against the crater, *no* diminution of the P.D. is observable. (6) If air or oxygen is gently blown through the *negative* carbon, so that it cannot get direct to the crater, *no* diminution of the P.D. follows. Thus there can be no shadow of doubt that *the sudden diminution of P.D. that accompanies the hissing of the open arc is due to the oxygen in the air getting directly at the crater and combining with the carbon at its surface.*

This explanation, like many another in science, solves certain difficulties, only to create others which may, perhaps, be yet harder to deal with. Directly we know exactly how the diminution of P.D. accompanying hissing is brought about, we ask, "How does this combination of gas and carbon, at the temperature of the crater, act in producing a diminution of P.D. so sudden, so certain, following such definite laws as those we have been considering? Why do certain gases produce it and not others? Why does hydrogen act in the presence of air, but not when air is absent?" &c. These are questions that have been occupying me for some time past, and which will, I hope, be completely answered by the series of experiments on which I am still engaged. These latter experiments, although suggested by the investigation on the hissing of the electric arc, have already opened up a different field of inquiry, and the further results may, therefore, with advantage be reserved for a future communication.

It only remains for me to express my high sense of the honour done me by the Institution of Electrical Engineers in asking me to read this Paper, and to thank the many people to whom I am indebted for very kind assistance. My most sincere thanks are due to Prof. Ayrton for much criticism, for advice as to the methods of conducting the experiments, and for invaluable help in the literary portion of the work; to Mr. Solomon for constructing with much ingenuity the first enclosing crucible, and for making the earlier experiments with it; to Mr. Phillips for assisting in the experiments and for drawing most of the diagrams, especially the admirably executed coloured drawings of the hissing and silent arcs; to Mr. Carter for supervising, and to Messrs. Manuel and Pletts for very carefully constructing the apparatus for the experiments of this evening; and lastly, to Messrs. Arundel and Spencer for helping with most of the experiments for the Paper, and for conducting many of them alone, with great skill and patience, as well as for carrying out all those that have been shown to you this evening.

The Pan-American Exhibition.—As has already been notified, it was intended to hold a pan-American Exhibition in the coming summer on the Niagara border, but owing to the outbreak of the Spanish-American war, it was decided to postpone it until 1901. The American press is again calling attention to the scheme. The exhibition has been planned on a large scale, and its principal object is said to be the extension of trade relations between the United States and all the South American States, by forcibly bringing before the public of the former country the products of the latter. It is stated that one of the chief features of the exhibition will be the electrical exhibits, but we should imagine that, with the exception of raw india-rubber, these would be provided entirely by the countries in the northern part of the hemisphere.

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PHYSICAL SOCIETY.

At an ordinary meeting, on March 24, 1899, Prof. Oliver Lodge, F.R.S., President, in the chair, Mr. W. R. COOPER read a Paper, by A. P. Trotter, on

"The Minor Variations of the Clark Cell."

The author describes a series of experiments in which he compared the E.M.F.'s of certain standard cells at frequent intervals from July, 1896, to February, 1897, at Cape Town, where the temperature of the double box containing the cells varied between the limits 13°C. and 28°C. One cell was selected for comparison with all the others. No special precautions seem to have been taken to keep the temperature of this selected cell constant. The observed differences between the E.M.F.'s of the respective cells rarely exceeded 0·001, corresponding to about a quarter of an inch on the slide-wire of the potentiometer. Details as to the area of the slider-contact are not stated; the readings were generally taken to the fourth decimal, *i.e.*, to one-tenth of a millivolt, and occasionally to one-fourth of this. Temperature was read to 0·1°C. on a mercury thermometer placed through a hole in the double box containing the cells—not in the cells themselves.

Mr. E. H. GRIFFITHS said that the Paper appeared to have value only in so far as it showed that Clark cells at Cape Town behaved in a manner that agreed with common knowledge and general experience everywhere else. Their variations depended upon shifts of temperature and the consequent changes in the degree of saturation of the liquid. From his own experiments during seven years, upon 42 Clark cells, he had shown that if temperature was kept constant to within 0·01°C., the steadiness and uniformity of all the E.M.F.'s was most remarkable. They started with discrepancies, but at the end of the time it was impossible to detect any differences. It was of little use to put a thermometer anywhere but within the cells; very slight changes of temperature caused serious changes in the degree of saturation of the liquid. The existence of the capricious lag of E.M.F. behind temperature precluded the possibility of formulating a temperature correction for Clark cells. In the case of Callendar cells there was no lag; their E.M.F. varied slightly with temperature, by a definite amount, which could be corrected by a coefficient.

Mr. W. R. COOPER said the method of comparison used by the author was unsuitable, because to arrive at the differences of E.M.F. necessitated the measurement of the E.M.F. of each cell. The variations only amounted to a few ten-thousandths of a volt. The length of potentiometer wire corresponding to a thousandth of a volt was only a quarter of an inch; under such conditions it would be difficult to ensure accuracy. A method of opposition would have been preferable. Mr. Cooper had found that Board of Trade cells only vary about one ten-thousandth of a volt between themselves from day to day. Cells of the H-form vary about one-fifth of that amount.

Prof. J. D. EVERETT then read a Paper by Dr. E. H. Barton and Mr. W. B. Morton, on

"The Criterion for the Oscillatory Discharge of a Condenser."

The object of the Paper is to inquire how the condition for the oscillatory discharge of a condenser is modified when the ordinary differential equation of the second degree is supplemented by the terms added by Maxwell to take account of the distribution of current in the (straight) wire. The co-efficients of these terms are relatively small, so that the algebraic equation giving the periods is a quadratic, with small terms of higher order added. The effect of these higher terms is, first, to introduce very rapid vibrations of small amplitude; and, next, to displace the roots of the unaltered quadratic. The nature of the discharge—oscillatory or non-oscillatory—may be taken to be determined by these principal roots, and the critical case is when they are equal. The condition for equality is obtained, by the property of the derived function, as a series of powers of the small coefficients of the equation, which may be carried to successive approximation as far as is desired. The Paper also treats the question by an alternative, and more physical, method, which consists in replacing the resistance, inductance, and capacity that occur in the ordinary formula, by modified values. This gives the criterion correct to the third order in the small terms. It is shown that a condenser satisfying the critical condition on the simple formula would, when the added terms are taken into account, give an oscillatory discharge.

Prof. LODGE said that the result naturally to be expected of "throttling," viz., the increase of resistance, and decrease of self-induction, due to the current keeping to the outside of the conductor, would tend rather to damp out the oscillations than to favour them.

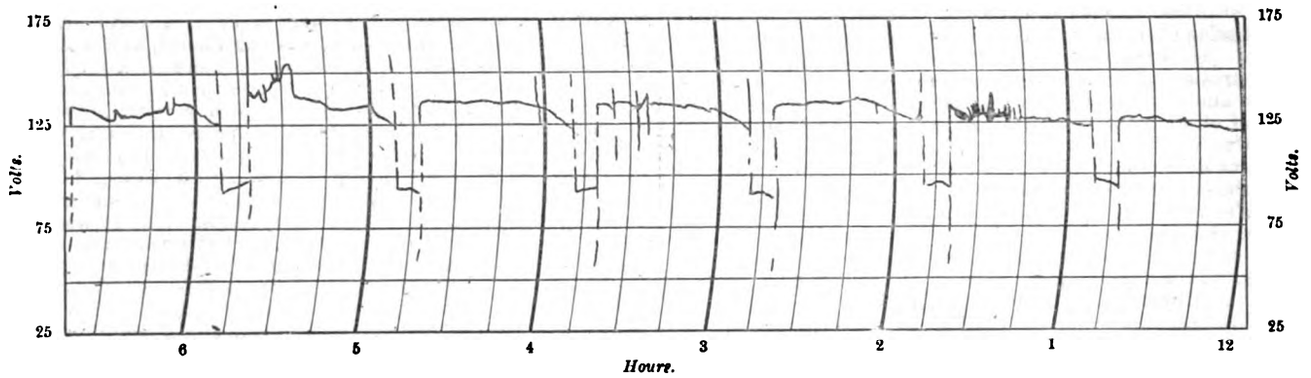
Prof. EVERETT observed that the equation was no longer a quadratic, and that the quadratic criterion as to whether the discharge was oscillatory or non-oscillatory, did not hold. The Paper appeared to be consistent with itself, and he considered that the authors had satisfactorily proved, in their discussion of the equation of current, that the effect of "throttling" was to *increase* the tendency towards the oscillatory mode of discharge.

Prof. LODGE admitted that the quadratic criterion did not hold; he thought it most likely that the authors, who evidently had gone into the matter with care, were right. At the same time, he wished to call attention to the singular and unexpected character of their conclusion. If it turned out that it was correct, *i.e.*, that there was no slip in sign, it was a result upon which he would desire to congratulate them.

The PRESIDENT proposed votes of thanks, and the meeting adjourned until April 21.

RECORDING INSTRUMENTS FOR TESTING INSULATION.

If a voltmeter be connected between any wire of an insulated two or three-wire network and earth, and then shunted by a known resistance, the insulation resistance of the network may be calculated from the two readings and the resistances of the shunt and voltmeter. Messrs. Elliott Bros. are introducing a recording voltmeter, fitted with a device patented by M. Travailleur, by means of which the instrument is automatically shunted for a short period once an hour. The voltmeter is intended to be connected between one of the switchboard 'bus bars and earth, and in this way a continuous test of the insulation resistance of the network is obtained. The recording voltmeter is of the type described in *The Electrician*, Vol. XXXVIII., p. 342, with the exception that Messrs. Elliott Bros. now replace the electromagnet by a permanent magnet. The device for switching in the shunt is merely a wheel fixed to the same clockwork train which moves the paper chart. On this wheel are pins, which at intervals of an hour close a spring contact connecting the shunt to the voltmeter. We give a reproduction of a piece of chart taken from an instrument in use at the Brussels electricity works. The resistances of the voltmeter and shunt are about 1,200 and 500 ohms respectively on 2 × 110 volt systems, and double this value for 2 × 220 volt systems.



We fear that the instrument will not have much application in this country, as the general custom is now permanently to earth the middle wire at the station. On pointing this out to Messrs. Elliott Bros., they at once described to us a registering ammeter working on the same principle as the voltmeter, but without the periodical shunting device. The instrument, being on the d'Arsonval system, is permanently shunted to a low resistance which is connected between the middle wire and earth. To protect the instrument from the effects of earths on the network, an automatic switch is fitted to it, which short-circuits the instrument if the current through it exceeds a fixed maximum value. This instrument does not, of course, afford a means of actually measuring the insulation resistance of the network, but merely records the current flowing from the middle wire to earth, thus taking the place of the ordinary non-recording ammeter usually employed for this purpose.

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A NEW RESISTANCE BOX.

A radical departure in resistance box design has been made by Messrs. Gambrell Bros. in a pattern recently exhibited by them in the Royal Institution library, and now being placed on the market. The plug resistance box has proved itself eminently serviceable, and is still employed as much as ever in spite of several disadvantages, more apparent in testing-room work than in the laboratory. Chief among these is, perhaps, the necessity of keeping clean the plugs and holes, and the ebonite surface beneath the latter. The dial and similar forms of resistance boxes, which have acquired considerable popularity where celerity and accuracy are all-important, have diminished but not eliminated the errors arising through bad plug contacts, at the same time lessening the probability of a mistaken reading. The insulation difficulty remains, however. To meet this, some makers adopted the sliding or rheostat form of contact, in dial form, but it does not seem to have replaced the plug contact to any great extent in boxes of large range and for accurate work. Against the good features of the dial form of box must be set the comparatively large space taken up by the coils, necessitating for the same thicknesses of wire and the same range, a larger box than when the coils are arranged in parallel lines.

Messrs. Gambrell Bros. appear to have had all these points in view when designing their new resistance box. Fig. 1 shows the general aspect of the apparatus, with the cover removed, and Fig. 2 shows one of the rows of contacts in elevation, plan and section, half actual size. In the box illustrated the coils are arranged in five rows: thousands, hundreds, tens, units and proportional coils. Contact is made by means of the shoes D (Fig. 2), which slide over the studs C. The contact shoes slide on the rods E, held down at each end by slight springs, and by turning the handle seen at the right hand end of the box in Fig. 1 all these rods are simultaneously drawn down and clamp the contact shoes, making, therefore, in each case practically perfect contact between the stud C and the rod E. When the handle at the side is not turned, the springs are sufficient to create enough friction between the metal surfaces of the shoe and stud to keep both clean, while at the same time allowing the rods F, for drawing the shoes along, to be moved with ease. The rods F pass through ebonite brushes G, and the numbers marked on the former enable the operator to read the resistance without having access to the contacts themselves. The contacts are kept free from dust and corrosion by the cover, which is screwed permanently over the top of the box. It should be added that there is a detent under each rod, so that the operator can know, without watching the figures, when the contact shoe covers the stud. As is seen in Fig. 2, there is ample space between all the studs, so that the insulation resistance should be high. The reading is very simple, and mistake is practically impossible, as the figures appear all in line, and can be read straight off. A slight disadvantage in the particular box illustrated is that the rods for the proportional coils draw out one to either side, thus considerably increasing the room which must be allowed for the box on the testing table. The contacts for the proportional coils are also not clamped by the handle referred to, stronger springs at the ends of the slide-rod being deemed sufficient to ensure good contact. However, we understand that these slight defects are remedied in other boxes on this system.

Of course, in a piece of apparatus of this sort, a great deal depends on price and durability. It would appear, that when made in numbers, and to template, the cost of the new pattern of box should compare favourably with that of the plug type. Time only can show whether the contacts will remain efficient after continued use; from an inspection of the box, however, we can see no reasen why it should not be possible to make it as durable as other apparatus of this character. A patent has been applied for.

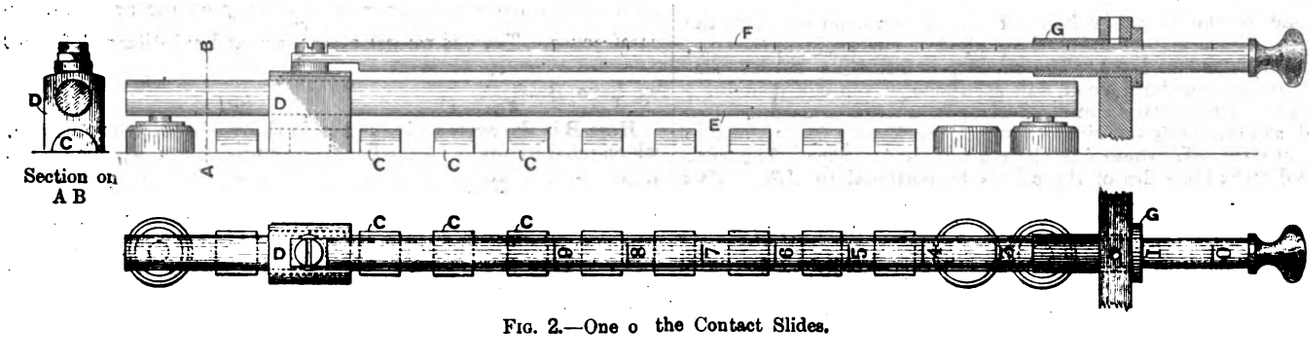

FIG. 2.—One o the Contact Slides.

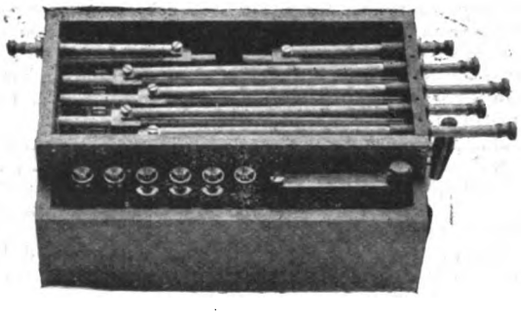

FIG. 1.—General View of Resistance Box.

THE SPARK LIMIT IN CONTINUOUS-CURRENT MACHINES.*

BY GISBERT KAPP.

Some attempts have recently been made to represent the process of current commutation in a strictly mathematical manner, taking account in the formulæ of the mutual induction of the coils, their resistance, the resistance of the constantly-changing contact surfaces between the brushes and commutator bars, &c. This manner of dealing with the subject has much interest for the mathematically inclined electrician; but the practical man will find the formulæ too complicated, as a rule, and, therefore, will not use them. He will either work quite without formulæ—*i.e.*, entirely by his experience—or he will only use such empirical rules as are favoured in his particular drawing office. The theory of sparkless commutation which I wish to develop here will occupy to a certain extent a mean position between these two methods.

One of these empirical formulæ, which has been of good service and is still extensively used to-day, consists simply in prescribing a certain maximum for the induction under the leading horn of the pole-piece—about 1,500 with drum armatures and 2,500 with ring armatures. As is the case with all empirical rules, this one can be used so long as it is applied to similar cases. It is quite possible that a rule which has no scientific foundation and is even inaccurate when looked at from the strictly mathematical standard, yet gives useful results in practice; but, then, the value does not lie in the rule, but in its limitation to definite cases. If, for instance, the rule mentioned above is only used for machines with slotted drum armatures, two armature bars per commutator segment, carbon brushes and about the same current-density with regard to the circumference of the armature, one would find that the behaviour of a machine, so far as sparking is concerned, could be predetermined with certainty. But that is no proof that it is right in general; it only proves that it is correct within particular limitations. I will now try to replace this empirical rule, which is only conditionally correct, by one which is generally followed, and to make this formula so simple that the practician is not afraid to make use of it. This latter condition can, of course, only be fulfilled at the expense of accuracy, for the process of commutation is by no means simple, and if a complicated process is to be represented by a simple formula, this formula can only be a more or less rough approximation. In addition to this, although it is desirable, it is not absolutely necessary to determine the spark limit with mathematical accuracy, for, in practice, one will endeavour to keep as far as possible from this limit. The exact knowledge of the spark limit would thus, in the first place, only have the value of allowing us to represent the safety with regard to sparking by a certain coefficient—somewhat in the way as the strength of a part of a machine can be indicated by a factor of safety. However, so long as the spark factor of safety is large enough, we do not need to trouble about its actual value. The more so as the

* Paper read before the Berlin Elektrotechnischer Verein.

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sparking in a machine does not only depend upon its design, but also, to an important extent, on the manner it is used.

After these introductory remarks, which are merely intended to show the object and extent of this investigation, I will proceed to the investigation itself. Let S be the number of commutator segments, s the number of commutator segments per pole, p the number of pairs of poles, $S = s\,2p$. Let q be the number of active conductors per commutator segment (the smallest possible value of q is 1 for ring armatures, and 2 for drum armatures), $z = s2pq$ the number of active conductors counted round the whole armature circumference, n the number of commutator segments covered by one brush, L the length, and D the diameter of the armature. We will first consider the conductors belonging to one commutator segment. The current in this induces a field whose total value depends on the current volume of the chosen conductors, on the length of the armature and on the method of winding (drum or ring, smooth, slotted or hole). The conductors belonging to one commutator segment form a coil, and each side of the coil contains q wires in a ring armature and $q/2$ wires in a drum armature. The field, as induced by one side of the coil, is evidently proportional to the product iqL, where i is the current in one wire. The work stored up in the sides of the coil is proportional to q^2i^2L. This work must, by the process of commutation, first be changed into mechanical and then again into electrical work, and this by the influence of the commutating field.

If T is the period of commutation the electrical work is transformed into mechanical energy during the first half of the period, T/2. The current flows against the E.M.F. induced in the field of commutation and the coil helps to rotate the armature. During the second half of this period the current must increase from 0 to i in the direction of the induced E.M.F., *i.e.*, the coil works as a brake. Thus an exchange of work takes place between the coil and the driving machine, which can, of course, only be brought about through the action of the field of commutation. If the induction in this field is B the work put in or taken out is given by the expression

$$\int_0^{\frac{T}{2}} 2qBvLi\,dt,$$

if v is the linear velocity of the wires. B and i are functions of the time, the nature of which we cannot know exactly. We only know that B changes with the time, and that i is diminished with the time to 0, and then increases again in the opposite direction. If we confine ourselves to the second half of the period of commutation, and count the time from the moment in which $i = 0$, we can say that i and B increase with the time—the former from 0 and the latter from a determined value. If the work put in during the time T/2 is smaller than that which should be stored up in the coil, the current when the particular section is leaving the brush has not yet reached the full value i, which it must have a moment later. The coil is not yet ready to enter the armature circuit, and a spark occurs. If more work is put in than should be stored up (if B is, therefore, too large)—*i.e.*, if the current is greater than necessary, it must, when the coil enters the armature circuit, be suddenly reduced to its correct value, and a spark also occurs in this case. We see that sparkless commutation can only take place if the work put into the coil is exactly equal to that which is stored up in the coil after it has entered the armature circuit. Strictly, the work put in ought to be increased by an amount corresponding to the heating of the wires by the current and the heating at the contact surfaces of the brushes. This is small, however, compared with the electro-dynamical work, and will be neglected here in order not to complicate the calculations.

Although we are not in a position to give the nature of the functions B and i, we can still, in general, assume that the solution of the integral, by leaving out one of the numerical coefficients depending on the nature of these functions, gives for the work put in the expression qiLvT/2. Here B means the average value of the induction within the region of commutation, which must naturally be smaller than that which obtains under the leading horn, and which is given by the expression $B'_a = B_a\left(\frac{X - X_r}{X}\right)$. In this formula B_a means the induction in the air space under the poles, X the amere-turns necessary for the armature and air space, and X_r the cross ampere turns of the armature.

The work put in varies according to the law by which the current increases with time. For, under the assumption that i is proportional to t, the work will be smaller than under the assumption that the current is a sine function of the time, and that in the proportion of $\frac{1}{2}$ to $2/\pi$. But it is not necessary to make any assumption on this point, for when completing the equation between the work put in and taken out we must yet bring in an empirical coefficient. Thus we write

$$q^2i^2\mathrm{L} = \mathrm{C}qi\mathrm{L}Bv\frac{\mathrm{T}}{2}$$

$$qi = \mathrm{C}Bv\frac{\mathrm{T}}{2}.$$

Now vT/2 is the path which a side of the coil traverses during the second half of the period of commutation, that is $n\beta/2$ in which β is the distance along the armature circumference to one commutator bar. Further, $\pi D = S\beta = 2ps\beta = 2ps\frac{q}{q}\beta = \frac{z}{q}\beta$,

from which

$$\frac{n\beta}{2} = nq\frac{n\pi D}{z}\frac{1}{2}$$

$$qi = \mathrm{C}Bnq\frac{\pi D}{z}\frac{1}{2}$$

$$\frac{zi}{\pi D} = \frac{\mathrm{C}}{2}Bn.$$

zi is the whole current volume in the armature; thus zi/πD is nothing else than the linear current density on the armature circumference. Thus, if we write $\Delta = \frac{\mathrm{C}}{2}Bn$, and substitute C_e for 2/C we have $B = C_e\frac{\Delta}{n}$.

Here B is the average induction in the region of commutation, which must naturally be smaller than the induction B'_a under the leading horn. From this we have $B_a > C_0\frac{\Delta}{n}$ as a condition for sparkless commutation, in which C_0 is an empirical coefficient which depends upon the type of the armature but not upon its size or load.

As is seen this formula differs from the empirical rule mentioned at the outset only by the fact that it contains the current density and the number of commutator segments touched by the brush. We will now see if the dimensions of the formula are correct. This is the case if C_0 is actually a coefficient, *i.e.*, an unknown number. To test that, we need only answer for the values B_a and Δ according to the absolute system of measurement (M for mass, L for length and T for time). The dimensions of induction are, as is known, $M^{\frac{1}{2}}L^{-\frac{1}{2}}T^{-1}$ of current $M^{\frac{1}{2}}L^{\frac{1}{2}}T^{-1}$, and of linear current density $M^{\frac{1}{2}}L^{-\frac{1}{2}}T^{-1}$. The dimensions for linear current density and induction thus agreeing, and as n is an unknown number, C_0 must also be an unknown number. The dimensions of the formula are thus correct, but the old empirical rule incorrect, for according to this the induction must have no dimension. If, in spite of that the old rule has been of good service, this is due to the fact that Δ as well as n do not vary much in machines of the same type.

If we write out in the form of an equation

$$B'_a = C_0\frac{\Delta}{n},$$

C_0 can be considered as a sort of elastic coefficient whose value gives security against sparking. The greater the value that is chosen for C_0 in the design of a machine, or the greater value it works out to for a machine already built, the further is this machine from the spark limit, *i.e.*, the more can the machine be overloaded.

The above equation gives the necessary conditions, but not all the necessary conditions for sparkless working. One recognises that at once from the circumstance that this equation does not contain the number of armature bars per commutator segment. Now, every practical man knows that sparkless working is harder to obtain the fewer the commutator bars there are per pole, *i.e.*, the more armature bars there are to a commutator segment.

In obtaining the formula it was assumed at starting that the field of commutation, whose average value was called B, actually existed and was not appreciably distorted by the self-induced field on each side of the coil. A certain distortion is, of course, always present, but it must certainly remain small, and that is the condition for the above formula to be true. A distortion is characterised by two things—first, the strength and secondly, the space over which the self-induced field extends. So far as the strength of this field is concerned, it has already been considered in determining a formula for $B'a$. Thus we have now only to consider the space over which the field extends, and this depends, as one sees at once, on the width of the commutator bars and on the number of them which the brush covers. As this brush touches n segments, the width of the self-induced field if it were conceived to stand still in space, cannot be greater than $n\beta$. But now, on turning the armature, the field moves forward and backward by the amount β, because new segments are continually coming up under the brush on the one side, and leaving it on the other side. The extent within which a self-induced field can have a disturbing action on the field of commutation is therefore proportional to $(1+n)\beta$. In order that this oscillation of the self-induced field causes no sparks, the extent $(1+n)\beta$ must be small compared with the extent of the field commutation measured round the circumference. But the latter is proportional to the air space δ between the armature and the poles, so that, leaving out a constant, we can write for the second condition for sparkless working $\delta > \beta(1+n)$.

As is known, it is often possible to cure a machine of sparking by placing the edges of the pole somewhat obliquely with regard to the armature wires, or by planing away the edges of the pole so that the air space is somewhat greater at the leading horn. Either

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means will occasion a rather larger extension of the field of commutation. If such means be adopted a value of δ must, of course, be inserted in the above expression, which is correspondingly greater than the actual distance between the armature and the middle of the polar surface. As now $S\beta = \pi D$, it also follows that

$$\delta > \frac{\pi D}{S}(1+n),$$

and by introducing the radius of the armature R and an elastic coefficient C_1, we have as the second condition for sparkless working

$$1 = C_1 \frac{\delta}{R} \frac{S}{(1+n)}.$$

The smaller C_1 is in any actual machine, the better is the machine so far as sparklessness is concerned. The condition for a machine working well is, therefore, C_0 large and C_1 small. It may now be asked how large and how small. This question can only be answered on the basis of experiment. I have determined average values for C_0 and C_1 from experiments on my own machines and from results kindly communicated to me by colleagues from trials of their machines, and I will give these presently. But now I must return to something which, in order to avoid too great complication in determining the equations, I have previously neglected, viz., the resistance between the brushes and the commutator. If this is large, a steadying action takes place, just as the well-known steadying resistance of the connecting pieces often arranged between a coil and the commutator bar. The steadying action of the resistance generally mostly influences the second condition,

$$1 = C_1 \frac{\delta}{R} \frac{S}{(1+n)},$$

because the effects of the peaks of the disturbing self-inducing field upon the field commutation are thereby lessened. Now, as carbon brushes give a greater steadying resistance than metal brushes, C_1 may be greater for the former than for the latter.

The mean values obtained for the experiments mentioned above are: —

For metal brushes	$C_1 \leqq 0{\cdot}4$
For carbon brushes	$C_1 \leqq 0{\cdot}8$
For ring armatures with smooth windings	$C_0 \geqq 12$
Ditto with slot windings	$C_0 \geqq 24$
Drum armatures with smooth windings	$C_0 \geqq 9$
Ditto with slot windings	$C_0 \geqq 15$

It is to be noticed that these values have an influence upon one another. If one finds, for instance, that in one machine C_0 is much larger than the lower limiting value comes out to, C_1 can be made larger than the upper limiting value; or if C_1 is considerably smaller than the upper limit, then C_0 can also be made smaller than the lower limit.

THE OSTEND ACCUMULATOR TRAMWAYS.

Some interesting figures relative to the cost of working a short line of electric tramways at Ostend, by means of accumulators, were furnished by the manager of the Ostend tramways, M. de Cuyper, to M. Jules Sarcia, and were embodied in a Paper recently read by the latter gentleman before the Société Internationale des Electriciens. The length of the line in question is 2½ miles, it forming part of a system of some 70 miles of tramways connecting Ostend with Blankenberghe, Nieuport, Furnes and Ypres. The generating station is situated in the main depôt and consists simply of a semi-portable non-condensing 60 H.P. engine driving a 30 kilowatt shunt Westinghouse dynamo through belting, a large hall being provided for charging the tramway batteries. The rolling stock was designed by M. de Cuyper and constructed under the direction of his assistant, M. Kamp. The truck has a wheel base of 7ft. 10½in., but, notwithstanding, can easily negotiate curves of 66ft. radius. The first batteries were supplied by the Société pour le Travail Electrique des Métaux (chloride cells), and later a Julien battery was added. The motors and controllers were supplied by the Westinghouse Co. and are of their latest pattern, the motors having laminated field magnets and steel carcases. The accumulator cars only work in Ostend during the season. At the end of 1897 M. de Cuyper was able to make the following analysis of expenditure per car kilometre:—

Coal	0·314d.
Oil and waste	0·087d.
Switchboard attendant	0·204d.
Stoker and driver (station)	0·166d.
Maintenance of batteries	0·366d.
Drivers (cars)	0·419d.
Total	1·156d.

During 1898 17,000 car miles were travelled, and the following are the items of expenditure per car mile:—

Inspectors	0·360d.
Superintendent at the charging board	0·142d.
Stoker and driver (station)	0·114d.
Maintenance of motors	0·047d.
Maintenance and repair of batteries	0·171d.
Drivers (cars)	0·408d.
Pointsmen and track-cleaners	0·190d.
Fuel	0·346d.
Oil	0·066d.
Waste	0·015d.
Total	1·859d.

To compare this figure with those customarily given for electric traction, the 0·36d., for the inspector, and the 0·19d. for the pointsmen and scavengers, should be deducted, when the total will be 1·309d. No account is taken of the renewal of battery plates, as no renewals have yet been made, the plates still being in good working condition. M. De Cuyper intends, however, to repaste the positive plates this winter ready for next season. The negative plates are as good now as they were on starting. No repair was needed to the Julien battery during 1898. Experiments made to determine the efficiency of the cars, gave on the level a mean of 552 watt-hours per car mile. The fuel consumption (briquettes) during 1898 averaged 7·11lbs. per car mile.

A tramway on similar lines has been put down at Ghent. Here there are 25 miles of track, on which 35 accumulator cars run. The mean consumption per car mile at the switchboard during the last two seasons has been 1,045 watt-hours, and the coal consumption about 6½ lbs. per car mile or per kilowatt hour.

If managers of larger lines of tramways would publish as detailed statements of costs as M. De Cuyper has done it would serve a very useful purpose.

CORRESPONDENCE.

GOVERNMENT TELEPHONES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Permit me to notice some statements in your issues of the 17th and 24th inst. In the former you printed a letter from me quoting a correspondent, who stated that there were from 1,500 to 2,000 telephone exchanges in operation in the United States with rates varying from $1.50 to $3 a month according to the size of the town. In commenting on this you say that a comparison of the telephone areas would show as a rule that rates in America are higher than in this country. If you have evidence in support of your statement, by all means produce it, but if not, then it is mere surmise. My correspondent is engaged in the business, and, therefore, spoke at first hand. Excepting in a few leading cities where the Bell Telephone Company have still a monopoly, telephone rates in the United States are lower than here, and the service is usually good. But even in some large cities the rates are lower in the United States. For example, in Baltimore the rate is $78 – say, £16—for unlimited service within two miles of the Exchange, which is, I believe, lower than any two-mile radius in any of our towns as large as Baltimore.

We now suffer from the maintenance of rates since the patents expired by the Post Office officials in defiance of the public interest. But when monopoly is swept away we shall have service cheaper than in the United States, because materials are rather cheaper with us, and labour, which is a most important part of the cost of erecting and working telephone exchanges, averages nearly twice as much as it does here.

In your issue of the 24th inst., in noticing the Parliamentary paper just issued relating to Telephone Service in Foreign Countries, in referring to Consul-General Sanderson's letter accompanying the New York report, you say that he does not speak of municipal corruption defeating efforts for cheapness, to which I referred in my letter of the 15th inst. Consul Sanderson would do nothing of the kind. No representative of this country would, in a report in reply to specific questions, make any statements reflecting on the authorities of the place to which he was accredited. But he refers to "the fact that efforts have been made from time to time to enact legislation reducing the charges for telephone service in New

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York." You add that you do not "see how the municipalities of this country would escape similar insinuations with just as much foundation"—a most unfair statement regarding our municipalities. My statements were not insinuations; they were brought before Committees of the New York State Legislature at Albany, in connection with the Bills introduced to limit telephone charges, referred to by Mr. Consul-General Sanderson. Mr. Sterne, who represented the New York Board of Trade and Transportation and other mercantile bodies of New York, in addressing the Senate Committee on February 19, 1895, referred to the reason of the enormous increase in telephone charges in New York. The service when first commenced was $5, but now they charge as high as $20 a month. This was brought about by obtaining a monopoly of underground routes, and in reference to this Mr. Sterne said, in reply to counsel representing the Telephone Company:—

"He speaks of the wires underground, and they are a great swindle. I speak advisedly. I cannot put my fingers upon the men who reap the profits of that system, but you have not far to seek outside the chiefs of Tammany Hall and various other political organisations to find out who reap the advantages of this underground system."

Why telephone service is dear in New York is, I may say, common knowledge, and the above references place within your reach the power to obtain all the information you desire on the subject. So oppressive has the monopoly been in the United States that Government has in some cases stepped in and fixed the rate at which service is supplied.—Yours, &c.,

A. D. Provand.

2, Whitehall Court, London, S.W., March 29, 1899.

[Reference is made to this letter in our editorial columns. —Ed. *E.*]

THE NERNST LAMP.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have read with much interest Mr. Swinburne's paper and your editorial comments upon it concerning the Nernst lamp. I cannot at all assent to Mr. Swinburne's statement that he has not been too sanguine. It seems to me that the lamp, although a beautiful possibility, is not yet a realised commercial factor, and perhaps never will be. Prof. Nernst is not the first to announce the principle upon which the lamp is constructed. In 1885 Mr. Jean Van Gestel and a Mr. Charles F. Beck, of Paris, were working in an analogous line, and availed themselves of the same properties of bodies which at ordinary temperatures were insulators, but at incandescence or thereabouts became conductors. Mr. Van Gestel is the well-known engineer who first described the eruption of Krakatoa, which occurred a few years ago, and which was followed by a tidal wave of which he was, perhaps, the only surviving witness. These gentlemen used plates of kaolin, which has much the same properties as oxide of magnesium, for this purpose. They employed the arc as a heating agent, with arrangements by which, when the kaolin or other electrolyte had reached its critical incandescing temperature, the main path of the current should be through it. The results are summarized in two United States patents, Nos. 322,024 and 322,033, of July 14, 1885.

Further, oxide of magnesium itself was used in the so-called "Sun Lamp," which was, I think, exhibited in London in about 1889, at an electrical exposition. At any rate, the lamp was well known at about that time. In this also the arc played over the face of a block of magnesia, which was raised to incandescence and then became the main current conductor. Air was partially excluded, and this I believe to have been the main difference between this lamp and the Nernst device; of course, I mean difference in principle.

I have witnessed a large number of tests of the Nernst lamp, and also had reports of others, amounting in all to many hundreds. In fact, three experts, not of such eminence, perhaps, as Mr. Swinburne, but certainly capable electricians and accurate observers, whose entire time is taken up with incandescent lamp experiments, worked on this lamp for many weeks, and finally abandoned it as absolutely impracticable for ordinary commercial purposes.

Mr. Swinburne says that the limiting resistance necessary is ten or twelve per cent. of that of the entire lamp. I suppose, although he does not say so, that this means 10 or 12 per cent. of the hot resistance. It was found necessary to use a limiting resistance many times this in order to secure any respectable results. The reason for this perhaps the following diagrams will make clear:—In Fig. 1, A is the resistance curve of the carbon as the temperature rises; B is the corresponding current curve. In Fig. 2, C is the resistance curve of an electrolyte, such as magnesia, and D is the corresponding current curve. It will be seen that, as the carbon gets hot, the resistance rises, and this tends to a finite value of current. In Fig. 2, however, as the electrolyte heats, the resistance falls, and the current curve diverges from it at once. The limit is removed to infinity. Of course, these are very rough diagrams, and only represent the phenomena in a general way. They do not, for instance, take into account the radiation, which very much modifies the curves.

Further, as you say in your editorial comments, Mr. Swinburne's neglect of the continuous-current side of this lamp is quite significant. In the experiments which I have named it was impossible to get any efficiency or life with continuous current; the candle-power ran down so rapidly that it was found useless to continue the experiments. Perhaps, in view of the apparent obsolescence of continuous current, or rather, the prospect of that occurring in the near future, this may not be so important as it otherwise would be.

One singular property of the Nernst lamp is not alluded to by Mr. Swinburne; perhaps he did not observe it, although it is probable that he did. Its candle-power is enough to deceive the very elect. Persons looking at it and at its apparent illuminating power upon the walls of a room, &c., made the wildest and most extravagant guesses at the photometer readings. I know that, although I had had considerable experience with the photometer, both in gas and incandescent work,

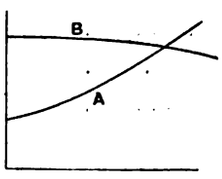

Fig. 1.

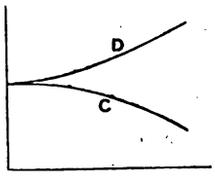

Fig. 2.

I guessed 15 c.p. when the lamp was giving three. I heard one gentleman of more experience than myself guess 32 when the photometer reading was five, and another thought it was eight when the reading was only three-fourths of one. Why this is so I cannot pretend to say.

I must dissent from Mr. Swinburne in thinking that there is no difference between luminescence and incandescence. It seems to me that this would mean that the same temperature would produce the same effect on all substances whatsoever. This is manifestly untrue at those temperatures which we can study. Hydrogen gas, for instance, takes a temperature almost inconceivable, and one certainly not attained by human means, to become luminescent; and white-hot iron is both incandescent and luminescent at what are to experimenters quite moderate temperatures.

Perhaps some of your other readers will be able to report on the Nernst lamp. It is never safe to say that any invention—so new and radical as that of Prof. Nernst—cannot be developed. I remember very well the ridicule with which Mr. Edison was met when he announced his plans for the use of the constant-potential systems now rapidly driving out everything else, and perhaps Prof. Nernst's lamp may become the incandescent lamp of the future; but I should judge that we need something better than spirit lamps and matches for an igniter, and something less than 500 volts pressure, before it will become commercial.

Is not Mr. Swinburne quite too pessimistic about the condition of the incandescent lamp in the old country? In the States we have developed quite a little in the last 15 years; we have not only cut the price into many minute fragments of what it used to be, but we make lamps which have enor-

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mously longer life and better performance; so much so that the idea of replacing a part of a lamp is to the average station man quite preposterous—it is cheaper in every way to replace the whole lamp than to handle it. We have been led to infer that substantially the same progress had been made in Europe, but from Mr. Swinburne's article this seems to be a mistake. —Yours, &c., T. J. JOHNSTON.

Schenectady, N.Y., March 21, 1899.

[Reference is made to this letter in our editorial columns. —ED. *E.*]

THE WEHNELT INTERRUPTER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Among the many letters you have published with reference to the new Wehnelt interrupter, little or no mention has been made of a form which has been found of great utility, here, *i.e.*, the multipolar interrupter, in which there are a number of fine platinum wire anodes with a common lead cathode. The dimensions of the one, which has been working with great success for the last three weeks here, are as follows:—The cathode was formed by the box itself, as first used, I believe, by Mr. Swinton, and was 8in. long by 3in. wide by 6in. deep, being made of lead. The anodes, six in number, were made of 18mil platinum wire, fused into glass tubes, and projected about $\frac{1}{20}$th of an inch from the ends of the tubes. As, however, considerable difficulty was caused by the breaking of the glass, it was found that the best plan was to fit an ebonite plug into the end of the tube into which the wire was tightly jammed; the whole tube was then filled up with soft wax. These have only been in use for a little over a week, so that they have not yet received a very severe test. Mercury has been discarded from the very first for making the connection of the platinum anode with the battery, the platinum wire being silver-soldered on to a copper wire connected to a terminal on the base of the instrument.

Using this form of interrupter with a 10in. Apps coil, it was possible to so regulate the current that the coil could be used to illuminate the most delicate helium or argon tube, or to give the now well known flaming arc 6in. or 7in. long.

The great difficulty is the rapidity with which the interrupter "fatigues." This has been found to be almost entirely due to heating, since, after ten minutes run at full power, the acid got quite hot and the instrument refused to work. A new one, with a larger reservoir for acid, is now being made in which it is hoped this difficulty will be overcome. By using a variable resistance in series with the above described interrupter, it was possible to get a very large range of current through the primary of the induction coil. Using the instrument on a 50-volt circuit the actual range was from less than 1 up to 25 amperes. It need hardly be stated that the great advantage of the multipolar instrument, as a regulator, was that a small current could be sent through the primary of the coil at a high frequency, while, by simply increasing the resistance in series, the frequency diminished with the R.M.S. current.

In confirmation of the theory of resonance given by Prof. S. P. Thompson, in your issue of the 16th inst., it has been noticed that with a considerable resistance in series with the instrument, it was possible to stop the intermittent discharge by increasing the number of anodes, *i.e.*, by increasing the capacity, and very slightly diminishing the resistance of the circuit, exactly as can be done with a Leyden jar discharge. When there was no resistance in series this could not be done, since the resistance was diminished approximately in the same ratio as the capacity was increased (by increasing the number of anodes); again, in accord with the theory of the Leyden jar discharge.

With one of the original instruments made in the laboratory with a single anode of thick (about $\frac{1}{16}$in. diameter) platinum wire used in connection with an 18in. coil and a suitable X-ray tube, illumination of almost dazzling brilliancy was obtained on the fluorescent screen, while the tissues of the body showed almost as clearly as when a 16 plate Wimshurst machine was used to excite the tube, and with the same steadiness in the glow.

With this interrupter a photograph of the characteristic quartet of the blue (4,800) cadmium line under the influence of a magnetic field (viewed across the lines of force) was obtained with an exposure of only three minutes.

Trusting that I have not trespassed too much on your space.—Yours, &c., E. W. MARCHANT.

Blythswood Laboratory, Renfrew, N.B., March 28, 1899.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: This valuable device appears to possess, in addition to its power of making a continuous-current oscillatory or intermittent, the in many cases even more useful property of converting an alternating current into one which is unidirectional.

An ordinary coil supplied from mains at a frequency of either 50 or 100 alternations per second gives only the short hot flaming arc, but with the Wehnelt interrupter in primary circuit it can be made to give either this kind of discharge, or the long, crackling, multiple sparks so very characteristic of continuous-current working with a good contact-breaker.

A vacuum tube of suitable length and degree of exhaustion is invaluable as a guide to the nature of a discharge, and with such a tube of low resistance giving striæ, the discharge is oscillatory on closed circuit, but with an air spark of suitable length, it can be made more and more unidirectional, until with exact adjustment it becomes apparently entirely so. The length of air-spark required depends on circumstances, such as the resistance and form of tube.

An X-ray tube works excellently, and the arrangement promises to be a great boon to workers who have only access to alternating-current mains.—Yours, &c.,

Leicester, March 18, 1899. E. E. BROOKS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In my communication which appeared in *The Electrician* of March 24, p. 766, occurs the passage:—"Without risk of burning the contacts, notably, as is the case when one terminal alone is constantly in circuit (by the magnetic make and break)." The word "terminal" may be somewhat obscure here: and the passage might have been:—"Without risk of burning the contacts, notably as is the case when one and the same pair of metallic interfaces is always concerned in breaking contact."

One object of the idea suggested was manifestly that one of these metallic interfaces should be perpetually changed by mechanical means; which conduces to a cooling effect at the point of interruption of the current, besides allowing rate of interruption to be accurately measured and adjusted for research purposes.—Yours, &c., S. TOLVER PRESTON.

March 29, 1899.

ROTATORY CONVERTERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the February issue of the *Journal* of the Institution of Electrical Engineers Prof. Thompson replies to my contribution to the discussion on his Paper, and, as his reply constitutes the termination of the discussion—so far as the Institution is concerned—I should like to give the reply which I think his remarks on my contribution (see *Journal*, pp. 736-7) call for, through your columns.

In the first place, Prof. Thompson correctly supposes that I refer to *single*-phase, and not to *two*-phase converters, in the first part of my remarks. I am at a loss to understand how this mistake occurred.

I entirely repudiate Prof. Thompson's charge that there is confusion between angular velocity and angular acceleration in my arguments. Prof. Thompson overlooks the fact that I was wishing to show the importance of the moment of inertia of the rotating part of the converter, and that for the purpose of my argument I show what would be the result if inertia were a negligible quantity (or zero), just as Prof. Thompson has treated resistance as a negligible quantity in his Paper.

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It is quite clear that if a single-phase alternate-current armature were entirely without inertia it could not run as a motor. If started it would move through an angle corresponding to half a phase, and stop when the current reached the zero point; in other words, "the angular velocity of the armature would vary between zero and a maximum.

On the other hand, if we suppose a converter entirely without inertia, and suppose it driven from the continuous side, and delivering an alternate current, the energy intake would correspond through any infinitesimal period with the energy output plus the losses, and the driving current would undulate —in the case of single phase—substantially in the manner shown in my diagrams (pp. 780 and 781).

I do not dispute the utility of Prof. Thompson's mode of determining the current distribution, *i.e.*, by superimposition, but I show that its results are not accurate, and that the truth lies between the results obtained in this way and those obtained when the result of conceiving moment of inertia negligibly small is taken into consideration.—Yours, &c.,

Nuremberg, March 26, 1899. W. B. Sayers.

AMERICAN NOTES.

New York, *March 17.*

Electric Traction.—The great event in electrical affairs is the decision of the Manhattan Railway Company to equip the Manhattan elevated roads of this city for electric power. Connected with this are repeated rumours of the consolidation of the Metropolitan and Third Avenue street railway surface systems. Another item of importance going the rounds is that all the Brooklyn surface trolley roads and the complex elevated system are to be consolidated. Consolidation is in the air. The rush of capital into combinations in the various industries since Jan. 1 was computed this week to be not far from one thousand million dollars. A syndicate with a capital stock of $25,000,000 has secured control of a large system of electric roads in the territory within a radius of 80 miles of Niagara Falls. A dozen valuable properties lose their individuality. The Philadelphia United Gas Improvement Co., capital $20,000,000, has secured control of a number of electric lighting plants in Northern New Jersey. A company with a capital of $4,000,000 is negotiating for the purchase of the street railways in six prosperous manufacturing towns in Eastern Massachusetts.

Telephony.—Independent telephone companies have been springing up fast, and the growth of these concerns has now reached a point where central organisation is possible. The Massachusetts Telephone and Telegraph Co. are taking steps to build lines throughout the New England States and to New York and Philadelphia, where they expect to do a big business. The Bell Co. is threatening to obstruct. The movement has already assumed quite formidable proportions in Michigan, where there are 26,000 independent telephones. The long-distance toll lines are of copper throughout. There is growing opposition to the high cost of the telephone service. A Bill is before the New York legislature to restrict charges. Three State officers are to act as arbitrators for the consideration of complaints.

Aluminium.—An aluminium line is about to be used in California to carry electrical power 80 miles.

Electric Rock Drill.—The first electric rock drill used in Australia has been installed by Messrs. Siemens Bros. at the Labrador Tin Mine, East Coast, Tasmania, and up to the present, according to the *Australian Mining Standard*, has given every satisfaction. The drill, which takes 1 H.P. to work it, is driven off a Siemens dynamo having an output of 30 amperes at 110 volts. This dynamo, which is also used for lighting the mine in question, is driven by a small Pelton wheel. The drill itself is a purely mechanical drill, operated by means of an ordinary small continuous-current electric motor.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"Laboratory Notes and Forms."—With the above title we have ready the New Edition of a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free; abroad 11s.

"The Students' Guide to Submarine Cable Testing."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition now ready.*

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"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s, post free.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s. *New edition ready May 1, 1899.*

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves."—By Dr. O. J. Lodge, with many original illustrations. *Enlarged Edition*, 2s. 6d. net, 2s. 9d. post free.

"Electromagnetic Theory."—By Oliver Heaviside *Vol. I.*, 12s. 6d. *Vol. II. ready May 1, 1899.*

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"The Bibliography of X-Ray Literature and Research, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Price 5s., post free; abroad, 5s. 3d.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. Prospectus on application.

"Electrical Engineering Formulæ," a pocket-book, by Messrs. W Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. A fine large paper edition with wide margins for notes can also be supplied. Price 12s. 6d.; post free, 13s.; abroad, 13s. 6d. *New Edition in the press.*

"The Alternate Current Transformer," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *New Edition.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"The Electrician" Primers.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

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"ARMATURE WINDINGS OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

IN THE PRESS.

"THE ELECTRIC ARC."—By Mrs. Ayrton.

"THE MANUFACTURE OF CARBONS FOR ALL ELECTRICAL PURPOSES."—By Francis Jehl.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. *Vol. II. ready May 1, 1899.*

"SECONDARY BATTERIES, THEIR DESIGN AND MANUFACTURE."—By E. J. Wade.

"PRIMARY BATTERIES: THEIR CONSTRUCTION AND USE."—By W. R Cooper.

"PRACTICAL TELEPHONY."—By Dane Sinclair and F. C. Raphael.

"'THE ELECTRICIAN' WIREMAN'S POCKET-BOOK."—By F. C. Raphael.

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The "Big Blue Book" for 1899 is NOW READY. The Directory Division has been corrected up to Feb. 8, 1899, and all the latest new names, changes of address, &c., will be found included. The Handbook Division has been much extended, many valuable tables having been added. The volume contains, also, the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways, finally corrected to Feb. 9, 1899. The price of the Directory and Handbook remains the same—10s., post free 10s. 9d.; abroad, post free, 12s. (United States 13s. 6d.).

TENDERS INVITED.

As advertised elsewhere, the *Epsom* District Council invite tenders for the supply and erection of: (*a*) Lancashire boilers and fittings, economiser, feed pumps, &c.; (*b*) pipework, &c., in engine and boiler house; (*c*) steam dynamos and motor boosters; (*d*) storage batteries; (*e*) main switchboard and connections; (*f*) overhead travelling crane; (*g*) underground mains and conduits; (*h*) arc lamps and posts; (*i*) street glow lamps and accessories; and (*k*) station lighting. Specifications, &c., may be obtained from the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C., on and after the 10th inst. Tenders to the clerk (Mr. E. G. Wilson), High-street, Epsom, by noon of May 8.

The *Hamps'ead* (London) Vestry invite tenders for the supply of two 500-kilowatt steam alternators, five Ferranti or similar type switchboard panels, boilers, feed-water heaters, feed pumps, a 40-kilowatt exciter, water softening plant, air pump and condenser, economiser, overhead travelling crane, &c. Further particulars are set out in an advertisement, and specifications, &c., may be obtained at the office of the clerk (Mr. Arthur P. Johnson), Vestry Hall, Hampstead, N.W., where tenders must be lodged by noon of May 18.

The Electric Light committee of the county borough of *Belfast* invite tenders for the supply and erection of mechanical stokers, economisers, pipe work and condensing plant. Specifications, &c., may be obtained from the city electrical engineer (Mr. Victor A. H. M'Cowen). Further particulars are given in an advertisement, and tenders must be sent in to the town clerk (Sir Samuel Black) by noon of Thursday, April 20.

As advertised elsewhere, the *West Ham* Council invite tenders for two 1,500 I.H.P. engines, two 800 kilowatt alternators and exciters, or two steam alternators and exciters. Specifications, &c., may be obtained at the borough electrical engineer's office, Abbey Mills, West Ham, on and after the 31st inst. Tenders must be sent to the town clerk (Mr. Fred. E. Hilleary) by 4 p.m. of Tuesday, April 25.

The Gas and Electricity committee of the *Stockport* Corporation require tenders for the supply and erection of a storage battery of 750 ampere hours' capacity. Specifications may be obtained from the engineer (Mr. S. Meunier), gas and electricity works, and tenders (addressed to the chairman) must be delivered by 19th inst. See advertisement.

The Town Council of *Reigate*, Surrey, require tenders for (1) two watertube boilers, economiser, brickwork, and flues, (2) steam exhaust and other pipes, steam pumps, &c., (3) two 100 kilowatt and one 20 kilowatt steam alternator, 8-ton overhead travelling crane, and sub-station equipment, (4) switchboard and instruments, (5) mains, lamp-posts, lamps and fittings. Specifications, &c., can be obtained from Mr. F. Hastings Medhurst, consulting engineer to the Council, 13, Victoria-street, London, S.W., on and after April 10, and sealed tenders must be delivered to the town clerk (Mr. Clair J. Grece), 84, Station-road, Redhill, Surrey, not later than noon of Monday, May 1. An advertisement on another page gives further particulars.

The *Bradford* Corporation invite tenders for the supply of a complete battery and switchboard for their electricity supply station, Bolton-road. Tenders to town clerk (Mr. George McGuire), by April 12.

The *London* County Council require tenders for the supply of engineers' goods and electrical stores. Tenders to Spring Gardens, S.W., by 10 a.m. 24th inst.

The *South Shields* Corporation require tenders for steam and water pipes and valves and a 15-ton hand-power overhead travelling crane. Tenders to town clerk by 20th inst.

The *St. Helens* Electricity and Tramways committee require tenders for constructing about six miles of tramways. Tenders to chairman by 19th inst.

The Corporation of *West Hartlepool* invite offers from firms or companies for "free" wiring of premises in the district. Offers to the town clerk by April 15.

The *Bristol* Electrical committee require tenders for high-tension switchboards, instruments, &c. Tenders by April 10.

The *Poplar* (London) District Board of Works invite tenders for engine and pump room equipment and all electrical plant except battery; boiler house equipment; battery and battery stands; and public street lighting. Tenders to Mr. Potts by 10 a.m. April 25.

The *Tynemouth* Corporation invite tenders for boilers, &c., economisers and fittings, ejector-condenser, circulating pumps, tanks and pipework and water cooler, pumps, feed pipes, &c., travelling crane, traction switchboard, lighting switchboard, accumulators, cables, and traction steam dynamo. Tenders to the town clerk by noon of April 15.

The Great Northern Railway Co. (Ireland) invite tenders for cables for feeders, returns, potential lines, &c., 6 motor and 6 trailer cars, overhead construction, and battery and booster. Tenders to secretary by April 20.

The Guardians of the Poor of *Rochdale* Union require tenders for a complete electric light installation at the workhouse buildings and cottage homes. Tenders to Mr. R. A. Leach, clerk, Union Offices, Townhead, Rochdale, by April 12.

The *Peterborough* Corporation invite tenders for the supply and erection of Lancashire boilers and economiser; steam dynamos, balancers and boosters; secondary battery and accessories; switchboard and instruments; piping, tank, condensers and pumps; and insulated cables. Tenders to town clerk by April 20.

The *Hull* School Board invite estimates for the installation of the electric light at the central higher-grade school and school of science. Tenders to clerk by 25th inst.

The *Edinburgh* Corporation invite tenders for installing the electric light at the City Chambers (extension buildings). Tenders to town clerk by April 10.

TENDERS RECEIVED AND ACCEPTED.

The Aberdeen Corporation have accepted the tender of Messrs. John M'Adam and Sons to construct the permanent way in connection with the electrical equipment of the George-street and Woodside tramways route, at £19,000. For the other sections of the contract, including overhead line construction, feeder, pilot, and test cables, tramway cars and accessories, and switchboard, instruments, &c, the final selection of tenders will be made by a sub-committee from the following firms:—R. W. Blackwell and Co., the British Thomson-Houston Co.; Macartney, McElroy and Co., and the Westinghouse Co. The whole undertaking is estimated to cost £35,000, and it is anticipated that the electric cars will be in operation about the end of August.

The Shoreditch (London) Vestry have accepted the following tenders for the supply of stores for the lighting department during the year:—

Crompton and Co., carbons.
Edison and Swan Company, incandescent lamps and arc globes.
Williamson and Joseph, switches, ceiling roses, and cut-outs.
General Electric Co., rubber tapes.
Johnson and Phillips, fuse and lead wires.
Pryke and Palmer, ironmongery and tools.
T. Tilley and Sons, street lamps and cradles.
G. Braulik, shades, flexible wires, and insulating materials.

The Shoreditch (London) Vestry have received the following tenders for the construction and erection of a new battery switch panel:—

Nalder Bros. and Thompson (*accepted*)	£197 10	Veritys Limited	£240 0
Electric Construction Co.	295 0	General Electric Co	225 0
		Crompton and Co	185 0

The Glasgow Tramways committee recommend the acceptance of the following tenders for the conversion to electric lines of various tramway routes:—Whiteinch to Anderston Cross, A. Stark and Sons £25,739; Langside to Overnewton, A. and J. Faill, £32,610; Anderston Cross to Bridgeton Cross and Bridgeton Cross to London-road terminus, Macartney, McElroy and Co., £20,754; Bridgeton Cross to Dalmarnock-road terminus, Pollokshaws and Pollokshields

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to Eglinton Toll, and Braehead-street, Rutherglen-road, to Crown-street, D. Murray, £22,973.

The South Shields Corporation have accepted the tender of Messrs. S. Z. de Ferranti (Limited) for switchboard extensions, at £1,047. 2s.

The Victorian Postmaster-General recently accepted the tender of the W. T. Henley's Telegraph Works Co. for the supply of 10 miles of aërial telephone cable at £2,210.

APPOINTMENTS VACANT AND FILLED.

The Gas committee of the Keighley Corporation require an electrical engineer to prepare specifications, &c., of an electric lighting scheme. Further particulars are given in an advertisement, and applications (addressed to the chairman of the committee) must be sent to the town clerk (Mr. George Burr) by May 1.

The Hull Electric Lighting committee require two junior assistants. Applications to city electrical engineer (Mr. A. S. Barnard), Electric Light Station, Dagger-lane, Hull, by April 20. See advt.

A fitter is required for the District Asylum, Millingar, with a sufficient knowledge of electrical engineering to enable him to take charge of and keep in repair an installation of 400 incandescents and 13 arc lamps. Applications to the resident electrical superintendent. See advertisement.

Mr. Alec Scott has been appointed electrician-in-charge at the Folkestone Electricity Co.'s works.

Mr. George E. Gittins has been appointed assistant in the Physics department of the Blackburn Municipal Technical School. Salary £110 per annum.

Mr. S. E. Bastow, of Hull, has been appointed clerk of works at Barnsley.

Mr. C. E. Squire has resigned his position as superintendent of the public lighting department at Blackpool, and has entered the service of the British Insulated Wire Co.

BUSINESS NOTICE.

Messrs. Meirowsky and Co., mica merchants, have removed from 10, Glasshouse-street, W., to 52, Queen Victoria-street, E.C., to which address all future communications should be made. Telegrams "Meirowsky London." Telephone 657 Bank.

BANKRUPTCIES, LIQUIDATIONS, &c.

D. U. Paine, electrician, 84, Gloster-road, Brighton, has been adjudicated bankrupt.

A receiving order has been made against J. E. Stott (trading as James E. Stott and Co.), electrician, 10, Wood-street, Byrom-arcade, Huddersfield.

Claims against Electricity (Limited) must be sent to the liquidator, Mr. P. W. Davis, 61½, Fore-street, London, E.C., by May 2.

It has been decided to wind up voluntarily the Electric Lighting Extension Syndicate (Limited), to approve an agreement with the Penny-in-the-Slot Electric Supply Syndicate (Limited), and to appoint Mr. C. O. Bastian liquidator.

It has been decided to wind up the Faraday Electrical Engineering Co. (Limited) voluntarily. Mr. Jas. C. Bowes, 203, West George-street, Glasgow, is liquidator.

Electrical Trades' Directory and Handbook, 1899—*Correction.*—By a clerical error the name of Mr. Mervyn J. P. O'Gorman was included under the heading of "Electric Tramway Contractors," on p. 751 of the 1899 edition of this work. The entry should not have appeared under this heading, as the firm of O'Gorman and Cozens-Hardy practice exclusively as consulting engineers, and are not contractors or manufacturers of any kind of plant, apparatus or materials.

Sale by Tender.—Pursuant to an order of the High Court there is for sale by tender the stock-in-trade, plant, furniture, fixtures, goodwill and British patents owned by the Elieson Lamina Accumulator Co. (Limited). Particulars will be found set out in an advertisement on another page. It will be seen that tenders are to be sent in not later than Wednesday, April 12.

King's College (London).—The special evening course of lectures and laboratory work on alternating currents commences on May 1.

"Snowdrift" Lubricants, &c.—A well-prepared catalogue of "Snowdrift" lubricants and the special types of automatic and other lubricators manufactured by Messrs. Snowdon, Sons & Co., Ltd., of Millwall, London, E., is to hand. The catalogue also contains particulars of vulcanised india-rubber goods, asbestos packings, &c.; beltings, boiler coverings, &c.; and forms a useful trade guide.

New Apparatus Catalogue.—Messrs. John J. Griffin and Sons, Ltd., of 20–26, Sardinia-street, London, W.C., forward a list of new apparatus for use in electrical, chemical, and general research work.

Interior Conduit Wiring.—We have received from the Simplex Steel Conduit Co., Ltd., an admirably arranged and complete catalogue of the material used for their system of house-wiring. In the Simplex system special steel tubes are used, with a longitudinal seam which leaves sufficient springiness for the connection and corner pieces to be slid over the ends, a serviceable connection being thus made without screwing the ends of the tube. The erection of the conduit is thus extremely easy, and justifies the name "Simplex." Connection pieces, bends, junction-boxes, &c., to meet every possible requirement are quoted for in the catalogue, and some new forms of these have recently been introduced. Among them we may mention the "half-normal" bend (Fig. 1), and some practical outlet boxes for pendants and other fittings. Fig. 2 is an "inspection" sharp bend, which should prove very

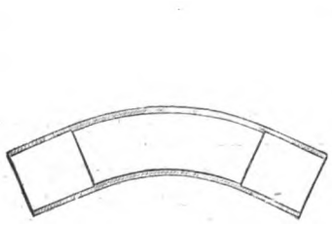

FIG. 1.

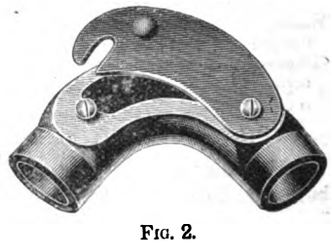

FIG. 2.

practical in situations where sharp bends cannot be avoided. It is claimed that the cost of installations on this system will compare favourably with those in wood or other casing.

Cassier's Magazine.—The contents of the April issue include "Electric Power in Steel Making," "Water Softening," "Modern Pumping Machinery for Mine Service," "America's Export Trade," "Engineering in Africa and the Far East," "Industrial Imperialism," "Horseless Carriages Four Hundred Years ago," and "American Lake Shipping and Casualties."

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) on March 29 and March 30, with the ports of destination:—

Argentina—Buenes Ayres, £225 (including £190 telegraph material); Rosario, £9. *Australasia*—Launceston, £186; Melbourne, £170; Otago, £7; Sydney, £102; Wellington, £234. *Borneo*—Labuan, £42 (telegraph material). *Brazil*—Rio Janeiro, £79. *British Guiana*—Demerara, £24. *Ceylon*—Colombo, £284. *Chili*—Valparasio, £100. *Egypt*—Alexandria, £64. *Holland*—Amsterdam, £90. *Hong-Kong*, £1,020. *India*—Calcutta, £11; Madras, £10. *Italy*—Genoa, £285; *Japan*, Yokohama, £96. *Russia*—Reval, £24; St. Petersburg, £180 (including £125 telegraph material). *Siam*—Bangkok, £29. *South Africa*—Cape Town, £44; Chinde, £13; Delagoa Bay, £5; Durban, £19 (including £28 telegraph material). *Uruguay*—Monte Video, £70. Total (for two days) £5,452, against £7,428 for one week last year (March 30 to April 5).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Blackburn.—The new electric tramways are in great favour. Last week 44,000 more passengers were carried than in the corresponding week of 1898, and the increased receipts amounted to nearly £450.

Blackpool.—The receipts of the electric tramway department for the last financial year were £18,196, against £15,376 in 1898, £13,223 in 1897, and £9,869 in 1896. It is proposed to give a 2½ minutes' service on the promenade.

Buenos Ayres.—The popularity of electric traction is strikingly shown by the results of the competition between the Belgrano Electric and the New Tramways Companies of this city. According to the *Review of the River Plate* both companies run through the same streets from Paseo de Julio to Recoleta, and while the cars of the former are generally crowded, those of the horse system are virtually empty. At night and in the morning the cars of the Electric Co. are always crowded, and the local train service to Palermo is, in consequence, suffering considerably.

Canterbury.—An inquiry was held last week into the application of the Town Council to borrow £13,250 for electric lighting extensions. The consulting engineer (Mr. Robert Hammond) submitted technical details. He said that the amount already sanctioned for electric lighting was £23,000. No greater success had ever been achieved by any local body than by Canterbury, for at the recent formal opening the orders in hand were sufficient to exhaust the capacity of the whole plant. The number of applications was then 172, of which 102 were connected up. The demand was increasing. There was no opposition.

Crewe.—Before sanctioning the Council's application for a loan for electric lighting purposes, the Local Government Board ask the probable revenue of the proposed supply works, and as to the suitability of the site.

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Darlington.—The borough engineer has been authorised to obtain tenders for electric lighting plant.

Derby.—The gas lamps are to be adapted for incandescent electric lighting in those streets where electric light mains are laid. The work has been authorised on condition that the cost of conversion does not exceed £1 per lamp, and that the charge for electric lighting does not exceed the present cost of gas.

Eastbourne.—The Council have definitely accepted the offer of the Eastbourne Electric Light Co. for the sale of the company's undertaking for £83,000. The transfer will take place at the end of the year.

Edinburgh.—On the question of creating a special reserve fund for the electricity department, the Electric Light committee report that they cannot recommend the Council to depart from the statutory provisions of their provisional order at present, and recommend that no special or separate fund for renewals should be formed apart from the reserve fund already established which should be made up to its maximum.

Glasgow.—Mr. H. F. Parshall has been appointed consulting engineer to the Tramway department in connection with the conversion of their lines to the overhead trolley system of traction, at a remuneration of 2½ per cent. on the capital outlay.

The following estimate prepared by the general manager of the tramways (Mr. John Young) as to the conversion of six additional routes (Section II.) has been approved by the Tramways committee. The estimates include permanent way alterations and renewals, including bonding and ducts for feeders, and also overhead construction :—

Paisley-road and Parkhead route	£35,000
Paisley-road and Possilpark route	11,400
Pollokshields and Garscube Cross route	2,800
Maryhill and Mount Florida route	54,050
Langside and Seamore-street route	4,900
Paisley-road and Oatlands route	2,150
	£110,300
Less cost of renewal of lines in ordinary course	55,000
	£55,300

The provision of depots at Kinning Park, Whitevale, and Maryhill will entail an expenditure of £13,814.

Great Grimsby.—A Local Government Board inquiry was held yesterday (Thursday) into the application of the Council to borrow money for electricity supply. The scheme provides for supply for lighting and power purposes.

Hanley.—Sanction to borrow £5,000 for electric lighting extensions has been applied for.

Hereford.—The Electric Lighting committee hope to be in a position to supply electric current by October. The committee reported the acceptance of tenders for the erection of the station buildings last week.

Hull.—Extensions of the mains, estimated to cost £1,323, were authorised by the Electric Lighting committee last week. The chairman (Councillor Skinner) made a statement on the financial position of the department, and said that owing to the great and unexpected demand for current from districts that had not been contemplated, a sum of £5,339. 3s. 6d. in excess of the loan sanctioned for new works had been expended in extending the mains in streets not included in the original scheme. To meet this over-expenditure, and in anticipation of requests to extend the mains to other districts, the question of borrowing another £10,000 is being considered. The new works at Sculcoates-lane were opened during the year. The whole of the works were designed by and carried out under the sole superintendence of their electrical engineer (Mr. A. S. Barnard), and in recognition of the time, energy, and ability Mr. Barnard has devoted to the work, and of the expense he had saved the committee, it has been decided to grant Mr. Barnard an honorarium of 100 guineas.

Kingston-on-Thames.—£15,000 is to be borrowed for electric lighting extensions.

Kingstown (Dublin).—The Council are considering a proposal of the Municipal Industries Syndicate to take a transfer of their provisional order and to establish electricity works.

Leigh.—Sanction to borrow £10,000 for electric lighting purposes has been received by the council.

Llanrwst (N. Wales).—The electricity works of the Llanrwst Electricity Supply Co. were formally opened by Earl Carrington on Thursday evening last week.

Motherwell.—The plans of the proposed electricity works have been approved by the Police Commissioners, and the consulting engineer (Prof. A. B. W. Kennedy) has been instructed to proceed with the scheme.

Musselburgh.—An agreement has been entered into by the Town Council with the Drake and Gorham Electric Power and Traction Co. for the establishment of electricity supply works. The company undertake to supply current for private lighting at 6d. per unit, and for public lighting at 4d. The Council reserve the right of purchase.

Newington (London).—The following charges for current has been decided upon :—6d. per unit for first hour, 4d. second hour, 3d. after. For power a uniform rate of 2½ per unit will be charged.

Oldham.—The Electric Light committee are recommended by their consulting engineer (Prof. A. B. W. Kennedy) to complete the work of doubling the pressure of supply and to carry out certain other alterations and extensions, at an estimated cost of £20,000.

Port Adelaide (South Australia).—The electricity supply works of the South Australian Electric Light and Motive Power Co. were formally opened on Feb. 1. The works have been erected to the plans and specification of Mr. W. W. Crawford, the company's consulting engineer and the Australian representative of Messrs. Johnson and Phillips. The generating plant consists of five 440-volt continuous-current Johnson and Phillips dynamos and five compound condensing high-speed engines. The feed pumps are of the Worthington type. The cables and arc lamps have also been supplied by Messrs. Johnson and Phillips, and the accumulators by the D.P. Battery Co.

St. Pancras.—Forty-nine additional arc lamps are to be erected, at an estimated cost of £3,583. Tenders are to be invited for two 750 H.P. steam dynamos, and two boilers, for the Regent's Park station. The cost of these additions is estimated at £19,000.

St. Saviour's, Southwark (London).—The Board of Works have resolved that if the City of London Electric Lighting Co. do not, within one month, commence to erect workmen's dwellings for the people dehoused several years ago, when the company's works were being built at Bankside, legal proceedings will be commenced to compel the company to carry out their agreement.

Shoreditch (London).—The Vestry have declined to adopt the recommendation of the Lighting committee to enter into a special contract for the supply of current for power purposes to Messrs. Wertheimer, Lea and Co. for 21 years. It was considered impolitic to make an agreement for so long a period, and the terms proposed were deemed too favourable to the company. The proposal was to supply current for lighting at 3d. per unit for an annual consumption of 50,000 units, and for power purposes at 1½d. per unit for 100,000 units per annum, 1¼d. per unit for 75,000, and 2d. per unit for under 75,000 units yearly.

Sierra Leone.—Telegraphic communication between Freetown and Waterloo was available for the first time on April 4.

South Shields.—The Electric Lighting committee have reduced the charge for electric current from 3d. to 2d. per unit after the first hour's maximum demand at 7d. The Corporation's electricity undertaking has made rapid progress, and, in view of the recent increase in the price of gas, the reduction in the charge for energy announced will lead to increased popularity for the electricity department.

The committee have approved the scheme for further extension of the electricity supply undertaking, at a total estimated cost of £21,150, sanction for the borrowing of which sum is to be applied for.

Stock Exchange Call Board.—The *Financial News* states that an electric call board has been erected in the London Stock Exchange, upon which are placed a number of figures in black on a white ground-glass background. These groups of figures indicate members' numbers, and on a member being inquired for, or called up, a loud electric alarm is sounded, and the number is illuminated by an incandescent electric lamp. According to the same authority the new board is the source of considerable speculation—of the betting order.

Sunderland.—The Corporation have come to an arrangement with the local tramways company to take over the tramways from Jan. 1 next. The purchase price is £34,000. The Corporation are at present seeking powers to introduce electric traction.

The Government and the Telephone.—The Parliamentary committee of the Liverpool Corporation have decided to co-operate with Chambers of Commerce and other public bodies in opposing the Government Telephone Bill on the ground that undue advantages are offered to London subscribers compared with those available in provincial centres, metropolitan subscribers benefiting exclusively from the Imperial funds, and in the abolition of the 10 per cent. royalty. The committee hold that the powers granted under the Bill to municipal authorities to establish telephone systems will result in complications, and that a central authority to work the whole telephone system of the country should be established.

A deputation, representing Glasgow, Aberdeen and Paisley, met Mr. Hanbury, M.P. (who will have charge of the Government's measure), at Preston on Wednesday, to discuss with him the question of telephonic municipalisation. Application was made by

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representatives of the Press for admission to the meeting, but Mr. Hanbury did not see his way to accede to the request. He stated that he thought it would be wholly inadvisable to have the proceedings reported in the newspapers, his interview with the deputation being entirely confidential. His chief object in meeting the deputation was to discuss the details of the Treasury minute (which has yet to be submitted to the House of Commons) relative to the proposed measure. To give the National Telephone Co. the benefit of the publicity of these details at this stage, he remarked, would be to "upset the coach" altogether. Edinburgh, having resolved not to apply for a municipal telephone licence, sent no delegate. It is understood that Mr. Hanbury indicated to the deputation that the proposed restriction of only granting licences to municipalities with populations of over 50,000 would be struck out, and that there is every reasonable prospect of an amicable settlement between the State Department which Mr. Hanbury represents and the municipalities interested regarding the question of wayleaves and the safeguarding of the rights and interests of municipalities at the end of 1911.

Trade of France.—In his report on the trade and commerce of France for the year 1898 Mr. H. Austin Lee, commercial attaché at the Paris Embassy, refers to the continued activity in the demand for electrical plant and apparatus. Exported dynamo electric machinery shows an increase of £8,000 over 1897 (from £48,000 to £56,000), and imports an increase from £132,000 in 1896 to £148,000 in 1898. The exportation of automobile vehicles amounted in 1898 to £68,000, a marked increase over the preceding year.

Tramway Extensions in London.—The London County Council propose to construct the following tramways in the northern, north-western and west central districts of London :—

1. From Theobalds-road, through Russell-square, Woburn-place, Tavistock-square, and Seymour-street, to Crowndale-road.
2. Crowndale-road from High-street, Camden Town to Pancras-road.
3. Along Euston-road from King's Cross to Marylebone.
4. Along Albany-street and Park-street.
5. Along Gower-street and George-street to High-street.
6. Along York-road from King's Cross to Camden-road and through Leighton-road.
7. Continuation from Hampstead-road in Tottenham Court-road to Grafton-street.
8. Continuation in Prince of Wales-road to Haverstock Hill.

Vienna.—Under a recent charter the Municipal Council is authorised to transfer its rights and privileges for tramway construction on specific conditions, and an agreement has been entered into with Siemens and Halske Aktien Gesellschaft, of Berlin, who are to form an Austrian company to take over the concession till 1925, when the entire system of electric tramways will pass into the hands of the town without payment, the Council reserving the right of taking it over at a valuation, either in 1914 or 1920. The existing tramways are to be transformed into electric lines, and the company will also undertake to construct, within four years, an extensive network of lines, which, together with the present tramways, will extend over about 300 kilometres, or nearly 200 miles. Overhead wires are to be allowed, except in the Ringstrasse. The network of electric tramways to be constructed will connect the outlying districts with each other and with the railway termini, and, when completed, will greatly increase the facilities for locomotion in Vienna.

Whitechapel (London).—A loan of £78,500 is to be borrowed from the London County Council for joint electric lighting and refuse destructor works. Mr. Arthur Wright intimated to the Board of Works last week that the work of laying electric light mains would be commenced forthwith. The question of the appointment of Mr. W. C. P. Tapper (Mr. Wright's assistant) as resident electrical engineer has been left in the hands of the Electric Lighting committee.

Wigan.—Now that the Council are definitely committed to an electric lighting project, attention is directed to the advisability of acquiring the local tramways and introducing electric traction. At the meeting of the Council, on Wednesday, the Tramways committee were authorised to open negotiations with the Tramways Company.

Willesden (London).—The Council's electrical engineer (Mr. E. T. Ruthven Murray) has been instructed to report upon the advisability of constructing electric tramways in the district.

Workhouse Lighting.—The Eccleshall Guardians will shortly hold a special meeting to consider Mr. H. W. Ravenshaw's electric lighting scheme.

The Barton (Lancs.) Guardians propose to borrow £3,355 for the electric lighting of their new workhouse and infirmary.

The Pontefract (Yorks.) Guardians have adopted the recommendation to light the workhouse buildings electrically.

Zomba (Central Africa).—An electric lighting scheme has been decided upon for this town, which is the headquarters of the British South Africa Co. in Northern Rhodesia. Only 150 16 c.p. lamps will be required for street lighting at the outset.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application an asterisk is affixed.*

February 16, 1899.

11,158A. H. H. LEIGH. London. Improvements in electrical couplings for railway cars (F. J. Sprague, United States). [Date claimed under Patents Rule 19, May 16, 1898.]*

11,158B. H. H. LEIGH. London. Improvements in pilots apparatus and reversing mechanism for controlling electric motors (F. J. Sprague, United States). [Date claimed under Patents Rule 19, May 16, 1898.]*

February 13, 1899.

3,137. J. J. GREEN. Halifax. Improvements in the construction of electric conduits or cable carriers.

3,141. A. BROADBENT. Liverpool. Temporary cord connections for telephone switchboards, &c.

3,151. C. A. LEE. London. New or improved apparatus for imparting a preliminary heating to refractory filaments of electric lamps.

3,152. W. H. WILLATT. Hull. A means of operating hydraulic machinery by electricity.

3,160. H. SMITHSON and E. R. SHARPE. Manchester. Improvements in and relating to electro-magnetic cut-outs and other like apparatus, specially applicable to electric arc lamps.

3,182. G. H. CONDICT. London. Charging stand and contact for storage batteries. (Date applied for under Patents, &c., Act, 1883, Sec. 103, July 18, 1898, being date of application in United States.)*

3,187. A. M. TAYLOR and C. H. GREENBANK. London. Improvements in and connected with road vehicles driven by electric current from conductor.

3,189. F. H. WITHYCOMBE. London. Improvements in insulators.*

February 14, 1899.

3,233. L. BELKNAP and A. SUNDH. London. Improvements in cables for carrying electric currents.*

3,252. C. WIGHTMAN and A. HUDSON. Bradford. Improvements in lining electric wood casings or conduits with steel or other metallic substances.

3,269. M. RAILING. London. A new or improved tilting device for the shades of electric incandescence lamps.

3,316. R. B. PAINTON and W. H. BAINBRIDGE. London. Improvements in or connected with electrically-propelled and/or controlled vehicles.*

February 15, 1899.

3,339. E. G. PINK. London. Improvements in electric traction.

3,374. C. H. MOUNSEY and J. F. WALSH. London. Improved method of and means for correctly and automatically guiding the trolleys of the connecting arms of cables of electric trams, electric railways and the like.

3,387. J. E. WINSLOW. London. Improvements in trolley apparatus for use in connection with electric traction.*

3,389. H. MOUL. London. Jointing conductors of the metal oxides to wires in incandescent electric lamps.

3,391. J. ARCHBUTT. London. An improved connector for electric light and power circuits for theatrical and other purposes.

3,392. POWELL-JONES AND CO. London. Improvements in automatic switches for starting and stopping electric motors.

February 16, 1899.

3,417. W. H. WILLATT and A. E. SEATON. Hull. A means of operating hydraulic or pneumatic machines and tools, and forcing water into boilers and other vessels by electricity.

3,440. E. DICK. Manchester. Improvements in and connected with means for electrically lighting railway carriages.*

3,469. L. ENCAUSSE and L. ENCAUSSE. London. Improved primary battery.

3,477. R. DUCORNOT. London. Safety contact interrupter for suspended electric wires or cables.

February 17, 1899.

3,528. R. P. GERLAND. London. Improvements in automatic electrically signalling the adjustment of dummy clocks.

3,531. E. A. JAHNCKE. Improvements in or connected with electric batteries.

3,570. W. O. ROOPER. London. Improvements in or connected with storage batteries.

3,586. F. FABER. London. An arrangement for collecting accumulator cells and the like.*

3,591. L. M. ERICSSON. London. Improvements in telephone switch apparatus.*

3,594. H. BAGGETT. London. Improvements in arc lamps.

3,597. A. J. BOULT. London. Improvements in or relating to electric railway switching and signalling apparatus. (The Continental Hall Signal Co., Belgium.)*

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February 18, 1899.

3,648. A. J. O. Chalandre, L. J. B. Colas and C. J. Gerard. London. Improvements in or relating to the electrolysis of salts in solution and apparatus therefor.
3,665. O. Imray. London. Impro vements in electric incandescence lamps. (W. Hernst, Germany.)

February 20, 1899.

3,704. R. Riley, T. Winstanley and S. Riley. Manchester. Improvements in and appertaining to electric street tramways.
3,717. O. Ward, Jun. Glasgow. Improvements in switch throwers.*
3,734. W. Borchers. London. Improved process for electric smelting or reducing.*
3,735. W. Börchers. London. An improved method of and apparatus for utilising the waste gases and heat from electric furnaces.*
3,736. J. Skwirsky. London. Improvements in secondary batteries.*
3,742. A. C. Brown. London. A combined thermo-electric or electro-thermal lamp.
3,746. W. J. Murphy. London. An improved electric switch.
3,754. P. F. W. Simon, H. H. Berry and C. Rayner. London. An improvement in electrical wall plugs.*
3,762. R. J. Crowley and A. C. Oakes. London. Improvements in wireless telegraphy through water.
3,773. W. J. Murphy. London. An improved dynamometer for use in laying submarine cables.
3,774. L. H. Newton, R. R. F. Neville, S. P. Newton and E. Tew. London. Improvements in galvanometers and the like.*
3,784. F. H. Badger and W. J. Plews. London. Improvements in electric safety appliances.

February 21, 1899.

3,836. R. J. Wallis-Jones and H. W. Couzens. London. A new or improved process for roasting or calcining mineral substances by electrical currents, especially adapted to the manufacture of Portland and like cements.
3,842. G. D. Granger. London. Improved electrically energised pendulum for use in clocks and for other like purposes.
3,861. T. Carles. London. Improvements in telegraph and telephone cables.
3,869. R. D. Cranston and S. M. Williams. London. Coin controlled and registering telephone apparatus.*

February 22, 1899.

3,893. Anchor Electric Co. and E. Freund. London. Improvements in electrical signalling apparatus.
3,899. J. F. Pierce. Oxford. "The Oxford watch lamp," an improvement in electric cycle lamps.
3,904. A. E. Slater. Derby. Improvements in telephone exchange switches for use in public central stations, large institutions, police service and the like.
3,910. R. Kennedy. Leeds. Improvements in starting alternating single-phase electromotors and in apparatus therefor.
3,936. A. Bodenheimer. London. Electric bell for velocipedes.
3,943. J. H. Betteley. London. Improved means for establishing connection between underground electric circuits and electromotors of vehicles.
3,947. T. Carles. London. Improvements in apparatus for applying electric currents of high frequency to telegraphy.

February 23, 1899.

4,001. E. N. Bray. Glasgow. Improvements in and relating to starting switches and resistances for electric motors.
3,999. J. Milnes. Manchester. Improvements in electric traction for tramcars and the like.
4,007. R. E. B. Crompton and E. A. N. Pochin. London. Improvements in electrically controlled switches.
4,027. J. H. Hollyer. Droitwich. Improvements in automatic electric warning signals for railways and the like.
4,046. V. A. Fynn. London. Improvements in or connected with electric motors and generators and other electric apparatus and instruments.
4,059. T. D. Farrall. London. Improvements in incandescent electric lamps.
4,065. Veritys (Limited) and L. J. Steele. Birmingham. Improvements in electrical switches.
4,068. S. S. Bromhead. London, A new and useful method of manufacturing electric resistances. (W. C. Heraeus, Germany.)*
4,078. D. Honeywood. London. A new or improved machine tool particularly applicable for refacing or turning commutators of electric generators and the like.
4,082. T. H. Stone. Oxford. Improvements in accumulators and storage cells portable and stationary.
4,088. W. Lynes. Birmingham. An improved lamp holder for incandescent electric lamps.
4,119. W. Rutherford. Birmingham. Improvements in the mode and means for operating the poles or masts of electrical cars or vehicles for tramways.*
4,121. W. Best. London. Improvements in miners' safety lamps and in means for electrically igniting the same.
4,122. W. Best. London. Improvements in or connected with induction coils especially applicable for use in mines.
4,123. S. G. Brown. Bournemouth. Improvements in electric glow and arc lamps.
4,124. H. J. Dowsing. London. An improvement in electric stoves.
4,137. P. L. Schmidt. London. A new or improved galvanic bandage.*
4,158. A. Wydts and G. Weissmann. London. Improvements in transformers for continuous electric currents. (Date applied for under Patents, &c., Act, 1883, Sec. 102, August 4, 1898, being date of application in France.)

February 25, 1899.

4,190. R. F. Hall. Birmingham. Improvemenrs in electrically propelled vehicles.
4,210. W. Kingsland. London. Improvements in and connected with electrical traction.
4,224. W. H. Wheatley. London. An electrical recording instrument. (H. R. Lockhart and R. O. King.)
4,231. W. C. Johnson and A. Wunderlich. London. Improvements in arc lamps.*
4,232. Société Geoffroy et Delore. London. Improvements in electromotor road vehicles. (Date applied for under Patents, &c., Act, 1883, Sec. 103, August 29, 1898, being date of application in France.)
4,244. H. T. Harrison. London. Improvements in or in connection with primary electric batteries.

Feb. 27, 1899.

4,276. N. Brown. London. Improvements in automatic potential regulators for dynamos. (The Tirrill Automatic Potential Regulator Co. United States.)*
4,283. G. Williams. Catford. An improved electrical sock.
4,312. O. Imbey. London. Improvements in electric welding and apparatus therefor. (G.L. Thompson Manufacturing Co., United States.)
4,313. M. Déri. London. Improvements in alternating current motors.*
4,318. L. Calisch. London. Improved electric signalling device for railways.
4,327. G. Westinghouse. London. Improvements in electro-pneumatic controlling system. (Date applied for under Patents, &c., Act, 1883. Sec. 103, August 20, 1898, being date of application in United States.)

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1898.

2,040. Blenheim. Electrical fire call.
2,389. Sherbin. Secondary batteries.
2,428. Wydts and Rochefort. Electrical transformer for currents of high potential and variable frequency.
2,455. Burn and Brown. Electric contacts suitable for railway signalling and other purposes.
2,584. Wise (Pieper). Manufacture of electric glow lamps.
3,431. Beach. Anodes for electrolytic operations.
3,496. Andrews. Electrical cut-out apparatus.
3,850. Geipel, Lange and Sattrick. Holders for electric glow lamps.
4,588. Bathurst. Method of and means for holding the bases of electrical fittings within boxes, or upon other surfaces.
5,064. Belfield (Lamme). Non-synchronous electric motors.
5,066. Belfield (Davis and Harder). Electric switches.
5,177. Sayers and Mavor and Coulsons (Limited). Dynamo electric machines.
5,208. Actiengesellschaft fur Fabrikation von Broncewaaren und Zinkguss vorm. J. C. Spinn and Sohn and von Romocki. Electrically operated gas valves for burners.
6,024. Sykes. Conduits for electric cables.
6,135. Nernst. Electric incandescence lamps.
6,773. Stewart. Street lanterns for the reception of incandescent electric lamps.
6,902. Aldred and Carr. Detail of electric tramways and railways on a road-suface sectional-contact system.
6,990. Weston. Electrical measuring instruments.
7,058. Underhill and Northey. Method of preventing the corrosion of electric battery connections.
7,751. Société Guyenet et de Mocomble. Lifts worked by electricity with hydraulic braking apparatus. (Date applied for under International Convention, Nov. 12, 1897.)
8,262. Rayner (Leitner). Controlling device for electric motor vehicles and the like.
15,496. Browne and Martineau. Electrical time switches.
18,754. Love. Electric tramways and railways on the conduit system.
23,529. British Thomson-Houston Co. (Limited) (Green). Method and system for generating and distributing electric energy.
23,530. British Thomson-Houston Co. (Limited) (Green). Method and apparatus for generating and distributing electric energy.
23,531. British Thomson-Houston Co. (Limited) (Green). Method and apparatus for generating and distributing electric energy.
24,172. Schloss. Process for obtaining a permanent electrical contact at the covers of voltaic cells.
24,747. Houpied and Girard. Electric sparking devices, more particularly for igniting devices of motors operated by explosive mixtures. (Date applied for under International Convention, June 13, 1898.)
24,993. Giorgi. Telegraphic receivers.
25,259. K. Obst. Electrical speed indicators.
25,479. Canfield. Electric igniter or sparker for gas, oil or vapour engines.
25,567. Siemens Bros. and Co. (Limited) (Siemens and Halske Aktien-Gesellschaft). Apparatus for transmitting motion to a distance by means of electrical energy.
26,026. Heys. (Silberberg.) Galvanic batteries.
26,067. Gover and Proctor. Holder for electric glow lamps.
26,068. Siemens Bros. and Co. (Limited) (Siemens and Halske Aktien-Gesellschaft). Electric glow lamp fittings.

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COMPANIES' MEETINGS AND REPORTS.

ANGLO-PORTUGUESE TELEPHONE CO. (LIMITED).—At the twelfth general meeting of this company, held on March 29, the directors report for the year to Dec. 31 last was adopted. The amount to credit of profit and loss, after making all deductions, and including balance brought forward, was £6,192. 12s. 2d., and after placing £3,000 to suspense account, and carrying forward £1,942. 12s. 2d., a dividend of 2½ per cent. was approved. Expenditure on capital account for the year amounted to £1,801. 6s. 3d. The number of paying subscribers at Dec. 31 was:—Lisbon, 1,326; Oporto, 983; showing a decrease in subscribers of 139, but an increase in value of £81 during the year. The continuance of the high rate of exchange between the two countries again entailed very serious loss on the company, amounting on the year to £3,824. 13s. 1d., an increase of £461 over the previous year. This loss is rapidly approaching 25 per cent. of the gross receipts, and has consequently increased the percentage of working expenses enormously.

AUTOMATIC TELEPHONE CO. (LIMITED).—The adjourned meeting of this company was held yesterday (Thursday), Mr. M. E. Alexander presiding. The chairman, who was the only director present, said he trusted the decision which they would arrive at that day would be beneficial to their interests. Mr. Barlow stated that Mr. Margowski had refused permission to the committee to inspect the books of the company. It was maintained by Mr. Margowski and the secretary that this was not a legal meeting, but he was of a different opinion. The point for them to settle was whether that gentleman should be allowed to continue to dictate to the shareholders the future policy of the company. It was an important matter to them what attitude towards the company was adopted by Mr. Seligman-Lui. He understood that, since the last meeting, that gentleman had been approached on behalf of Mr. Margowski, but, apparently, he had not materially changed his opinion. The object of the resolutions to be submitted to the meeting was to give the shareholders a voice in the control of a business, which he believed to be capable of great and valuable development. Mr. White, solicitor to Mr. Seligman-Lui, said that his client had been interviewed in Paris by Mr. Moore and Mr. Penny, with the object of finding out on what terms he would resume his duties as consulting engineer; and he understood that Mr. Moore promised Mr. Seligman-Lui's requirements should be conceded. Mr. Moore denied having made any such promise. He might add that Mr. Seligman-Lui laid great stress on his being allowed freedom to work for any other company, which, under existing contracts, he could not do. He (the speaker) replied that he did not think the company would give him complete freedom in regard to companies having anything to do with telephones, although they might do so in regard to electric light and other companies. Mr. White, in the course of further remarks, said that, if Mr. Margowski were removed, he thought Mr. Seligman-Lui would not raise any further difficulties. On the motion of Mr. Parker, seconded by Mr. Ettinghausen, a resolution was passed to remove forthwith Mr. Margowski from the office of managing director. The articles of association, so far as they referred to the voting power of the shareholders, were then altered in such manner as to prevent Mr. Margowski from out-voting the other shareholders. It was further decided to authorise the committee to take such steps as they might be advised to be necessary to enforce these resolutions.

CITY OF BIRMINGHAM TRAMWAYS CO. (LIMITED).—At the meeting of this company, held last week, the Chairman (Mr. James Ross) said no further progress had been made in their negotiations with the Corporation. A report of the Public Works Committee in favour of municipalisation was recently approved by the Council. The company was formed in 1896, upon a resolution passed by the Council agreeing to give them 21 years' leases of their tramways, and he still relied upon the good faith of the Coporation to see that the company received fair treatment. They were ready and willing to deal with the Corporation on the basis of any arrangement that would leave the company in as good a financial position as it was now in. He had hoped long before now to have taken part in a work of great public benefit, by substituting a convenient and rapid electric service for their cumbersome and antiquated steam trams. An improved method of traction was necessary to meet public requirements. He was still hoping that when Birmingham saw the improvements in traction that were being introduced in other places in Great Britain, and the benefit that these improvements conferred, the citizens would desire something better in the way of tramway accommodation than they possessed.

EVERED AND CO. (LIMITED).—At the annual meeting held last week the chairman (Mr. R. B. Evered) moved the adoption of the report and accounts, which, he said, showed, after providing for debenture interest amounting to £2,416. 13s. 4d., a net profit of £25,698. 16s. 6d., making, with £6,361. 11s. 8d. from 1897, £32,060. 8s. 2d. to be dealt with. An interim dividend at the rate of 7½ per cent. per annum to June 30, had been paid, and it was now proposed to pay a dividend at the rate of 7½ per cent. per annum for the remaining six months, and pay a bonus of 2½ per cent. per annum. The remainder of the profits would be used in writing off plant (£2,000), clearing off the goodwill (£4,000), writing off buildings (£1,000), placing to an equalisation of dividends account (£1,000), and £6,986 would be carried forward. The business continued to make good progress, and the number of customers was increasing. Despite higher prices and ever-increasing competition, their works were fully employed in all departments. The stocks of copper and other raw material figuring on the balance sheet at £100,707. 1s. 9d. had been taken at prices ruling in 1897. The report was adopted, and the retiring directors re-elected.

FOLKESTONE ELECTRICITY CO. (LIMITED).—The third general meeting of this company was held at the works last week. The directors' report stated that the prospects of the company were very satisfactory. The contract with Edmundson's Corporation stipulated that the works had to be completed by July 1, 1898, so that practically the company had only the benefit of six months' working up to Dec. 31. At the end of the financial year the equivalent of 10,089 8-c.p. lamps was being supplied, and up to the end of February this number (including street lighting) amounted to 11,861 lamps. There was a profit on revenue account of £405. 2s. 3d., which was carried forward.

GUILDFORD ELECTRICITY SUPPLY CO. (LIMITED).—At the annual meeting last week the chairman (Dr. F. R. Russell) said they had made a profit during the past year of £300, for what was practically the second year's working. They had applied to the Board of Trade for a new order extending the company's area of supply to the parishes around Guildford. That extension would entail increased expenditnre in laying down more cables. Mr. Money-Kent congratulated the shareholders on the accounts presented. He said that last year he showed that for the end of a first year, with an output of only 15,000 units, they were doing very well. He also prophesied that at the end of another twelve months they would be doing well, and he thought the figures before them showed that. Last year their cost per unit came out at 11d.; this year at about 5½d. (5.24). Their work compared favourably with other two-year-old companies.

THAMES IRONWORKS AND SHIPBUILDING CO. (LIMITED).—A very favourable report was presented to the meeting of shareholders last week in connection with the past year's work of this company. Arrangements have been made for taking over the well-known works of Messrs. John Penn and Son, at Greenwich. The report states that the system adopted some years back of giving every workman in the company's employ a direct interest in the work he has in hand has proved in every way satisfactory.

WESTERN UNION TELEGRAPH CO.—This Company have issued their report for the quarter ended March 31, 1899. The following statement, dated March 8th, shows the condition of the Company at the close of the quarter ended Dec. 31, 1898:—

Surplus Oct. 1, 1898, as per last quarterly report.....		$8,049,213 99
Net revenues, quarter ended Dec. 31, 1898		1,459,194 22
		$9,508,408 21
From which deducting for—		
Dividend of 1¼ per cent. paid Jan. 16th	$1,216,987 50	
Interest on bonded debt	224,273 00	
		$1,441,260 50
Left a surplus Jan. 1, 1899, of		$8,067,147 71
The net revenues of the quarter ending March 31st, based upon nearly completed returns for January, partial returns for February, and estimating the business for March will be about		1,250,000 00
		$9,317,147 71
From which appropriating for—		
Interest on bonds		224,237 00
		$9,092,874 71
It requires for a dividend of 1¼ per cent. on capital stock issued, about		1,216,987 50
Deducting which leaves a surplus, after paying dividend, of		$7,875,887 21

In view of the preceding statements, the Committee recommend that a dividend of 1¼ per cent. on the capital stock of the Company be declared payable on and after the 15th inst.

NEW COMPANIES, STATUTORY RETURNS, &c.

BLACKBURN, STARLING AND CO. (LIMITED).—This company was registered on March 28, with a capital of £12,000, in £1 shares, to acquire and carry on the business of a steeplejack, electrical, heating, ventilating and mechanical engineer, &c., now carried on by Joseph Blackburn. The first subscribers are: Joseph J. Blackburn, electrical engineer; Francis H. Starling, electrical engineer; C. Osborne, electrical engineer; A. T. Ashwell, G. Tutin, E. M. Tinsley and E. H. Bridges. The first directors are: Joseph Blackburn, Frank H. Starling, C. Osborne, and A. Campbell.

INTERCHANGEABLE FLASH SIGN SYNDICATE (LIMITED).—This company was registered on March 22 with a capital of £5,000, in £1 shares, to acquire provisional patent No. 20,027 (1898), granted to Mr. A. D. Douglass, for an interchangeable electric flash sign to carry on the business of electric flash sign manufacturers, advertising contractors, electrical and mechanical engineers, machinists, &c. The first subscribers are: W. T. Todd, W. T. Fowler, H. J. Murray, H. A. Taylor, A. T Palace, R. C. Oldham and G. F. Longden.

HODGES AND TODD (LIMITED).—The statutory return to Dec. 15 gives the capital as £25,000, in £1 shares, of which 757 shares have been taken up and paid for in full.

JULIUS SAX AND CO. (LIMITED).—The annual return to Jan. 24 has been filed. The capital is £20,000, in £10 shares, all of which have been taken up; 1,993 shares have been issued as fully paid and no calls have been made on the others.

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LONDON ELECTRIC WIRE CO. (LIMITED).—The annual return to Feb. 7 has been filed. The capital is £100,000, in £5 shares (10,000 Preference); 6,280 Preference and 6,893 Ordinary shares have been taken up, and 3,860 of each class are considered as fully paid. The full amount has been called on the remaining 2,420 Preference and 3,033 Ordinary shares.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 2, 1899). Price of silver 27 7/8d. per oz. (April 6). Consols (2¾ per cent.) 110⅛—110⅜ for money, 110 1/16—110 3/16 for account; 2½ per cent. 103¼—103¾ (April 6), Stock Exchange Settling Days: Stocks and Shares Continuation Days, April 11 and 25; Ticket Days, April 12 and 26; Pay Days, April 13 and 27; Mining Share Carry over Days, April 10 and 24.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LIMITED).—The half-yearly interest on this company's Four and a-Half per Cent. Debentures, due on 15th inst., will be paid at Messrs. Sperling and Co.'s, 8, Austin-friars, E.C.

ELECTRICAL ENTERPRISE IN RUSSIA.—A syndicate has been formed in St. Petersburg, with a capital of 20,000,000 roubles, for the purpose of establishing and exploiting electric lighting and power undertakings in Russia. The backers of the syndicate comprise the Siemens and Halske Aktien Gesellschaft, the Allgemeine Elektricitäts Gesellschaft and the Union Elektricitäts Gesellschaft, of Berlin, and several German banking houses. Messrs. Rothschild, the Société d'Etudes Russes, of Paris, and the Franco-Russian Electricity Co., of Geneva, are also interested in the syndicate, the head offices of which will be at St. Petersburg.

LEATHERHEAD ELECTRIC LIGHTING AND POWER CO. (LIMITED).—It has been officially announced that this company has never been in operation.

LIVERPOOL.—The Corporation have determined to create 2¾ per cent. redeemable stock to the extent of £1,000,000. The money is required to pay off £750,000 borrowed in anticipation of the present issue, and to meet capital expenditure on electric lighting and traction undertakings, &c.

MUNICIPAL ISSUE.—The Birkenhead Corporation are inviting applications until Monday for an issue of £250,000 2¾ per cent. redeemable stock, at a minimum price of £97 per cent. The loan is for electric lighting, tramway, &c., undertakings.

STEWART ELECTRICAL SYNDICATE (LIMITED).—Mr. Douglas C. Bate, A.M.Inst.C.E., the well-known manager of this company, has been appointed managing director.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has appointed Wednesday, 12th inst., as a special settling day for the further issue of £40,000 Four and a-Half per Cent. Debenture stock of the *Chelsea Electricity Supply Co. (Limited)*, and 24,000 Ordinary fully-paid £5 shares (Nos. 10,001 to 34,000) of the *New General Traction Co.* The committee has ordered the shares of the latter company, as well as the further issue of £100,000 Five per Cent. Perpetual Debenture Stock of the *British Electric Traction Co. (Limited)*, and 20,000 £5 shares, £3 paid (Nos. 1 to 20,000) of the *Calcutta Electric Supply Corporation (Limited)*, to be quoted in the official list. The committee has been asked to appoint a special settling day for £233,334 First Mortgage Four per Cent. Irredeemable Debenture Stock of *Doulton and Co. (Limited)*.

SUBMARINE CABLES TRUST.—Notice is given that on and after April 15 the due coupon will be paid in full by Messrs. Glyn, Mills and Co., 67, Lombard-street, E.C. Coupons should be left four clear days.

TELEGRAPH MANUFACTURING CO. (LIMITED).—Mr. J. S. Harmood Banner has joined the board of this company.

WEST INDIA AND PANAMA TELEGRAPH CO. (LIMITED).—The estimated amount of the traffic receipts of this company for the half-month ended March 31 is £2,333, against £2,309 in the corresponding period of 1898.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Apr. 1	4,013	+ 506	12	48,804	+ 3,817
Blackpool Corporation...	...	...	...	...	...	...
Blackpool and Fleetwood	„ 1	433	...	13	2,520	...
Bradford Corporation ...	„ 2	315	...	35	8,982	...
*Bristol Trams & Carriage	Mar. 31	2,746	+ 406	13	32,578	+ 1,956
City & South London Ry.	Apr. 2	889	− 161	14	15,275	+ 333
Dover Corporation	„ 1	199	+ 82	52	9,094	...
DublinUnited(Southern)	Mar. 31	722	+ 370	13	8,083	+ 2,980
*Glasgow Corporation ...	Apr. 1	8,394	+1,135	...	...	...
Liverpool Corporation						
Dingle Route	Mar. 25	447	...	19	9,847	...
Prince's Park Route...	„ 25	325	...	10	3,080	...
Liverpool Overhead Rly.	Apr. 2	1,405	+ 92	14	18,316	− 440
*Sheffield Tramways.....	„ 2	1,298	+ 402	13	15,537	+ 3,408
*South Staffs. Trams.....	Mar. 31	572	+ 5	13	7,665	+ 193

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price March 28.		Price Wednesday, April 5.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Eight Days Ending April 5. Highest	Lowest
			TELEGRAPHS.					£ s. d.			
£124,400	100	4¼	*African Direct Telegraph 4% Mort. Deb. (red)	103	104	103	104	3 16 11	January and July	..	..
25,000	10	..	Amazon Telegraph	3	4	3	4	..	June and December	..	..
£125,000	100	5%	Do. 5 per Cent. Debentures	87	92	87	93	5 6 5	..	..	..
£905,500	Stock	24,0	Anglo-American	65	68	65	68	5 2 0	Feb., May, Aug., Nov.	65½	..
£1,047,250	Stock	20,0	Do. Preferred	117½	118½	117½	118½	5 1 11	" "	118½	117⅞
£1,047,250	Stock	.8/0	Do. Deferred	14½	15	14½	15	6 0 0	..	14⅞	14 13/16
£25,161	10	3/0	Brazilian Submarine xd	16	16½	15½	16½	4 6 2	Mar., June, Oct., Dec.	16 1/16	15⅞
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	110	114	110	114	4 7 9	June and December	..	..
10,000,000	$100	$1½	Commercial Cable Capital Stock xd	193	203	185	195	4 2 1	Jan., Apr., July, Oct.	..	..
£1,332,523	Stock	4%	* Do. 4 per Cent. Debenture Stock xd	105	107	104	106	3 15 6	" "	103	105⅝
16,000	10	8/0	Cuba Submarine Ordinary (Deferred)	9	10	9	10	7 0 0	February and August	10	..
6,000	10	10/0	Do. Preference 10 per Cent.	17½	18½	18	9	5 5 3	" "	18½	18 1/16
12,951	5	2/0	Direct Spanish (Ordinary) xd	4	5	4	5	4 0 0	April and October	..	..
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	10	11	4 12 10	" "	1 1/8	..
£80,000	50	4½%	Do. 4½ per Cent. Debentures	106¾	109¾	106¾	109¾	4 3 4	January and July	..	..
60,710	20	3/0	Direct United States Cable x d	12⅞	12⅞	12½	13	5 2 0	Jan., Apr., July, Oct.	12½	12½
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	103	106	103	106	4 5 6	June and December	..	..
£4,000,000	Stock	5%	Eastern Ordinary	180	185	179	184	3 16 9	Jan., Apr., July, Oct.	181½	180
£1,795,000	Stock	3½	Do. 3½ per Cent. Pref. Stock	102	105	102	105	3 7 0	" "	104½	..
£1,432,200	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	125	129	125	129	3 2 9	May and November	..	..
£89,900	100	5%	* Do. 5 per Cent. Debentures, 1899	99	102	99	102	4 18 0	February & August	..	..
250,000	10	2/6	Eastern Extension	18	18½	18	13½	3 15 8	Jan., Apr., July, Oct.	18½	18⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	129	125	129	3 2 3	February & August	..	..
£16,200	100	5%	* Do. 5 p. c.(Austin.Gov.Sub.)Deb.190 (reg.)	99	103	99	103	4 17 1	January and July	..	..
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	" "	..	..
£35,100	100	5%	*Eastern and S. African 5 p.c. Mor. Deb., 190 (reg.)	99	103	99	103	4 17 1	" "	..	..
£46,500	100	5%	Do, (Bearer)	100	103	100	103	4 17 1	" "	..	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102	105	102	105	3 17 8	February & August	103½	..
£200,000	25	4%	Do. 4% Mauritius Sub. Debs. (red.)	104¾	107¾	104¾	107¾	3 16 2	May and November	..	..
120,232	10	1/9	Globe Telegraph and Trust	12⅝	13⅛	12⅝	13⅛	3 17 4	Jan., Apr., July, Oct.	13⅛	12 1/16
180,042	10	6%	Do. 6 per Cent. Preference	16⅜	17⅛	16⅜	17⅛	3 9 7	" "	..	..
150,000	10	5/0	Great Northern of Copenhagen	30	31	30	31	3 4 6	January and July	..	..
£97,800	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red)	100	103	100	103	4 8 0	June and December	..	..
17,000	25	12/6	Indo-European	57	60	57	60	4 3 4	May and November	..	..
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	108	111	108	111	5 8 1	March & September	..	..
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red)	105	108	105	108	3 14 5	June and December	..	..
11,839	8	4/0	Reuter's	6½	7½	6½	7½	5 6 8	April and October	7	..
3,881	£100 Cert.	6%	Submarine Cables Trust	140	145	140	145	4 4 3	" "	..	..
15,609	10	..	West African Telegraph	2½	3½	2½	3½	..	December and July.	..	..
£100,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	4 18 0	March & September	100½	..
10,008	2½	..	West Coast of America	½	1	½	1	..	..	..	..
£150,000	100	4%	* Do. 4 per Cent. Debentures	103	106	103	106	3 15 9	June and December	..	..
£8,551	10	1/6	West India and Panama	2	2½	2	2½	..	May and November	2½	2 1/16
£4,162	10	6/0	Do. 6 per Cent. 1st Preference	10½	11	10½	11	5 9 1	" "	..	..
4,665	10	6/0	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	" "	..	..
£80,000	100	5%	* Do. 5 per Cent. Debentures	105	108	105	108	4 13 3	January and July	..	..
64,269	15	5/0	Western and Brazilian Ordinary	12⅜	13½	12⅜	13½	4 9 3	May and November	..	..
38,129	7½	3/9	Do. 5 per Cent. Preferred Ordinary	8½	9	8½	9	4 3 4	" "	..	..
38,129	7½	1/3	Do. Deferred Ordinary	4½	4¾	4½	4¾	..	" "	..	..
£259,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	106	109	106	109	3 14 1	June and December	..	..
£128,100	100	6%	Western Union 6 per Cent. Sterling Bonds (red.)	100	105	100	105	5 14 3	March & September	..	..

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price March 28.		Price Wednesday, April 5.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Eight Days Ending April 5.	
								£ s. d.		Highest	Lowest
			TELEPHONES.								
£4,000	£5	4/0	Chili Telephone (fully paid)	2½	3	2½	3	6 11 4	August	–	–
£24,850	£1 10s.	1½d.	Consolidated Telephone Const. & Manufacturing	1/16	1/16	1/16	1/16	6 7 0	July	–	–
71,000	1	–	Monte Video Telephone Ord.	½	1	½	½	5 0 0	October	1/16	–
84,000	1	6/4	Do. Preference	..	..	¾	1	..	–	–	–
490,000	5	3/0	National	4½	5	4½	5	6 0 0	February & August	4⅝	4½
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	11	13	11	13	4 5 9	" "	..	..
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	11	13	11	13	4 5 9	" "	..	..
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	4⅜	5½	4⅜	5½	4 15 2	" "	4 5/16	4 3/16
1,329,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	99	101	99	101	3 9 8	June and December	99½	..
71,504	1	0/4	Oriental	¾	1	¾	1	5 0 0	April and October	..	..
58,000	5	6/0	United River Plate	4⅜	5½	4⅜	5½	5 14 3	July	4⅜	–
£151,788	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	104	107	104	107	4 13 11	June and December	–	–
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	–	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (10s pd.)	⅜	⅜	⅜	⅜	..	–	–	–
6,000	10	7/9⅜	Bournemouth and Poole Electricity Supply Ord xd	13½	14	13½	13⅝	2 16 10	–	–	..
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10½	11½	10½	11½	4 4 0	–	–	–
30,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	10	12	11	12	3 6 8	February & August	11⅛	11⅛
20,000	5	2/8	Do. 4½ per Cent. Preference	6	6½	6	6½	3 9 3	" "	–	–
£34,000	5	3 6	Chelsea Electricity Supply Ordinary	8	9	7½	8½	3 10 7	March	8½	7⅞
£100,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	114	116	114	116	3 18 1	June and December	114	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red)	101	105	101	105	4 17 7	April and October	..	–
60,000	10	7/0	City of London Elec. Lighting Ord.	17	18	17	18	3 6 8	February & August	17⅜	13⅜
40,000	10	6%	Do. 6% Cumulative Pref.	15	16	15	16	3 15 0	January and July	..	–
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	124	129	124	129	3 17 10	June and December	..	..
40,000	10	..	County of London & Brush Prov. Ord. (1 to 30,000)	11	12	11	12	–	–	11½	..
20,000	10	6/0	Do. 6% Cumulative Preference xd	14	15	14	15	4 0 0	March & September	–	..
19,661	5	3/6	House-to-House Electric Lighting Supply Ord.	8½	9½	8½	9½	3 13 8	–	–	..
12,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	March & September	..	..
15,000	5	10%	Kensington and Knightsbridge Ord.	13	14	13	14	3 18 7	–	–	–
10,000	5	6%	Do. 6% 1st Pref.	7⅞	8½	7⅞	8½	3 12 9	January and July	–	–
110,000	3	–	London Electric Supply Ordinary	3¾	4	3¾	4	–	–	–	–
48,050	5	3/0	Do. 6% Preference	6½	7	6½	7	4 5 9	–	6½	..
£100,000	Stock	..	Do. 4% 1st Mort. Deb.	105	107	105	107	3 14 9	Mch., June, Sept., Dec.	–	–
62,500	10	5/0	Metropolitan Electric Supply Ordinary xd	16½	17½	17	18	2 15 7	April and October	17½	17
22,500	10	8½d.	Do. (£7 paid) xd	12½	13½	13	14	..	–	–	..
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	120	117	120	3 15 8	June and December	–	..
6,452	10	6/0	Notting Hill Electric Ordinary	16½	17½	16½	17½	3 8 7	March	–	–
10,000	5	5/0	Oxford Electric Ordinary xd	6⅞	7⅞	6⅞	7	3 11 5	"	–	..
275,000	1	–	Rand Electric	⅞	1⅛	⅞	1⅛	–	–	–	–
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'c't'n, Ltd., 5% 1st Mor. Deb	83	93	83	93	5 8 1	–	–	–
150,000	$100	$2	Royal Electric Company of Montreal Shares xd	..	190	185	185	4 6 6	–	–	–
130,900	100	4½%	* Do. 4½% 1st Mort. Debs. xd	..	109	105	107	4 4 1	April and October	–	–
31,980	5	9/6	St. James and Pall Mall Electric Ordinary	17	18	17	18	4 0 7	February & August	17⅜	17 11/16
20,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	" "	..	..
65,000	5	..	South London Electric Supply Ordinary (£3 paid).	3⅛	3⅜	3⅛	3⅜	..	–	–	..
79,900	5	7/0	Westminster Electric Supply Ordinary	15½	16½	15½	16⅝	3 12 9	March & September	15 13/16	–
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	2	1/2⅜	Brush Electrical Engineering	1⅞	2⅛	1⅞	2⅛	2 13 5	September	2 1/16	2
90,000	2	1/2⅜	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	"	–	–
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	110	114	110	114	3 19 2	February & August	..	–
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	102	105	102	105	4 6 7	June and December	102	–
£20,000	5	5/0	Callender's Cable Construction	12½	13½	12⅞	13⅞	5 0 0	" "	..	–
£90,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	114	117	114	117	3 17 5	November and May	..	–
300,000	1	9½d.	Castner-Kellner Alkali Co. (fully paid)	1⅛	1⅜	1⅛	1⅜	5 13 5	–	1 3/16	–
50,000	1	–	Chadburn's Ship Telegraph Ordinary	1⅛	1½	1⅛	1½	–	–	1 3/16	–
50,000	1	7½d	Do. 6 per Cent. Cumulative Pref. xd	1½	1⅝	1	1⅛	4 13 0	–	1 1/16	–
32,098	3	1/6	Crompton and Co. (Nos. 1 to 32,098)	3⅛	3⅜	3⅛	3¾	4 0 0	January and July	–	–
£100,000	100	5%	* Do. 5% First Mort. Deb. (red.)	98	101	93	101	4 19 8	" "	–	–
99,261	5	1 9/32	Edison and Swan United ("A" Shares) (£3 paid)	2	2⅛	2	2⅜	7 1 8	February & August	..	–
17,139	5	2/9⅜	Do. (£5 paid)	4	5	4	5	6 11 0	" "	–	–
£744,023	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	97	99	97	99	4 1 8	June and December	–	–
17,400	5	5%	Edmundson's Electric Corporation Ord (fully pd)	5⅛	5⅜	5⅛	5⅜	4 6 11	Half-yearly	–	–
112,100	2	1/2⅜	Electric Construction Co. (Limited)	2⅛	2⅜	2⅛	2⅜	4 14 10	January & July	..	–
25 000	2	2/9⅜	Do. 7 per Cent. Cumulative Pref.	3	3⅛	3	3⅛	4 0 0	July	..	–
£140,300	Stock	4%	Do. 4% First Mortgage Deb. (red.)	103	106	103	105	3 15 10	January and July	–	..
91,196	1	–	Elmore's Patent Copper Depositing	⅜	⅝	⅜	⅝	..	–	–	–
15,000	10	20/0	Henley's Telegraph Works Ordinary	23	27	25⅛	26½	5 5 8	February & August	26½	25⅝
3,000	10	7/0	Do. 7 per Cent. Preference	18½	19½	18½	19½	3 11 10	" "	–	–
£50,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	112	115	112	115	3 19 10	" "	–	..
40,000	10	15/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	4 8 11	" "	22½	21 13/16
800,000	100	4%	Do. 4% First Mortgage Debentures (red.)	104	105	104	105	3 16 2	March & September	102	101⅛
£7,310	12	24/0	Telegraph Construction and Maintenance	38	42	37	41	4 7 4	March and July	39½	38
£150,000	100	..	Do. 4 per Cent. Deb. Bonds, 1908	105	108	105	108	3 14 3	..	–	–
£13,400	5	–	Do. Manufacturing Ordinary	9½	10½	9⅜	10½		–	9 15/16	..
13,430	5	2/9½	Do. 5% Cum. Pref. xd	5⅜	6⅜	5⅜	6⅜	4 0 0	–	–	–
£30,000	5	4/0	Williams and Robinson Ordinary	9⅛	9⅞	10	10½	3 16 2	April and October	10½	9⅝
£30,000	5	3/0	Do. 6% Cumulative Preference	7⅛	7⅜	7⅛	7⅜	3 17 5	" "	7 11/16	–
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	106	108	106	108	3 18 8	May and November	–	–
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
12,000	10	8/0	Blackpool and Fleetwood Tramways	24½	25	24⅛	25⅛	3 2 6	–	–	–
50,000	10	7/-	Bristol Tramways and Carriage	23⅝	24½	23½	24½	2 14 4	February and August	–	–
£100,000	Stock	4%	Do. 4% Debenture	120	124	120	124	3 6 2	–	–	–
80,000	10	1 0/0	British Electric Traction Ordinary xd	19½	20	19⅛	20	3 0 0	–	20	19 1/16
10,000	10	6/0	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm. pd.)	13⅞	14½	13⅞	14½	4 4 10	–	14½	14 1/16
£100,000	Stock	5%	Do. 5% Perp. Deb. xd	125	129	125	128	3 18 4	–	–	–
40,000	5	1/6½	Buenos Ayres & Belgrano 6% Cum. Pref. (£3 paid) x	3⅜	3⅝	3⅜	3⅝	..	..	3 13/16	..
27,500	5	..	Do. do. do. (fully paid)	5	5⅛	5⅛	5⅜	..	..	5 7/16	5½
£260,000	Stock	5%	Do. do. 5% Deb.	108	111	109	112	4 11 4	..	110⅜	110
£35,250	10	3/0	Central London Ordinary	9½	10½	9½	10½	4 18 6	June and December	10	–
178,303	10	1/9⅜	Do. (£8 paid)	7⅛	8⅛	7⅛	8⅛	3 13 2	" "	..	..
£380,000	Stock	3%	City and South London Railway Con. Ordy.	68	70	68	70	3 0 9	January and July	69½	68½
22,500	10	..	Do. Ordinary (£5 paid)	4⅛	4½	4⅛	6½	..	..	..	..
9,251	10	5%	Do. 5% Perpetual Preference	14¼	15¼	14¼	15½	3 5 7	January and July	–	–
137,701	Stock	4%	Do. 4% Perpetual Debenture	131	133	133	135	3 19 7	May and November	–	–
20,000	10	7½%	Imperial Tramways Ordinary x all	24½	25½	24⅜	25½	2 13 6	March & September	–	–
10,000	10	6%	Do. 6% Preference x all	6	15½	16	16⅜	3 12 9	" "	–	–
£100,000	Stock	4½%	Do. 4½% Debenture xn	118½	119½	118½	119¼	3 15 4	January and July	–	–
87,500	10	4%	Liverpool Overhead Railway Ordinary	10	10⅜	10	10⅜	3 9 2	February & August	–	–
19,000	10	5%	Do. 5% Preference	14⅜	14⅝	14⅜	14⅝	3 7 3	" "	–	–
125 000	Stock	4%	Do. 4% Debenture	105	108	106	105	3 14 1	January and July	–	–
30,000	5	3/3½	New General Traction 6% Cumulative Pref	5	5½	5	5½	5 9 1	May	–	..
£549,000	Stock	3%	Waterloo and City Ordinary	109	112	109	112	2 13 7	January and December	–	–

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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CONTENTS OF THE CURRENT NUMBER.

NOTES	851	The Milan-Monza Electric Railway	869
Meetings of Scientific Societies	853	The Hissing of the Electric Arc.—*Discussion*	869
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe	854	The Wehnelt Electrolytic Interrupter. By A. Blondel. Illus.	870
Alexander Pelham Trotter	854	Additional Observations with the Wehnelt Interrupter. By E. Thomson	870
Carbons for Electric Lighting and Other Purposes. By F. Jehl. Illus. Continued	855	American Notes	871
Experiments on Alternate-Current Arcs by Aid of Oscillographs. Illustrated	857	Correspondence	871
The Induction Motor. By E. Wilson. Illus. Concluded	861	Parliamentary Intelligence	872
Electricity Works Accounts	862	Legal Intelligence	873
THE WEHNELT INTERRUPTER	864	The City of London Electric Lighting Contract	874
Reviews	865	Trade Notes and Notices	875
Induction Motor Diagrams. By C. C. Hawkins, M.A. Illus. Concluded	866	Companies' Meetings and Reports	882
		City Notes	883
		Companies' Share List	884

NOTES.

THE Corporation of London has placed itself in a remarkable position with regard to the electric lighting of the City, and when Sir COURTENAY BOYLE issues his report on the inquiry he has held into the applications for Provisional Orders of the three companies anxious to compete with the City of London Electric Lighting Co., the City Fathers will still have to extricate themselves from their difficulty by some action of their own. By the agreement between the City authorities and the predecessors of the City of London Co., the former undertook to withhold their consent to the granting of a Provisional Order for the City to any other company before the year 1911, and the same agreement fixed a tariff for the public lighting distinctly advantageous to the Corporation. There was also a clause debarring the Corporation from themselves establishing a competing electricity supply service before the above date. In consequence, the Corporation felt itself bound to withhold its consent when the Charing Cross and Strand, Metropolitan, and Smithfield Markets Companies sought to obtain Provisional Orders. According to the electric lighting law, the Board of Trade, if it finds sufficient reason, has power to dispense with the consent of a local authority, and the Board of Trade inquiry which has just closed has been made with a view to determine whether there is, in this case, sufficient ground to do so. In the meantime, at the instance of Mr. A. C. MORTON, the contract between the Corporation and the Company has been examined by learned counsel and has been declared to be illegal, owing to the fact that Sir JOSEPH SAVORY and some other Commissioners of Sewers and Common Councillors were, at the time, also shareholders in the contracting company.

IT is obviously the duty of the Corporation to approach the City of London Company with a view to getting the contract put upon a legal basis. To consider the contracts dead, and "to let the initiative of legislation come from the other side," as Mr. MORTON suggests, might be good policy if it were merely a question of freeing itself from a troublesome agreement. But if the agreement is declared null and void and no subsequent one is made, might not the electric lighting company be able to recover additional payment for the public lighting supplied during all these years? The situation is, moreover, complicated by one section of the Council being in favour of the Corporation erecting its own electric lighting works, if the contract with the company is no longer valid. As the result of a long discussion, it will be seen that the Court of Common Council was unable to make up its mind, and, to be on the safe side, resolved that, after the evidence of Mr. Ross had been taken, it should not tender any further evidence at the Board of Trade inquiry. The Streets Committee has been directed to take further opinion of counsel on the question of the legality of the agreement, and we await with interest further developments.

SIGNALLING has been continued between the South Foreland and Wimereux during the week, and on Saturday last, amidst hail, snow and thunder storms, Mr. MARCONI received a deputation of Post Office officials, including Mr. LAMB, Mr. HOOKEY and Mr. GAVEY. As during previous experiments, neither the snow nor the hail in any way disturbed the transmission of messages, and a telegram was even successfully sent by Mr. LAMB during a thunderstorm. A deputation from the Amazon Telegraph Co. was present at these trials and expressed a determination of testing the system in Brazil. Additional experiments are being arranged to take place between Newhaven and Dieppe (64 nautical miles), between a cross-channel steamer and the shore, and between a French warship at different points in the Channel and the South Foreland. The United States War Department

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has been conducting experiments between Washington and Fort Meyer. The Central News states that a proposal has been made in all seriousness, by the representative of a syndicate which wishes to acquire from the Wireless Telegraph Co., for the sole rights of establishing wireless telegraphic communication between England and America!

THE widespread interest which is being excited by all these experiments will no doubt lead to further trials on all sides, and it will be of advantage to bear clearly in mind the danger of interference alluded to in our last issue. Wireless telegraphy falls within the POSTMASTER-GENERAL'S monopoly, and no doubt his advisers see clearly that if licences were to be given to all who were willing to pay for them it would frequently be impossible to receive messages owing to the interference of other signals. In his letter to *The Times*, Captain BADEN-POWELL somewhat thoughtlessly appealed to the Post Office not to assert its monopoly against this method of telegraphing, but, unless there is a controlling authority, the use of the system on land will be practically impossible until the receiving of signals can be limited to the apparatus for which they are intended. Perhaps the most striking way to put this point is to say that any one, by installing, at the expense of a few pounds, a transmitting apparatus in the neighbourhood of the South Foreland and sending signals continuously, could paralyse MARCONI'S experiments to the Goodwins and Wimereux.

WE are able to give our readers the text of the first message transmitted between England and France by wireless telegraphy. It was sent by Mr. MARCONI from Wimereux, and, although certainly prosaic, fully answered the purpose for which it was intended. It ran thus:—"V V V Are you there V V V"

IN spite of the endeavours of the daily press, which are seconded in no way by the financial papers, the organs of probably the greatest users of the telephone, considerable discontent is being shown with the measure Mr. HANBURY is introducing in Parliament. Among the public bodies which have more recently passed resolutions disapproving of the Bill and in most cases favouring a general Government telephone service are the Liverpool City Council, the London and Liverpool Chambers of Commerce, and the Mersey Dock and Harbour Board. A long and interesting correspondence has also been published in *The Times* on the same question, and we would draw attention more particularly to letters from Sir JOHN LUBBOCK, who disapproves of monopoly whether owned by a company, Government or municipality; from Mr. FAITHFULL BEGG, who is an advocate of the Government taking over the whole business; from Mr. EDWARD RAE on the financial aspect of the question, and last, but not least, from Mr. F. E. BAINES, formerly Surveyor-General of the Post Office Telegraphs, the two latter also favouring absolute State control.

ALTHOUGH there were a number of telephone engineers present at the reading of Mr. GAVEY'S Paper on "Telephones" before the Society of Arts on Wednesday last, the greater proportion of his audience were representatives from the subscriber's end of the line, and the lecturer was well-advised in giving a simple and "popular" exposition of his subject, entirely avoiding technical and controversial matters. After briefly describing the telephonic receiver and transmitter, and touching on the advantages of metallic circuits over single-wire lines, he traced, in a few well-chosen words, the development of the telephone switchboard from the original "Umschalter" to the modern multiple board. He then waxed most eloquent over the very latest thing in switchboard design, viz., the central battery system, evolved by the Western Electric Co., of America. In this system, to which we have referred on previous occasions, the individual subscriber's batteries or magnets are replaced by one central battery at the exchange, serving both for ringing and speaking purposes, and, in addition, the calling and ringing-off is automatically performed by the removal of the subscriber's telephone from its hook and its subsequent replacement. Mr. SINCLAIR pointed out that a difficulty presented itself when a subscriber has more than one telephone in his establishment, but Mr. GAVEY prophesied a speedy solution. The National Telephone Co.'s exchange at Bristol is shortly to be equipped on this system, when it will have the practical trial in this country which it is already undergoing in the United States.

The other point chiefly emphasised by Mr. GAVEY was the large amount of labour involved in the erection of an exchange. Although to the subscriber who airs his grievances in the newspapers, and to the town councillor who thinks he could, himself, establish a better service, it may appear a matter of ridiculous simplicity to afford means of connection between the lines of any two subscribers, those who have technical knowledge of the subject know that the design and equipment of a large telephone exchange requires skill and experience by no means inconsiderable. To quote Mr. GAVEY'S words:—

> To take an analogy. It is a simple matter to provide the catering for a single establishment, but there are few problems of greater magnitude than the provisioning of an army of, say, 100,000 men. In the same way, any plumber-electrician can run up a few score wires and connect them to a switch, but when the wires grow from scores to thousands, and tens of thousands, spread over an area of some hundreds of square miles, the problem becomes as intricate as that involved in any other type of heavy electrical engineering.

MR. PREECE, who was in the chair, contributed the greater part of the discussion, alluding chiefly to what—to borrow a system of nomenclature now fashionable in other branches of electrical engineering—we may term the "grumble factor." This factor, it would seem, depends more on the education of the subscriber than on the efficiency of the system; in other words, the subscriber ought "to know better." One method of bringing this about, Mr. PREECE suggests, would be for the subscriber to visit an exchange and see for himself what the operators' duties are. We may mention that a most successful cure was recently administered in this way to our contemporary the *Financial News*. Mr. PREECE held up the Berlin subscriber as a pattern. In that city technically speaking, the service is one of the most backward, the lines being single-circuit, and the pattern of the instruments respectably antiquated. Yet the proportion of

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inhabitants who are subscribers is large, and there appears to be no great dissatisfaction among them. But we may mention that every one of these subscribers has been trained to strict discipline, and is accustomed to obey orders and to bow down to Government officials. The punishment for calling a telephone operator a "sheep's head" may be imprisonment without the option of a fine; even the name of the offence is terrific, being a word of no less than sixteen letters. Assuredly all telephone officials will become advocates of compulsory military service and large standing armies.

The Royal Society Soirée.—The first of the two annual Royal Society soirées will be held on Wednesday, May 3rd.

The Soudan Telegraph Line.—A Reuter's telegram from Cairo announces that the telegraph is now open to Sennar on the Blue Nile.

Electric Lighting Bills.—The Central Electric Supply Bill and the St. James' and Pall Mall Electric Light Bill were read a third time in the House of Commons on Tuesday.

Cable Interruptions and Repairs.—

	Date of Interruption.	Date of Repair.
Paramaribo—Cayenne	Feb. 10, 1899 ...	April 10, 1899
Cayenne—Pinheiro	Mar. 10, 1899 ...	—
Maranhan—Para.....	April 10, 1899 ...	—

The Proposed National Physical Laboratory.—The London correspondent of the *Birmingham Post* announces that Government will ask Parliament for a grant of £4,000, to be continued for five years, and, as well, to make provision for a sum of about £12,000 for the erection of suitable buildings and laboratory equipment.

Patagonian Telegraphy.—The Argentine Government has, according to *Engineering*, invited Senor Luigi from Bahia Blanca for the purpose of discussing with him the construction of a telegraph line to Patagonia. The Argentine Government originally intended to build a land line, but opinion appears now to be inclined to favour the laying of a submarine cable.

The Paris Exhibition of 1900.—The Royal Commission for the Paris Exhibition of 1900 informs us that a Sub-Committee, consisting of the following gentlemen, has been appointed in connection with the British Electrical Section of the Paris Exhibition of 1900:—Mr. W. H. Preece, (Chairman), Sir Henry Mance, Mr. Alexander Siemens, Mr. Henry Edmunds, Mr. J. W. Swan, Mr. H. Thomson Lyon (secretary).

Obituary.—We regret to record the death on the 6th inst., at his residence in London, of Mr. F. L. Hutchins, in his 73rd year. Mr. Hutchins was a member of the firm of Murray, Hutchins and Stirling, and had a long connection with electrical matters through his position as legal adviser for the last 33 years to the India Rubber, Gutta Percha and Telegraph Works Co. Those who had relations with the deceased have lost an able counsellor and a sincere friend.

Accidents on the Continent.—The daily papers last Friday contained Reuter's telegrams, notifying two rather serious accidents in Switzerland and France respectively. At the electricity works in course of construction at Hagneck, on the Lake of Bienne, a dam, together with a caisson, was carried away by the River Aar. Of twelve workmen who were in the caisson at the time four were killed, while two were seriously and others slightly injured. In Nancy, the brake of an electric tramcar broke down while the vehicle was going down a hill. The vehicle dashed down the street at full speed, and collided at the bottom of the incline with another tram. Fourteen persons were slightly injured.

The Government Telephone Bill.—At a meeting on Wednesday of a joint committee of the Electrical and Allied Trades Section and Postal, Telephone and Telegraph Committee of the London Chamber of Commerce, appointed by the Council to consider what action the Council should take in connection with the Government telephone bill, the following resolutions were passed:—

1. "That this Committee recommends the Council to urge upon the Government that it is undesirable that the Postmaster-General should license the councils or county boroughs to provide systems of public telephonic communication, pending the report of the Joint Committee about to be appointed by the two Houses to consider the whole question of municipal trading."
2. "That the Council be recommended to urge upon the Government that, pending the Report of the Joint Committee to be appointed by the two Houses on municipal trading, the Telegraphs (Telephonic Communication, &c.) Bill should be postponed."

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on the 10th inst., His Grace the Duke of Northumberland presiding, on this the first general monthly meeting since his election as president. His Grace announced that the Hodgkins Medal, which is the first gold medal for scientific work ever given by the Smithsonian Institution, has been awarded to Prof. Dewar, of the Royal Institution of Great Britain, in recognition of his discoveries in the liquefaction of air, and in doing so he congratulated Prof. Dewar on this honour conferred on him, and also on the Royal Institution. He regarded it as specially gratifying as a sympathic recognition of scientific work and discovery in this country, coming from the great nation of our own blood on the other side of the Atlantic. The special thanks of the members were returned to Sir Benjamin Baker, K.C.M.G., for his donation of £50, and to Nobel's Explosives Co. for a donation of £105 to the fund for the promotion of experimental research at low temperatures.

Supply Interruptions.—Two recent failures of the electric supply at Hull are reported. The former, which affected the New Town section of the network only, occurred at 1:40 a.m. on the 30th ult., the cause being a short-circuit of the mains in the same street as on a previous occasion. Mr. A. S. Barnard, the borough electrical engineer, in his report to his committee, attributed the mishap to bad work on the part of the contractors. The supply being recommenced before six o'clock the same morning, no great inconvenience was caused. The second failure occurred about two o'clock on the 1st inst., and the whole supply was interrupted until 6:30. The cause appears to have been a too sudden switching-on of a large motor used in the *Eastern Morning News* printing office, thus reversing one of the 110 volts dynamos then running. The long delay in re-establishing the supply was due to the fact that half of the storage battery at the works was disconnected for repairs.—An accident which occurred at the Port Adelaide electric light station on Feb. 9 is reported by mail. It is particularly unfortunate, as the station in question had only been running for a few days. Soon after the engines had been started for the evening, the main steam-pipe, connecting one of the boilers with the engine-room, burst close to the expansion joint. Fortunately a very small load was on, and the stop valve was open barely a quarter of a turn, so that in spite of the darkness the steam was shut off without great difficulty. The broken length of pipe was thrown with considerable force against the wall of the boiler-room, but no one appears to have been injured. There being no spare lengths of steam main available, the station was obliged to shut down for a few days.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, April 14th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Earth Currents and Electric Traction," by Prof. A. W. Rücker.

WEDNESDAY, April 19th.

ROYAL METEOROLOGICAL SOCIETY.

7:30 p.m. Ordinary Meeting at 25, Great George-street, S.W.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Meeting at 20, Hanover-square, W.

THURSDAY, April 20th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Special Meeting, when Prof. J. A. Ewing, F.R.S., will deliver the seventh "James Forrest" Lecture, the subject of which will be "Magnetism."

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Wehnelt's Electrolytic Interrupter.—H. Pellat throws some further light on the curious phenomenon noticed by him (*see The Electrician* of April 7, p. 822) by an observation which shows that the strong and the feeble current intensities obtained with the same resistance, according to the impedance in the circuit, are convertible, and only differ in stability. With an E.M.F. of 110 volts and the coil in position, the current strength is 25 amperes, the long flame plays between the terminals of the secondary and the interrupter makes a good deal of noise. On short-circuiting the primary, the current falls to five amperes, but not till several seconds have elapsed. The interrupter is then silent. On reintroducing the impedance, the strong current is not necessarily re-established. Often there is no difference, but a kind of chirping noise in the interrupter. But if the commutator of the coil is opened and closed, the strong current and long flame at once set in again, and the interrupter hums. This shows conclusively that of the two explanations proposed, the second is the correct one, and that the impedance introduced modifies the ratio of the open to the closed time, or more precisely, the quantity

$$\frac{E}{T}\int_0^T \frac{dt}{R}.$$

[Pellat, *Comptes Rendus*, March 27, 1899.]

Properties of Uranium Rays.—H. Becquerel has repeated some of his earlier experiments on the rays named after him, and has found that the conclusions originally derived from them were to a great extent erroneous. As a matter of fact, it cannot be proved that these rays, whether proceeding from uranium, thorium, polonium, or radium undergo either polarisation, refraction, or regular reflection. The absence of these properties places them on a line with Röntgen rays. There are some distinct indications of diffused reflection, and there again the analogy with X-rays holds good. As regards absorption, it is found that polonium gives out rays which are easily absorbed, even by black paper, whereas radium and uranium rays have much greater penetrative power. As regards the source of the energy of these rays, the author still considers that an open question. Even when kept beyond the reach of any known radiation for three years, these substances still give out rays capable of impressing a photographic plate and of ionising the air. It has been suggested that they undergo some internal process which leads to the radiation of energy, and as the latter is very small, such radiation could be kept up for very long periods. But that is unlikely, since no known physical process is capable of increasing the energy thus given out.

[Becquerel, *Comptes Rendus*, March 27, 1899.]

Slow Oscillations.—Some elegant new methods of studying oscillating discharges have been devised by W. König. They are based upon the well-known phenomenon of Lichtenberg's figures, and are applicable to all oscillations of periods not exceeding those of ordinary sound-waves. He uses a metallic plate painted with asphalt lacquer and attached to a pendulum. The discharge is conducted to the plate through a conductor provided with a tip of straw, thus reducing the spreading of the figures. Well defined red and yellow lines are thus obtained, when the plate is strewed with a mixture of red lead and sulphur. The method may be further improved by attaching the straw to the prong of a tuning-fork. Every section of the wavy line obtained then represents a reversal, and the number of waves in each section is a measure of the period of the discharge. The method is extremely accurate as such measurements go, the errors not exceeding 1 per cent., and it is available down to 20 volts. The author has applied it to verify the theoretical laws of discharge, and especially the influence of an iron core. When that is present, the period greatly alters with the amplitude, but as the frequency increases, the influence of the iron core becomes less and less marked.

[König, *Wied. Ann.*, No. 3, 1899.]

Demonstration of Wire Waves.—When the parallel wires of the Lecher system are led through long vacuum tubes, as proposed by Arons, the tubes light up along their whole length on working the exciter. But if the wires are bridged both in front and behind the tubes, in such a manner that the distance between the bridges is a multiple of half a wave-length, stationary waves are formed along the wire, indicated by the luminosity of the sections, and the darkness at the nodes. W. D. Coolidge has now succeeded in reproducing the same phenomenon in the open air, and with waves only 12cm. long. This was done by increasing the amplitude of the oscillations and by reducing the diameter of the parallel wires to 1mm. or even 0·1mm. The author used a Blondlot exciter immersed in petroleum. The secondary circle was just below the primary, and only separated from it by a plate of mica. The source of energy used was an induction coil provided with a Tesla transformer. The distance between the parallel wires was 1 or 2cm. On darkening the room the wires were seen to glow at the ventral segments, and some capital photographs were obtained.

[Coolidge, *Wied. Ann.*, No. 3, 1899.]

Consumption of Energy in Vacuum Tubes.—H. Ebert has measured the energy dissipated in vacuum tubes fed, not with a continuous, but with an alternating current. Direct-current measurements cannot be applied to this case on account of the phase difference introduced by the capacity of the discharge tubes. He carried the measurements to very high vacua, and made the important observation that the higher the vacuum the less the energy consumed in proportion to the luminous effect obtained, especially with the high potentials (3,000 volt) and the high frequencies employed (22,000 ∿ per minute). At a certain point, however, the consumption of energy attained a minimum, after which it rose again on further increasing the exhaustion. This "pressure of reversal" has a simple relation to the mean free path of the gas in the tube, being, in fact, inversely proportional to it. The further conclusion arrived at is that where the molecular diameters are equal the reversal pressure is the higher, the smaller the number of valencies in the gaseous molecule, *i.e.*, the fewer the ionic charges which are liberated on complete dissociation. A gas offers the greater resistance to discharge the higher the valency and the smaller the sphere of influence of its molecules.

[Ebert, *Wied. Ann.*, No. 3, 1899.]

ALEXANDER PELHAM TROTTER.

We are glad to announce that Mr. A. P. Trotter, the Government Electrical Engineer and Inspector for Cape Colony, has been appointed electrical adviser to the Board of Trade, in succession to Major Cardew, whose resignation we recently recorded. We feel sure that all our readers—even those who do not know him personally—will echo our congratulations to Mr. Trotter, and welcome his return to this country, as he was for five years their "guide, philosopher and friend" during the period he occupied the position of editor of *The Electrician*. Major Cardew, whom he is to succeed at the Board of Trade, having carried out his duties with such extreme ability and tact, the task for his successor must necessarily be no easy one, but we cannot imagine a man better suited to undertake it than Mr. Trotter.

Mr. Trotter is an old Harrovian. At Harrow he was most distinguished by his being the best swimmer and diver; and, subsequently, at Trinity College, Cambridge (where he went, after a few months at King's College, London) he was as successful as an athlete as in reading, for he took Honours (Second Class) in the Natural Science Tripos, having studied under Clerk Maxwell, Prof. Michael Foster and Prof. J. Stuart, and yet found time to be captain of the Cambridge Bicycle Club, and to lower several records in bicycle racing: he was the first to accomplish one mile in less than three minutes. In 1880 Mr. Trotter articled himself to Messrs. Easton and Anderson, of Erith, and in 1884 he was engaged by the War Office on the design of electric search-lights, and also

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assisted Mr. Preece in photometric tests of street lighting. His next engagement was with Messrs. Edmunds and Goolden, and about this time some may remember his lectures to evening classes at King's College. Subsequently he entered into partnership with Mr. W. T. Goolden, and the works of Messrs. Goolden and Trotter were built at Halifax. In 1887, not caring for the commercial part of the business, Mr. Trotter dissolved partnership, and returned to London to practise as a consulting engineer. In April, 1889, in addition to his consulting work, he fulfilled the duties of Technical Secretary to the Electrical Trades' Section of the London Chamber of Commerce, and in 1890 became editor of *The Electrician*. Since the beginning of 1896 Mr. Trotter has been in Cape Town as Advisor to the electrical Government, and has been doing a vast amount of useful work there. Mr. Trotter is forty-one years of age. Space will not allow us to give a full list of all the Papers he has contributed to scientific and engineering societies, but we may mention, among the more important, one read before the Institution of Civil Engineers on "The Distribution and Measurement of Illumination;" several others on similar subjects and on the physics of the electric arc, and the interesting account of his investigations of the disturbances caused in the submarine cables in Cape Town by the working of the electric tramways there. The latter, it will be remembered, formed the substance of a Paper, which received the honour of an extra premium by the Institution of Electrical Engineers, in 1897. Mr. Trotter has also been to the front in his advocacy and development of graphical methods and in everything pertaining to the slide rule.

CARBONS FOR ELECTRIC LIGHTING AND OTHER PURPOSES.*

BY FRANCIS JEHL.

(Continued from page 790).

VIII.—ESTIMATION OF HIGH TEMPERATURE.

Among carbon manufacturers, the ordinary parlance, when referring to the temperature at which they bake their carbons, will generally be found similar to that used in the pottery industry, that is, designated by Prof. Seger's pyramids. It is a well-known fact to pottery manufacturers that it was formerly a very difficult thing for them to estimate in a practical way the temperature at which they had to bake their goods. To use pyrometers, no matter of what design, generally required some skilled attendant, while at the same time the readings of such instruments were often misleading.

At the request of a well-known "Chamotte" works in Germany, Prof. Seger made a series of exhaustive experiments to determine the different points of fusion of certain mixtures of pure silicates, &c., which he moulded into the shape of small blunted pyramids. In fact, the Seger pyramids represent a series of systematic mixtures, each of which have a different point of fusion, varying 20°C to 30°C from one another. Thus one set of the Seger pyramids that is numbered from 0·22 to 0·10 can be used to estimate temperature that lies between 590°C to 950°C respectively, there being a difference of about 30deg. between each successive number in regard to its point of fusion. Another set, numbered from 0·9 to 1·0, is used for temperatures varying from 970deg. to 1,130deg., while each succcessive number's point of fusion varies by 20deg. A third set, 1 to 36, is used for temperatures between 1,150°C and 1850°C respectively, each successive number's point of fusion varying also by 20deg. Thus, by means of the 58 pyramids, any temperature between dull red and the melting point of platinum can be estimated. When a carbon manufacturer, therefore, says he uses a No. 17 or 18 Seger pyramid in his Mendheim furnace, he means that he bakes his carbons at an estimated temperature of about 1470°C or 1490°C respectively.

It must be understood that this mode of measuring temperature is not to be taken as scientifically correct, but in practice it has been found to suit all requirements and the estimation of heat obtained by such means has enabled the pottery industry (as well as the carbon trade) to burn or bake their goods with a precision heretofore unknown. The above table* gives the numbers, chemical composition and the estimated temperature at which the pyramids most commonly used by carbon makers fuse, or rather fall over, when subjected to a certain heat.

Pyramid number.	Chemical composition.	Estimated temp. Degs. Centigrade.
10	$\left.\begin{matrix}0{\cdot}3\ K_2O\\0{\cdot}7\ CaO\end{matrix}\right\}$ 1·0 Al_2O_3 10 SiO_2	1,330
11	$\left.\begin{matrix}0{\cdot}3\ K_2O\\0{\cdot}7\ CaO\end{matrix}\right\}$ 1·2 Al_2O_3 12 SiO_2	1,350
12	$\left.\begin{matrix}0{\cdot}3\ K_2O\\0{\cdot}7\ CaO\end{matrix}\right\}$ 1·4 Al_2O_3 14 SiO_2	1,370
13	$\left.\begin{matrix}0{\cdot}3\ K_2O\\0{\cdot}7\ CaO\end{matrix}\right\}$ 1·6 Al_2O_3 16 SiO_2	1,390
14	$\left.\begin{matrix}0{\cdot}3\ K_2O\\0{\cdot}7\ CaO\end{matrix}\right\}$ 1·8 Al_2O_3 18 SiO_2	1,410
15	$\left.\begin{matrix}0{\cdot}3\ K_2O\\0{\cdot}7\ CaO\end{matrix}\right\}$ 2·1 Al_2O_3 21 SiO_2	1,430
16	$\left.\begin{matrix}0{\cdot}3\ K_2O\\0{\cdot}7\ CaO\end{matrix}\right\}$ 2·4 Al_2O_3 24 SiO_2	1,450
17	$\left.\begin{matrix}0{\cdot}3\ K_2O\\0{\cdot}7\ CaO\end{matrix}\right\}$ 2·7 Al_2O_3 27 SiO_2	1,470
18	$\left.\begin{matrix}0{\cdot}3\ K_2O\\0{\cdot}7\ CaO\end{matrix}\right\}$ 3·1 Al_2O_3 31 SiO_2	1,490
19	$\left.\begin{matrix}0{\cdot}3\ K_2O\\0{\cdot}7\ CaO\end{matrix}\right\}$ 3·5 Al_2O_3 35 SiO_2	1,510
20	$\left.\begin{matrix}0{\cdot}3\ K_2O\\0{\cdot}7\ CaO\end{matrix}\right\}$ 3·9 Al_2O_3 39 SiO_2	1,530

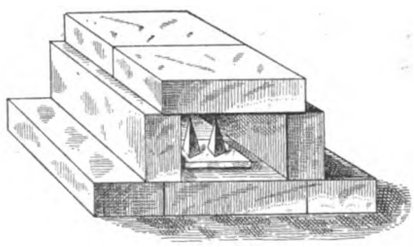

FIG. 53.—Method of Protecting the Pyramids.

It is usual to place the pyramids (two or three successive numbers) in two different parts of the furnace so as to be able to get a good idea of how the heat is distributed, and not to turn off the gas until all parts of the chamber have an even temperature. It is, of course, understood that the pyramids should be protected from the direct action of the flames, as otherwise erroneous results are obtained.

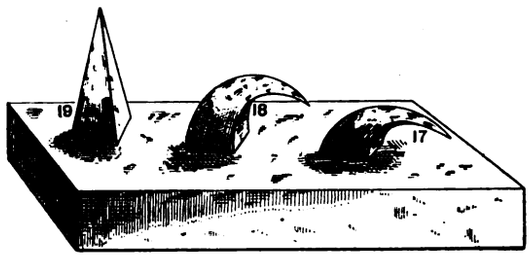

FIG. 54.—Seger Pyramids in the Furnace.

The best way to place the pyramids in the furnace is to protect them by some fire-bricks, as shown in Fig. 53, and at the same time they must be so placed that they can be seen from the peep-holes of the furnace. These peep-holes are generally covered with mica, to prevent the air from getting in when observations are made, which when not in use are covered with fire-bricks. In using three successive numbers of the pyramids at a time for observation we have a convenient way of noticing the rise in heat, and Fig. 54 will serve to show how the estimation is approximately judged and fixed. Here we have the three pyramids—17, 18, 19—that have already been subjected to the action of a furnace. We see that 17 is fused down, and conclude that the temperature

* From a forthcoming book to be published by *The Electrician* Printing and Publishing Company (Limited). All rights reserved.

* For a detailed account of Prof. Seger's pyramids, *see* pamphlet published by the *Thonindustrie Zeitung* (Berlin).

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that existed must have been higher than 1,470deg. Pyramid 18 is pretty well bent over, and we can thus estimate that the intensity of the heat must have been very near to 1,490deg. That the temperature did not reach as high as 1,510deg. is proved by the fact that pyramid 19 is still straight..

It will be seen that the whole method of observation is a very simple one, and that any common workman can be entrusted with it. It may be mentioned that the pyramids should always be placed in the same place in the furnace, so as to always get the same relative results. When the pyramids have once been used they are not good for a second time, and new ones are thus always placed in the furnace with each charge. As they are very cheap, this is a matter of no importance. To prevent the pyramids from falling over, it is usual to use a little fire-clay and paste them at their base on to the fire-brick.

IX.—THE MANUFACTURE OF ELECTRODES ON A SMALL SCALE.

The financial success of many electro-chemical or smelting works is often dependent upon the cost of the electrodes they employ, which in most cases are made from carbon. It would, no doubt, be to the interest of such concerns to manufacture their own electrodes, and the following estimate will give the approximate costs of a small plant that can produce about 500 kilos. (1,100lbs.) of electrodes per day, or 3,000 kilos. (6,600lbs.) per week.

In the following estimate a Braun hydraulic press, No. 3, is taken, which can squirt electrodes having a width up to 180mm. (F″). If larger sizes are required than the above, a Braun hydraulic press, No. 5, must be employed, which can produce electrodes having a width up to 500mm. (19·5″). Such a press would increase the cost of the plant about £541. 6s. = $2,600 = fl.6,500.00. Press No. 3 can work off about 1,300 kilos. (2,860lbs.) per day, and press No. 5 about 13,000 kilos. (28,600lbs.) We see thus a press in a plant that only makes about 500 kilos. (1,100lbs.) works only a few hours every day.

It may also be mentioned that in the following calculations the price of the raw material (common mixture, Table B and D) is taken at fl.0.05 (1d. or 2.5cts.) per kilo., and the material consists of either petroleum coke, or gas retort carbon mixed with tar. However, in many cases common coke, as obtained at any gas works, is just as suitable for making electrodes, while its cost is less than half. Works that produce carborundum, calcium carbide, or aluminium, &c., will find that electrodes made of common coke will answer their requirements. It is well when buying the coke to pay a little more per ton, and have only dense pieces picked out, which are better suited for making electrodes. In the estimate the writer has taken the low figure of fl.0.20 (4d. or 8cts.) per kilo. as the cost of the finished electrodes, although it is not probable that any concern can buy their electrodes at such a low price.

It is supposed that power is at hand (about 10-12 H.P.), also a small space where the machinery can be set up, and for both an item of rent will be inserted in the yearly expenses.

Machinery for Making Electrodes, &c.

1 Crushing machine	fl.630.00	£52 10 0	$252.00
1 Crushing mill with runners	960.00	80 0 0	384.00
1 Roller mill, No. 2	600.00	50 0 0	240.00
1 Wet mixer	650.00	54 3 4	260.00
1 Roller mill for kneading	600.00	50 0 0	240.00
1 Cake pounder	360.00	30 0 0	144.00
1 Hydraulic press, No. 3	4,020.00	335 0 0	1,608.00
1 Five-Cylinder press pump	1,620.00	135 0 0	648.00
Sundries	560.00	46 13 4	224.00
Packing, freight, duty & erecting	2,000.00	166 13 4	800.00
Total	fl.12,000.00	£1,000 0 0	$4,800.00

Complete Plant.

Special machinery	fl.12,000.00	£1,000 0 0	$4,800.00
Foundations, &c.	300.00	25 0 0	120.00
Mendheim furnace for electrodes	12,000.00	1,000 0 0	4,800.00
Countershafts, belting, &c.	700.00	58 6 8	280.00
Utensils and small tar tank	300.00	25 0 0	120.00
Sundries	700.00	58 6 8	280.00
Total sum	fl.26,000·00	£2,166 13 4	$10,400·00

Labour Necessary.

6 men at fl.1.20 (2s. or 48cts.) per day, or per year of 300 days	fl.2,160.00	£180 0 0	$864.00
1 man at fl.3.00 (5s. or $1.20) per day, or per year of 300 days	900.00	75 0 0	360.00
2 men for the furnace, or per year of 365 days	1,095.00	91 5 0	438.00
	fl.4,155.00	£346 5 0	$1,662.00

Yearly Expenses.

Labour	fl.4,155.00	£346 5 0	$1,662.00
Coal for furnace	2,000.00	166 13 4	800.00
Oil and waste	300.00	25 0 0	120.00
Fire bricks, &c.	800.00	66 13 4	320.00
Belting, &c.	100.00	8 6 8	40.00
Repairs, &c.	2,500.00	208 6 8	1,000.00
Rent for power (average, 10 H.P)	2,000.00	166 13 4	800.00
Rent for space in the works	500.00	41 13 4	200.00
Insurance	75.00	6 5 0	30.00
10 per cent. redemption on fl.26,000.00	2,600.00	216 13 4	1,040.00
Sundries	270.00	22 10 0	108.00
	fl.15,300.00	£1,275 0 0	$6,120·00
Capital invested in electrode plant	fl.26,000.00	£2,166 13 4	$10,400.00
Working capital put in	10,000.00	833 6 8	4,000.00
Total capital considered as invested	fl.36,000.00	£3,000 0 0	$14,400.00

1,100lbs. = 500 kilos. electrodes per day is about 330,000lbs. = 150,000 kilos. per year.

At the low price of 4d. (8cts. or fl.0.20) per kilo. (2.2lbs.) we have :—

$\frac{330,000}{2.2} \times 4 = £2,500$, or $\frac{330,000}{2.2} \times 8 = \$12,000$, or $150,000 \times .2 = fl.30,000$.

Raw mixture at 1d. = 2cts. = fl.0.05 per kilo :—

$\frac{330,000}{2.2} \times 1 = £625$, or $\frac{330,000}{2.2} \times 2 = \$3,000$, or $150,000 \times .05 = fl.7,500$.

Expenses per year	£1,275.00	$6,120.00	fl.15,300.00
Raw material	625.00	3,000.00	7,500.00
Total	£1,900.00	$9.120.00	fl.22,800.00
Price of electrodes	£2,500.00	$12,000.00	fl.30,000.00
Expenses	1,900.00	9,120.00	22,800.00
Profits	£600.00	$2,880.00	fl.7,200.00

This shows that when electro-chemical works or smelting concerns make their own electrodes, they can produce them at about £1. 13s. 4d. = $8.00 = fl.20.00 per 100 kilos. (220lbs), and yet have a profit on the money they invest, or, in other words, they can produce their electrodes at less than £1. 13s. 4d. = $8.00 = fl.20.00 per 100 kilos., when they desire only an interest of 5 per cent. on the capital they invest.

In carborundum works there is a by-product of good carbon which will make excellent electrodes, so that such concerns have at hand a very cheap raw material which can be considered as costing them hardly anything. It is self-evident that when a works needs more than about 500 kilos. (1,100lbs.) of electrodes per day, the cost of manufacturing will not increase proportionally, as the more they make the cheaper will be the price of production per kilo., up to a certain limit. The writer has calculated, for instance, that when a carbon works invests about £600 ($2,880 or fl.7,200) for an electrode plant that can produce about 4,000 kilos. (8,800lbs.) per day, electrodes can be produced at about £1. 5s. ($6 or fl.15.00) per 100 kilos., and at which price there will still be a profit of about 25 per cent. to 30 per cent. on the capital invested.

The main success in all enterprises is, of course, largely dependent upon the amount of goods that will be sold, which amount cannot with certainty be fixed beforehand, yet the writer is of an opinion that the carbon industry would thrive well in England, while in the United States high grade carbon factories must, under all circumstances, prosper, as there is a growing demand for such brands. The fact that Europe has been sending large quantities of carbons, &c., to the above mentioned countries is enough to warrant the establishment of such works. A carbon factory, as has already been mentioned should have its own soot works, and thus obtain a greater margin in its profits, as soot can no doubt be produced at about 20-30 per cent. less than the price the writer took in his calculations.

Having a soot factory, printers' inks can also be made, as done by a carbon factory in Austria. Shoe blacking, crucibles,

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water filters, and other articles, the manufacture of which are all sister branches to the carbon industry, afford an extension in business that will help to swell the profits by investing a little extra capital. As carbon factories have good furnaces, there is no reason either why they should not make their own retorts in which the carbons are baked or carbonised, which will thus also cut down some of the yearly expenses. Only one or two extra machines are necessary for the purpose, by which the broken retorts are ground up, and, with an addition of some fireclay (chamotte flour), new retorts can be moulded or pressed and baked in the same furnace in which the carbons are placed if there is room, or when business is slack. The broken retorts furnish a very favourable material, as they have been subjected to high heat.

(To be concluded).

EXPERIMENTS ON ALTERNATE-CURRENT ARCS BY AID OF OSCILLOGRAPHS.

The Paper which, under the above title, has just been presented by Messrs. W. Duddell and E. W. Marchant to the Institution of Electrical Engineers, forms one of the most valuable contributions to our experimental knowledge of the alternate-current electric arc which have yet been published. The communication is printed in full in No. 138 (Vol. XXVIII.) of the *Journal*, of which it fills no less than 107 pages. Not only has the investigation a value intrinsic to the particular conditions of alternate-current working, but, as we have before observed, we think that a careful study of the alternating, as compared with the continuous-current arc, is likely to prove as fruitful, if not more fruitful, of that experimental evidence and subsidiary phenomena which will ultimately lead to an explanation of the whole collective phenomenon. In view of the impossibility of reproducing the whole of this voluminous Paper, it is hoped that the following abstract will present some of the more important results which the investigation has developed.

The Paper commences with a very useful little bibliography of the published literature bearing on the subject of the investigation, which may be said to be a general examination of the reaction which an arc has long been known to exercise on the wave form of the alternate current in the circuit. Thus, if a non-inductive resistance between two points in an alternate-current circuit be replaced by an arc, the current wave and the wave of potential difference between these two points will be modified, although the arc transmit the same virtual or "root-mean-square" current at the same potential difference. This modification which takes place in the wave forms, depends upon the nature of the carbons employed, the nature of the rest of the circuit, frequency, length of arc, &c. The authors thus remark :—

In an investigation like the present into the reactions of the alternate current arc on the wave form, we in general require three wave forms, viz. :—

1. The form of the wave of potential difference between the terminals of the dynamo when the arc is burning (which we will call for short the "P.D. dynamo" curve).
2. The form of the wave of potential difference between the terminals of the arc (which we will call the "P.D. arc" curve).
3. The form of the wave of current (which we will call the "current" curve).

We also require the root-mean-square values of the above waves, the power supplied to the arc, the arc length, and the data of the circuit in which the arc is burning. It is preferable, and in many cases absolutely necessary, that the corresponding wave forms of the different electrical quantities, *i.e.*, P.D., current, &c., should be obtained simultaneously. Many of the most interesting phenomena of the arc and those on which we require additional information are of a more or less variable or transient nature, such as the hissing arc, and arcs between electrodes other than carbons, consequently the waves only repeat themselves a very limited number of times, if at all.

These considerations led us to choose a method in which the time taken in recording each wave is as small as possible, and by which the several P.D. and current wave forms can be obtained simultaneously.

A description of the oscillograph used was given in a Paper on "Oscillographs" before the British Association at Toronto.* The arrangements permitted of a photograph being taken at any moment, such as when the wave-form, as viewed directly by the eye, was seen to be representative of the general form under the particular conditions. The connections generally used were :—In the main circuit of the alternator was included (in series with the arc) a non-inductive resistance or impedance coil, as the case required. Also, in series with the arc was a resistance of 0·1 ohm, across which that coil of the double oscillograph for recording the current wave was connected. The other coil of this oscillograph was connected across the terminals of the arc, and recorded the pressure wave of the arc. An Evershed alternate-current ammeter and a Ganz wattmeter enabled the current through and the power taken up in the arc to be measured. An Ayrton-Mather electrostatic voltmeter permitted either the alternator potential difference or the pressure across the first-mentioned resistance or impedance coil to be read. Finally, a reflecting electrostatic voltmeter indicated the potential difference between the lamp terminals. A single oscillograph connected across the alternator terminals recorded the alternator pressure wave. Then follows an account of the experiments :—

We must call attention here to the fact that we measured the P.D. between the terminals of the lamp and not between the tips of the carbons, therefore what we call "P.D. arc" includes the drop of pressure in the terminals, the metal work of the lamp, the carbon holders, and two 10cm. lengths of carbon, 10cm. being the length we usually allowed to project from the holders. We determined experimentally, by short circuiting the carbon holders with a 20cm. length of carbon, what this drop amounted to, and found that, with our ordinary working current of 14·8 amps. and all the metal work hot as in use, the drop was 1·15 volt, and thus the resistance of these contacts, &c., is 0·078 ohm. All the figures which we give later are the actual readings and are *not* corrected for this drop.

Two alternators, which differed very greatly from each other, were used for our experiments :—

1. A Ferranti alternator of 9 kw. capacity which had a small armature reaction and which gave on open circuit, or on a non-inductive resistance, a very close approximation to a sine wave ; this machine had a range of frequency from 90 to 240 ∿ per sec. and gave at 100 ∿ per sec. on open circuit with maximum excitation about 100 volts.

The resistance of the armature is 0·24 ohm.
The self-induction „ „ 0·0009 h.

2. A Pyke and Harris inductor alternator* of 6 kw. capacity which had a very large armature reaction and which gave on open circuit a peaked wave form, and on a non-inductive load a kind of hump. This machine had a range of frequency from 30 to 125 ∿ per sec. and gave at 100 ∿ per sec. on open circuit with maximum excitation about 330 volts. The resistance of the armature is 0·4 ohm. The self induction of the armature, which is very large, varies with the exciting current and position of the inductor from a maximum with no excitation and the inductor opposite the pole of 0·012 henrys to a minimum with the maximum exciting current we have used, and the inductor half-way between the poles of 0·009 henrys.

The arc lamp used was a hand-regulated one, having adjustments for centreing the carbons, and fitted with holders for two search carbons. For the purpose of measuring the length of the arc its image was projected on a screen by means of a lens so placed that the image was six times as large as the arc ; the screen was ruled with lines 6mm. apart, so that the length of the arc could be read off direct in millimetres. And it is the length as measured on this screen which we mean when we speak of the length of the arc ; thus, for example, length 0·0mm. does *not* mean that the *carbons* were actually *touching*, but that the *images* of the carbons were *touching*.

Plan of Experiments.

In every experiment, a certain length of arc and current having been selected, the speed and excitation of the alternator were kept constant, and *the distance between the carbons was regulated so as to keep the P.D. between them constant during the whole course of the experiment.*

When once the arc had burnt into shape—that is, had attained the steady state corresponding with the length, current and other conditions under which it is burning—we found, as long as the conditions of the dynamo and circuit remained the same, that regulating the length of the arc so as to keep the P.D. between its terminals constant, maintained the arc length, the current and the power supplied to the arc constant. Thus it is possible to compare our results with those of M. Blondel, who kept the current constant, and those of Prof. Fleming, who kept the power supplied constant. Mrs. Ayrton has drawn attention to the fact that, with the direct-current arc, a considerable time is required for it to attain a steady state, and we find that this, as might be expected, applies equally to the alternate-current arc.

We have had considerable difficulty in obtaining even approximately comparable results when using an arc with one or both of its carbons cored ; this difficulty, which we believe was also first pointed out by Mrs. Ayrton, seems to be due to a want of uniformity in the composition of the core and in the binding material which holds the core together. There are two kinds of carbons in general use—namely, solid and cored—and these give three combinations between which we can burn an arc, and they are :

1. The arc between solid carbons, which we will call, for the sake of shortness, the "solid arc" ;

* See *The Electrician*, Vol. XXXIX., p. 637.

* A description of this machine is given in *The Electrician*, 1892, Vol. XXIX., p. 37.

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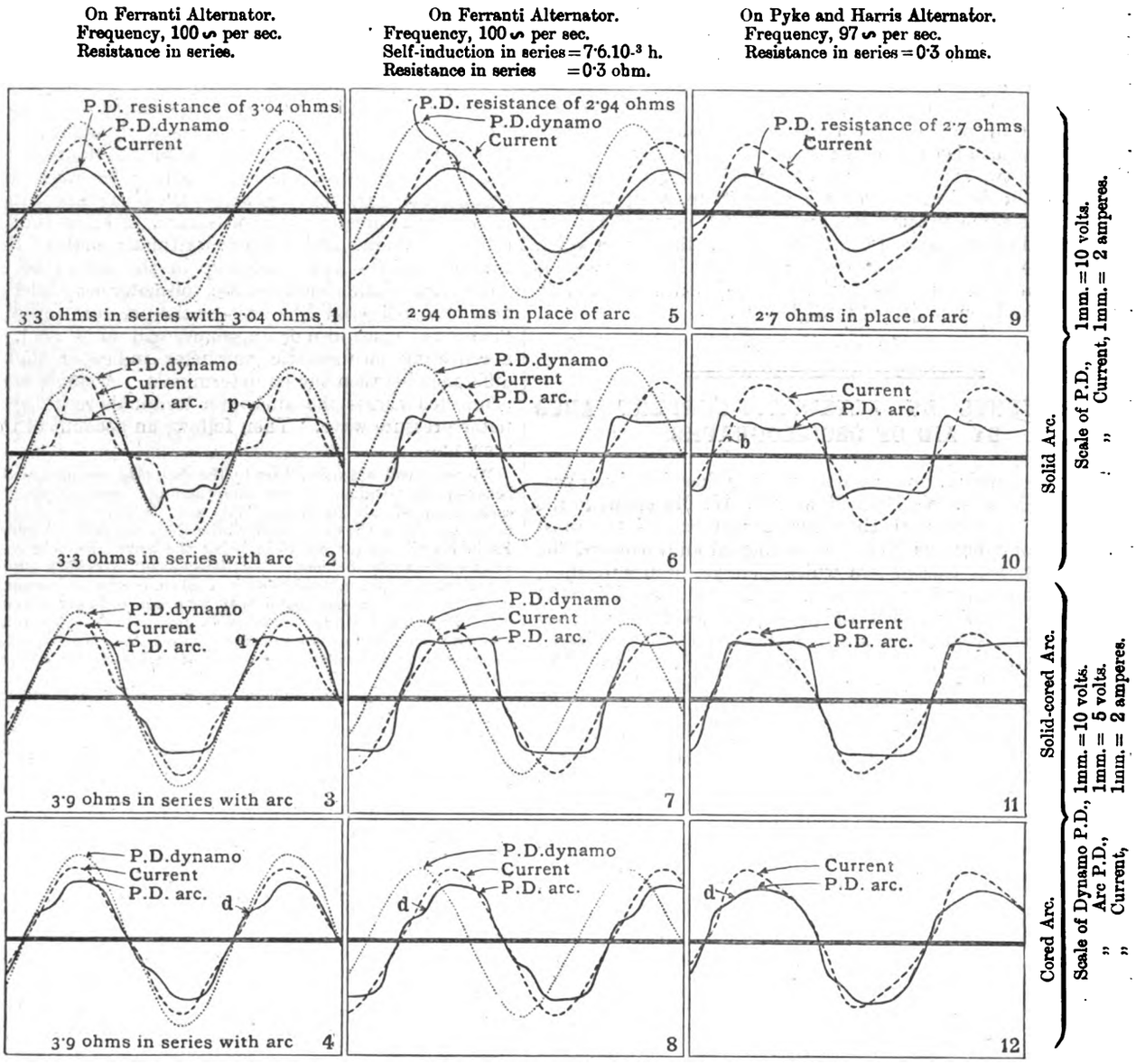

Carbons, 13mm. "Apostle." Current, 14·8 amperes. Arc Length, 3mm.

FIG. 1.—Preliminary Experiments.

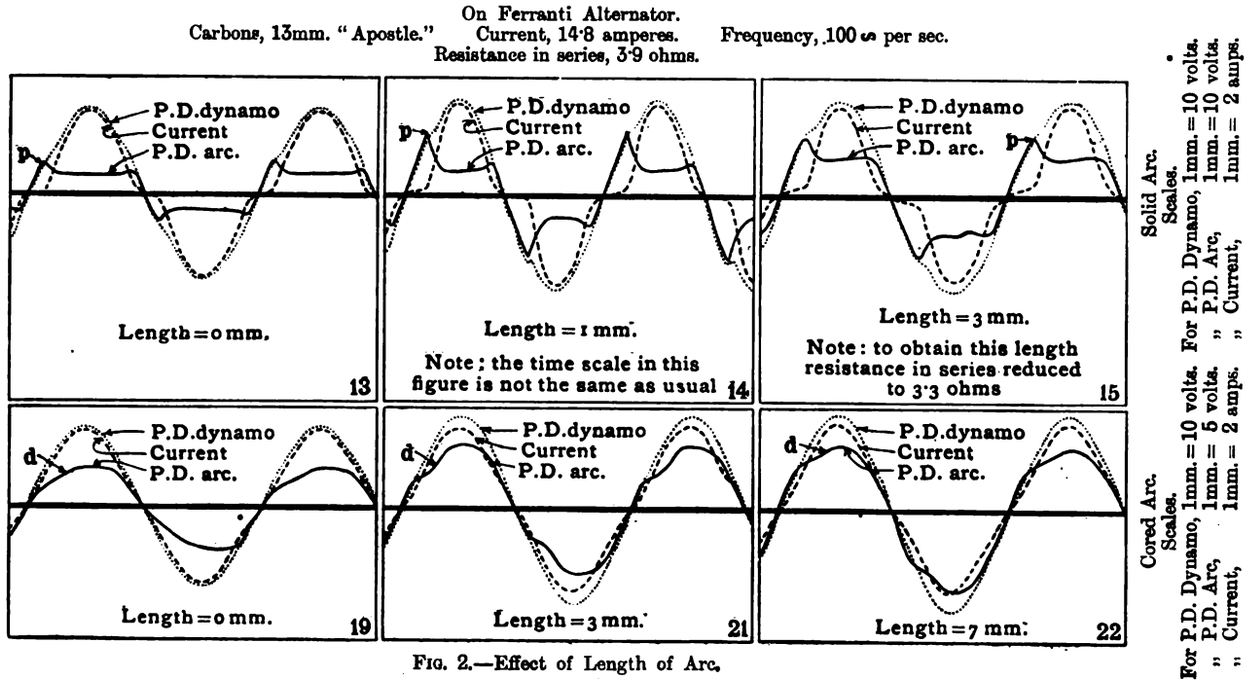

FIG. 2.—Effect of Length of Arc.

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2. The arc between one solid and one cored carbon, which we will call the "solid-cored arc," always putting the top electrode first; and

3. The arc between two cored carbons, which we call the "cored arc."

In most of our comparative experiments we have used one make of carbons throughout—namely, the "Apostle"—and we have tried in turn the effects with the "solid," the "solid-cored" and the "cored arc" with carbons of this make.

In the diagrams and tables corresponding numbers in each refer to the same experiment, the number of the experiments in the diagrams being given in the right-hand bottom corner of each set of wave forms. In the wave forms given in the diagrams time is always measured from left to right, as usual, and the scales of the respective curves are given on each diagram as so many volts or amperes per millimetre. Also in all cases the top half of the wave form corresponds to the top electrode being positive.

Section 1.—Preliminary Experiments.

(Fig. I and Table I.)

To give a clear idea of the main features of the reaction of the arc on the alternate current wave forms, we replaced a non-inductive resistance, between two points in a circuit, by a solid arc taking the same r.m.s. (root-mean-square) current, while the dynamo excitation and the other conditions of the circuit remained unchanged. The results of this substitution, for three different circuits, are given in the first two rows of Fig. 1. In each case the arc substituted had the same length, carbons, and current.

In the first case the whole circuit, including the alternator, was comparatively non-inductive, and with resistances alone all the waves were sinusoidal (experiment 1). The substitution of the arc for part of the non-inductive resistance caused a flattening of the P.D. wave between the terminals of the resistance, the production of a large front peak p, and the reduction of the current to zero for a considerable portion of the period (experiment 2).

In the second case, in which some of the resistance was replaced by inductance (experiment 5), the P.D. arc curve is almost rectangular, while the current rises nearly as rapidly as before the arc was introduced (experiment 6).

In the third case, the total inductance in the circuit had approximately the same value as in the last; but instead of having inductance outside the alternator an inductive machine was used. Although before the introduction of the arc the P.D. and current curves (experiment 9) are quite different from those previously obtained, yet after the substitution the P.D. arc curve is nearly rectangular, as before; but the current wave is little affected by the change (experiment 10).

In row 4, two cored carbons are employed; and although, to keep the arc conditions constant, it was necessary to change the dynamo excitation, the curves are comparable in *form*, respectively, with those in the first row obtained with resistance in place of the arc. It will be noticed that the current curves in row 4 are practically the same as those in row 1, but that there is a characteristic dent, d, on the front side of the P.D. arc waves (experiments 4, 8, 12). It might be expected that the solid-cored arc would have a reaction intermediate between those of the solid and the cored arcs, and this is the case, the P.D. arc waves, row 3, being squarer in shape than those in row 2. But, further, the two halves of the P.D. wave, above and below the zero line, are not exactly the same; the top half, which corresponds to solid carbon +, being slightly convex to the axis of time as in row 2, while, on the other hand, the lower half, which corresponds to the cored carbon being +, shows, especially in experiment 3, the characteristic dent of the cored P.D. arc curve. *Hence it follows that the nature of the positive, at any instance largely governs the reaction at that time*, and this conclusion is amply borne out by experiments to be described later.

There is an observation of M. Blondel which is illustrated by Fig. 1, and which impresses itself on us the more we work at the subject, and that is, that the shape of the P.D. arc wave depends on the total resistance and self-induction in the circuit (including the alternator armature) and is almost independent of the type of machine used, whereas the current wave form is largely dependent on the machine used and the nature and amount of the impedance of the circuit.

When for a resistance between two points in a circuit we substitute a solid arc taking the same R.M.S. current, and the dynamo excitation and other conditions remain unaltered, we find that the R.M.S. of the P.D. between these points is raised in all cases (experiments 1 and 2, 5 and 6, 9 and 10, Table I.). The power supplied to the circuit between the two points is greatly reduced by the substitution of a solid arc for one of the two resistances in series with the Ferranti alternator (experiments 1 and 2); and as the R.M.S. current has not been changed, the power supplied to the circuit outside the arc is constant, therefore the whole output of the alternator is reduced by replacing part of the outside resistance by a solid arc, the main current and the excitation, &c., being the same in both cases. We arrive at a similar conclusion when we consider an inductance and a resistance in series with the Ferranti machine, the resistance being replaced by a solid arc taking the same current (experiments 5 and 6); in this case, however, the effect is only slight.

With the third circuit—that is, a large and small resistance in series with the inductive Pyke and Harris alternator—the replacing of the larger resistance by a solid arc taking the same current (experiments 9 and 10), the other conditions remaining the same, leads to an increase of the output of the machine, which is the opposite to the effect in the last two cases. An examination of the wave forms (experiments 1 and 2) shows that the reduction in output on the Ferranti alternator is due to the current remaining small during a considerable portion of the period while the P.D. is comparatively large, and in a less degree to the drop in the P.D. dynamo which accompanies the higher maximum value of the current. This also explains the slight reduction observed in experiments 5 and 6. The observed increase of output of the Pyke and Harris alternator is not so easily explained, for the total self-induction of the circuit in experiments 9 and 10 is roughly the same as in experiments 5 and 6. The explanation,

Table I.

On Ferranti alternator. Frequency, 100 ∽ per sec.

Expt. No.	Carbons. Top.	Carbons. Bot.	Resistance in series. Ohms.	S.I. in series. Henrys.	Impedance of inductance coil. Ohms.	P.D. arc. Volts.	Power arc. Watts.	Power factor. Arc.	Dynamo excitation. Amps.	Notes.
1	3·04 ohms in place of arc		3·3	Very small	...	45·1	666	1·00	20	To be compared with No. 2
2	Solid	Solid	3·3	„	...	53·2	581	0·74	20	Slightly hissing
3	„	Cored	3·9	„	...	37·4	521	0·94	20	Not hissing
4	Cored	„	3·9	„	...	32·0	470	0·99	18·5	„
5	2·94 ohms in place of arc		0·3	7.6×10^{-3}	4·77	43·4	642	1·00	20	To be compared with No. 6
6	Solid	Solid	0·3	7·6 „	4·94	50·2	635	0·855	20	Slightly hissing
7	„	Cored	0·3	7·6 „	4·79	37·8	536	0·96	16·3	Not hissing
8	Cored	„	0·3	7·6 „	4·80	31·6	461	0·985	16·0	„
	On Pyke and Harris alternator. Frequency, 97 ∽ per sec.									
9	2·7 ohms in place of arc		0·3	Very small	...	39·9	590	1·00	0·74	To be compared with No. 10
10	Solid	Solid	0·3	„	...	50·0	654	0·885	0·74	Slightly hissing
11	„	Cored	0·3	„	...	37·8	536	0·96	0·69	Not hissing
12	Cored	„	0·3	„	...	33·3	483	0·98	0·68	„

Table II.

On Ferranti alternator. Frequency, 100 ∽ per sec. Carbons, 13mm. "Apostle." Current, 14·8 amps. Resistance in series, 3·9 ohms.

Expt. No.	Carbons. Top.	Carbons. Bot.	Arc length. mm.	P.D. arc. Volts.	Power. Watts	Power factor.	Notes.
13	Solid	Solid	0	26·2	309	0·795	Giving roaring sound and small green flames
14	„	„	1	43·5	404	0·63	Hissing steadily
15	„	„	3*	53·2	581	0·74	Near hissing point and slightly hissing
16	Solid	Cored	0	24·9	334	0·91	Hissing
17	„	„	1	31·0	426	0·93	Not hissing, but near hissing point
18	„	„	3	37·4	521	0·94	Not hissing; steady
19	Cored	Cored	0	20·9	303	0·985	„ „
20	„	„	1	25·6	375	0·99	„ „
21	„	„	3	32·0	470	0·99	„ „
22	„	„	7	36·2	515	0·96	„ „

* Note the resistance in series had to be reduced to 3·3 ohms to get this length.

Table III.—*Effect of Length.*

On Pyke and Harris alternator. Frequency, 97 ∽ per sec. Carbons, 13mm. "Apostle." Current, 14·8 amps. Resistance in series, 0·3 ohms.

Expt. No.	Carbon. Top.	Carbon. Bot.	Arc length. mm.	P.D. arc. Volts.	Power. Watts.	Power factor.	Notes.
23	Solid	Solid	0	26·7	321	0·810	Small green flames and roaring sound
24	„	„	1	43·0	502	0·790	Hissing
25	„	„	3	53·8	688	0·865	Very slightly hissing
26	„	„	6	63·6	807	0·860	Not hissing
27	„	„	15	83·0	1,100	0·89	Humming sound, same pitch as dynamo
28	„	„	20	91·5	1,220	0·90	Same; very unstable
29	„	Cored	0	28·4	388	0·925	Hissing
30	„	„	1	33·6	476	0·955	Not hissing
31	„	„	3	38·6	550	0·965	„
32	„	„	6	45·8	653	0·965	„
33	„	„	15	66·0	949	0·97	„
34	„	„	30	91·6	1,315	0·97	Humming sound of dynamo
35	Cored	„	0	23·4	338	0·975	Not hissing
36	„	„	1	27·4	394	0·975	„
37	„	„	3	33·3	483	0·980	„
38	„	„	6	34·8	507	0·980	„
39	„	„	15	52·3	745	0·965	„
40	„	„	30	81·5	1,135	0·95	Giving loud humming sound of dynamo
41	„	„	45	107	1,605	1·01	Same flaming; very unstable; readings only rough approximations

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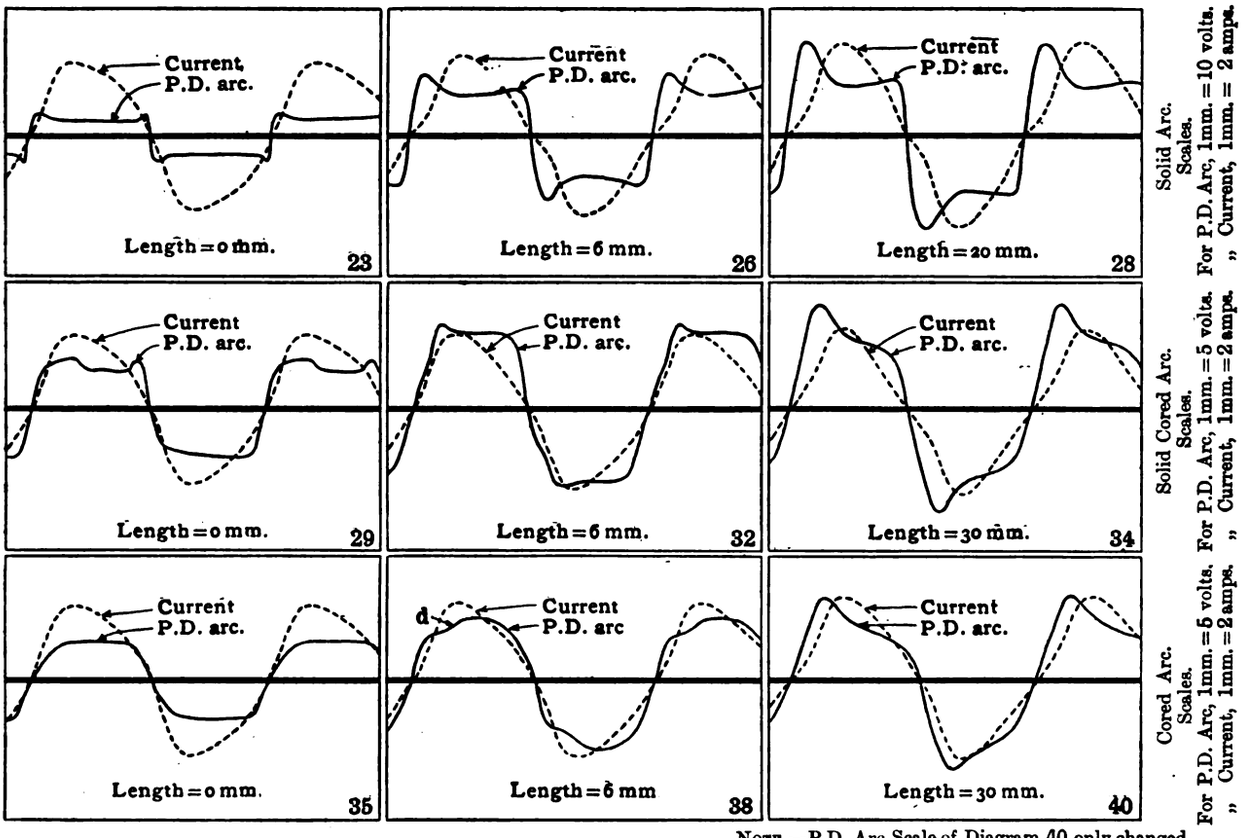
however, seems due to the fact that, owing to the very large internal drop of pressure in this machine, a slight diminution in the current at any instant is accompanied by the large increase in the P.D. between the dynamo terminals. With the solid-cored and cored arcs the effects are similar; but all occur in a much less degree.

The R.M.S. value of the P.D. between the terminals of the alternate-current arc, the power it absorbs and its power factor are not fixed functions of the nature of the carbons, the arc length and the current, but depend also on the nature of the circuit outside the arc. Thus, with the solid arcs (experiments 2 and 6), which are between the same carbons, have the same length and R.M.S. current, and are supplied by the same alternator, the P.D. between the terminals of the arc is reduced 3 volts, or 6 per cent., if resistance in series with the arc be replaced by self-induction, while at the same time the power absorbed by the arc is increased by 9 per cent., with a consequent improvement of the power factor from 0·74 to 0·855. The same effect is also produced if, instead of self-induction in series, a highly inductive alternator supplies the arc (experiment 10). With solid-cored and cored arcs the same changes occur, but to a less extent. The power factors of solid-cored and cored arcs are always higher than those of solid arcs, and for the cored arc are generally very close to unity.

One of the most striking results we have obtained is the great stability and comparative silence of all the arcs we have tried on the inductive Pyke and Harris machine, coupled with their steadiness and high-power factors. We think that, *if a highly inductive alternator, having good efficiency and a steep characteristic, could be built, these machines would be eminently suitable for arc lighting. For then the necessity for choking coils would vanish, and harder carbons, giving, therefore, a much higher luminous efficiency, could be employed without loss of steadiness of the light.*

On Pyke and Harris Alternator.
Carbons, 13mm. "Apostle." Current, 14·8 amperes. Frequency, 97 ~ per sec.
Resistance in series, 0·3 ohm.



Note.—P.D. Arc Scale of Diagram 40 only changed to 1mm. = 10 volts.

Fig. 3.—Effect of Length of Arc.

Section 2.—Effect of Length.

(Figs. and Tables II. and III.)

In order to test the effect of the arc length on the reaction on the wave form, the size and kind of carbons, the current through the arc, the resistance, &c., in series, and the frequency of the impressed E.M.F. were kept constant, while the arc length alone was varied, the current being kept at the same value by changing the dynamo excitation.

With the solid arc on the Ferranti alternator, length 0mm. (experiment 13), the P.D. arc curve has two small peaks connected by a slightly wavy* horizontal portion which we find is characteristic of the sound which the arc produces, the current remaining small for about one-eighth of the period. If we now lengthen the arc, keeping the R.M.S. current through it constant, we find the front peak p on the P.D. arc curve grows higher and higher, while the back peak and waviness in the horizontal portion do not change much, until we reach an arc length of 1mm. (experiment 14), which is a steady hissing arc; in this curve the length of time during which the current remains small has increased to about one-fourth of the period, and has caused the power factor to drop to the low value of 0·63. On still further increasing the length of the arc the peak on the P.D. arc curve no longer increases rapidly, and the time during which the current is small remains about the same (*see* experiment 15), which was with an arc length of 3mm. Experiments 19, 20,* 21 and 22 are with the cored arc. In this case the characteristic change in the P.D. arc curve is that the dent d occupies a relatively higher position up the side of the curve as the arc length is increased. The results with the solid-cored arc (experiments 16, 17 and 18) are much more complicated.

On the inductive Pyke and Harris machine, owing to its higher E.M.F., much longer ranges of arc lengths were obtainable, being only limited by the instability of long arcs. Thus, with the solid arcs on this machine, we were able to obtain a range of lengths from 0mm. to 20mm. (experiments 23 to 28†). In this experiment, as with the solid arc on the Ferranti dynamo, the front peak in the P.D. arc curve increases with the length, but in a more regular manner, while the second or back peak is hardly noticeable when the arc length is more than about 10mm. The current wave form tends to become more triangular in shape as the arc length increases; but this effect, we think, is due to the increase in excitation of the alternator, and not to the change in length of the arc itself, as this machine gives, when sending current through a non-inductive circuit, a more triangular wave when the exciting current is increased.

The effect of change of length with the solid-cored and cored arcs on this machine is illustrated by experiments 29 to 41,‡ the dent d moving up the side of the P.D. arc curve with cored carbons as before, and finally forming a front peak for long-cored arcs. The P.D. arc curve of long solid-cored arcs also has a high front peak.

A point of interest, as measuring in a way the stability of the arcs, is the length at which each arc could be burnt, the frequency, the resistance in series and the arc current, all remaining the same, the corresponding lengths being 20mm. for the solid arc, 30mm. for the solid-cored, and 45mm. for the cored arc. The power factor, in all cases, on both alternators is lowest for hissing arcs, and generally increases with increase of arc length. With solid carbons, however, we find that the power factor has a minimum in our experiments, when the arc length is about 1mm., and the arc is hissing steadily.

In all the long arcs we have tried, whether with solid or cored carbons, we find that the P.D. between the terminals of the arc rises rapidly to a high value after passing through zero, and then falls again almost at once, forming a front peak on the curves. The increase in height of this peak, with increase of arc-length, led us to think that it was connected with the resistance of the gaseous column forming the arc proper, and we, therefore, tried the experiments described in the next section to settle this point.

(To be continued.)

* This waviness has partly disappeared in the reproduction of the curves.

* Diagrams 16, 17, 18 and 20 in Fig. 2 have not been reproduced.

† Diagrams 24, 25, and 27 of Fig. 3 have not been reproduced.

‡ Diagrams 30, 31, 33, 36, 37, 39 and 41 have not been reproduced.

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THE INDUCTION MOTOR.*

BY ERNEST WILSON.

(Concluded from page 827).

Armature Reaction.

Before dealing with the armature or secondary circuit of this motor, it will be well to examine the disturbance produced in the primary induction, as the external resistance ρ is varied from ∞ to zero. The inductions $m_1\int\frac{dI_1}{dt}dt$, $m_2\int\frac{dI_2}{dt}dt$ give the average over a half period $\theta/_2$, and are plotted in Figs. 8 and 9 respectively for values of $\rho=\infty$, 1·07, 0·149 and 0·0095, the frequency being 95 periods per second. It will be seen that the disturbance is not great; it is greatest when $\rho=0{\cdot}0095$. The variation of this average induction for $\rho=0{\cdot}15$ at 52 periods per second can be seen by comparing Table IV. with III.

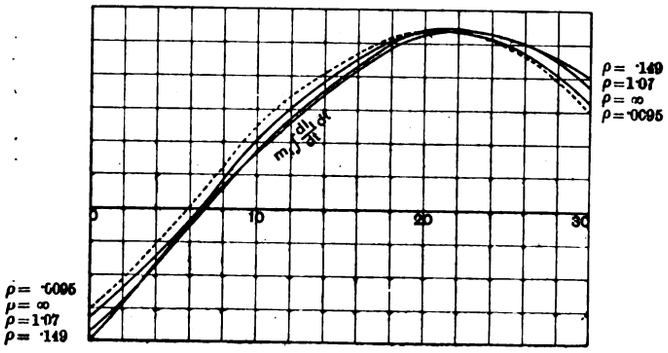

Fig. 8.

We now come to the armature. If the leakage is known, and we have examined it in this motor, it is not difficult to deduce the fe_1dt, fe_2dt and fe_3dt curves when $\rho=\infty$, since there is no disturbance due to armature currents. We have to investigate the relations between these curves for $\rho=\infty$, and when ρ has diminishing values given to it down to zero.

If the ordinary self-induction theory be assumed, and if the coils on the armature were simply closed on themselves and not pooled together as in this three-phase arrangement, the relation could be expressed in the form of the equationse: $_1$ (for $\rho=\infty$)$=(r_1+\rho_1)$ y_1+Li_1; e_2 (for $\rho=\infty$)$=(r_2+\rho_2)$ y_2+Li_2; e_3 (for $\rho=\infty$)$=(r_3+\rho_3)$

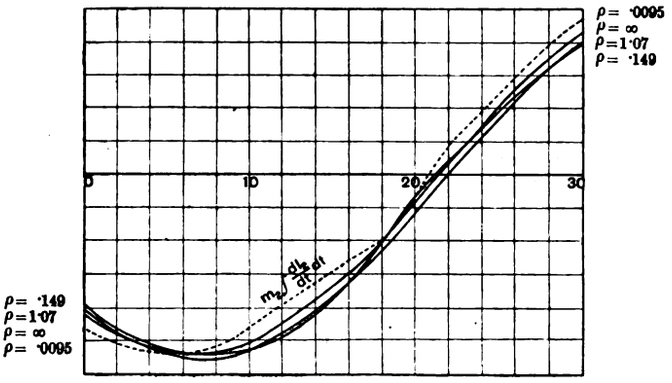

Fig. 9.

y_3+Ly_3; where L is a co-efficient of self-induction. Integrating the above from time 0 to time t and equating periodic parts, we have—

$$\int_0^t e_1\,(\text{for }\rho=\infty)\,dt=\int_0^t(r_1+\rho_1)\,y_1\,dt+\mathrm{L}y_{1t}$$
$$\int_0^t e_2\,(\text{for }\rho=\infty)\,dt=\int_0^t(r_2+\rho_2)\,y_2\,dt+\mathrm{L}y_{2t}$$
$$\int_0^t e_3\,(\text{for }\rho=\infty)\,dt=\int_0^t(r_3+\rho_3)\,y_3\,dt+\mathrm{L}y_{3t}$$

If the epochs be chosen when y_1 y_2 y_3 are zero, the last term in each equation vanishes.

In our case the electromotive force of an armature coil is not $(r+\rho)$ y at any moment owing to the influence of the respective coils on one another. The extent of this disturbance can be judged by an examination of the phase difference between e_1 and y_1, e_2 and y_2, and e_3 and y_3 in each case (*see* Tables IX. and XIV.). But by variation of L we may write—

e_1 (for $\rho=\infty$)$=e_1$ (for $\rho=a$)$+\mathrm{L}y_1$; e_1 (for $\rho=\infty=e_1$ (for $\rho=b$)$+\mathrm{L}y_1$ where $a\,b$ — — — are the values of ρ in the acual experiments. In these cases also when $y_1=0$ we have—

$$\int_0^t e_1\,(\text{for }\rho=\infty)\,dt=\int_0^t e_1\,(\text{for }\rho=a)\,dt$$
$$\int_0^t e_1\,(\text{for }\rho=\infty)\,dt=\int_0^t e_1\,(\text{for }\rho=b)\,dt$$

and so on for e_2 and e_3.

Now the curves e_1, e_2, e_3, for $\rho=\infty$, a, b, — — — obtained at frequencies 52 and 95 (see Tables V., VI., VII., VIII., X., XI., XII., XIII.), have been integrated, and the difference between the ordinates (when $y_1=0$) of fe_1 (for $\rho=\infty$) dt and fe_1 (for $\rho=a$, b — — —) dt, which on the theory should be zero, is *not* zero. It appears that as ρ is varied the fe_1 (for $\rho=\infty$) dt curve must be increased to cut the other when $y_1=0$, up to the value of ρ corresponding to maximum torque, but that after this with $\rho=0{\cdot}01$ ohm, the fe_1 (for $\rho=\infty$) dt curve has to be decreased to cut the other curve when $y=0$; and so for e_2, e_3. The extent to which the ordinates have to be altered is given in Table XV. for the frequencies 52 and 95.

If the ordinates of the curve fe_1 (for $\rho=\infty$) dt be increased or decreased according to the difference found in this way (when $y_1=0$), for the different positions of the phase, then the relation between such modified curve and fe_1 (for $\rho=a$, b — — —) dt is to be accounted for by the term L y_1 and so for e_2 and e_3. This has been done for different positions of a half period and the value of L deduced. The collected results are given in Table XVI. Fig. 10 gives one set of curves, and Table XVII. shows how L has been deduced. The values of L are not constant, but as ρ is decreased we see that L becomes somewhat smaller. This may be connected with the disturbances shown in Figs. 8 and 9. The maximum value of L is $1{\cdot}8\times10^{-6}$ C.G.S.

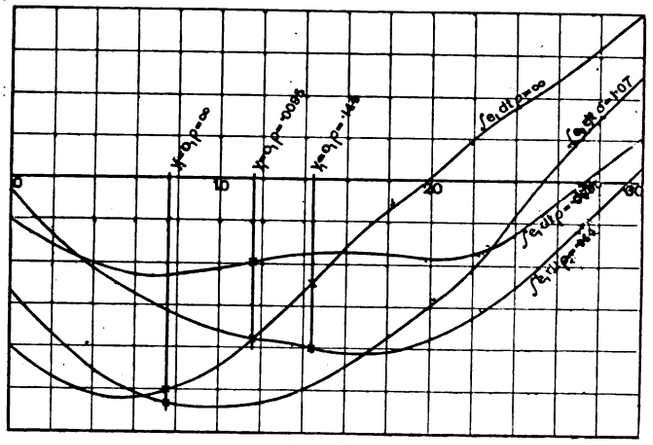

Fig. 10

units according to the experiments. We can calculate the value of L approximately from the magnetic circuit of this motor. The area enclosed by one armature coil is measured and found to be 280 sq. cm. The length of the air space can be taken to be 0·175cm. Then the induction due to unit current-turn (C.G.S.) is approximately 4π 280/0·175$=$20,110 C.G.S. units.

The reaction will be that due to the rate of change of this flux multiplied by 6 $(n/6)^2$, where $n/6$ is the number of turns per coil, there being six coils in series. In this armature $n=24$, so that $\mathrm{L}=6\times16\times20{,}110=1{\cdot}9\times10^6$ C.G.S. units as against $1{\cdot}8\times10^6$ found in the experiments.

This, then, gives an account of the armature reaction in this motor. Its effect is to increase and then decrease electromotive force as the external resistance ρ is varied as shown in the experiments.

An examination of the results in Tables IX. and XIV. shows that as ρ is decreased, the phase difference between e_1, e_2, e_3 (for $\rho=\infty$) and the currents y_1, y_2, y_3 increases up to the point of maximum torque; after this the effect at 52 periods per second is to slightly increase phase difference, but at 95 periods per second phase difference is decreased. The currents are not displaced a quarter period, in which case their demagnetising effect for a given current would be greatest. One has only to examine Tables VIII.* and XIII. to see how violent the reactions are when ρ has the smallest value. The torque fluctuates in any coil between positive and negative values; the effect is a differential one: on

* Paper read before the Institution of Electrical Engineers, March 9.

* The experiments in this Table were very difficult to perform owing to the rapid heating of the alternators—the load was so excessive. It will be seen that the instantaneous value of $y^1+y^2+y^3$ is not always zero. However, the deductions are amply borne out by Table XIII., which is well up to the average accuracy of these experiments.

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the whole there is a small positive torque. If we consider $r+\rho$ the independent variable, and the torque the dependent variable we have for large values of $r+\rho$ the currents y practically in phase with impressed electromotive force e (for $\rho=\infty$): the torque is small because y is small. As $r+\rho$ decreases the angle of lag of y increases, it is true, but y also increases, and we have seen that the electromotive force e (for $\rho=\infty$) is also increased by armature reaction as distinct from self-induction pure and simple; the torque increases. This goes on until the torque has a maximum value. After this, on further reduction of $r+\rho$ until $\rho=0{\cdot}01$ ohm, although phase difference is not greatly altered (it may even be decreased) the current y is increased; armature reaction diminishes the electromotive force very greatly, with the result that the torque decreases.

During these experiments I have received help from Messrs. Greenbank, Davey, Renfree, and Poole, past and present student demonstrators in the Siemens Laboratory, King's College, London. To these gentlemen I tender my thanks. I wish specially to acknowledge the assistance I have received from Mr. Renfree in the working out of results.

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"*Geschichte der Physikalischen Experimentierkunst*," by Dr. E. Gerland and Dr. F. Traumüller. (Leipzig: Wilhelm Engelmann). Price 14m.

"*Transactions* of the American Institute of Civil Engineers." No. 1, Vol. XVI., January, 1899. (New York: Published by the Institute.) Price 50 cents.

"The Official Gazette of the United States Patent Office." Nos. 12 and 13, Vol. LXXXVI. Published by authority of Congress. (Washington: Government Printing Office.)

"Fortschritte der Angewandten Elektrochemie und der Acetylen-Industrie im Jahre, 1898," by Dr. Franz Peters. (Stuttgart: Arnold Bergsträsser).

"The Slide Rule," by Charles N. Pickworth. Fifth Edition. (London and Manchester: Emmott and Co.). Price 2s.

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ELECTRICITY WORKS ACCOUNTS.

Bradford Municipal Electric Supply Works.

Having started supply in September, 1889, the Bradford municipal electricity Supply undertaking has now completed its ninth year of working.

During 1898, the accounts for which are analysed in the first table, the loan capital has been increased by £42,600 borrowed, £40,000 at 3 per cent., and the balance at rates from 2⅞ per cent. to 2¾ per cent. Of the total amount of £167,312 borrowed, £6,525 has been repaid. The expended capital has increased by £28,353, and the total now stands at £170,225, representing £61·5 per kilowatt of plant available for generating purposes.

The business appears to be increasing at a very satisfactory rate judging from the increased output, which exceeded that of 1897 by as much as 42·9 per cent. The average price obtained per unit comes out at the very moderate figure of 3·6d., the total revenue from all sources being 3·75d. per unit. Notwithstanding the moderate tariff, however, the expenditure is no higher than 42·9 per cent. of the revenue, and at 1·61d. per unit for total costs, is something like 0·5d. *below* the average for municipal stations of similar output during 1897. This result is an excellent one, especially considering that, included in this figure for the total costs at Bradford there are charges which, though perhaps chargeable in the revenue account, appear somewhat unfairly therein to the extent they do. It will be noticed that in the item "Repairs, renewals of mains, &c." there is a sum of £669 to "Incandescent lamps for free supplies." Then there is under "Management" £698 to "bank interest and commission." These two sums together represent 0·23d. per unit, and this, deducted from the 1·61d., we have 1·38d. as the remaining total costs. The fuel costs, at 0·327d., is more than a ¼d. below the average of similar stations, and generating costs, at 0·794d., compare very favourably with 1·25d., the approximate average (for 1897) for stations with an output of 1,419,000 units in the year. These costs, in combination with the low expenditure on capital account, are results of which Bradford has every reason to be proud. No doubt the tramways, as a customer, contribute substantially to the economy effected, but it should be noted that the load factor is not above or up to the average.

Turning to the financial results, the working profit for the year was £12,678, representing 8·12 per cent. of the mean capital. Out of this was paid £3,249 to the depreciation fund, £4,730 to reserve, and £3,350 as interest on the loans. There is thus a balance which, with £9,425 from the previous year, amounts to £10,827.

Newcastle-upon-Tyne Electric Supply Co. (Limited).

The date of commencement of supply being in 1889 the undertaking of the Newcastle-upon-Tyne company has completed with 1898 its ninth year of working. Since the last accounts £6,854 of share capital has been paid up, raising the total received capital to £78,149. The total amount expended is about £98,183, or £75·5 per kilowatt of generating plant. With a 34 per cent. increase in the equivalent lamp connection the output has risen from 660,906 to 803,789 units sold, or about 22 per cent.

The average revenue from supply was 3·87d. per unit sold, or counting all sources 4·375d. Owing to the meagre information contained in the abstract of the accounts supplied us we are unable to separately render the items of expenditure either on capital account or out of revenue. It will be seen that the works costs show a sensible improvement over those of 1897, and that they are well below the average in company undertakings of equal annual output. The management and property charges have increased, but not by much, and the costs are still below the average of similar stations.

There is an item in the net revenue account which we have, following the original accounts, kept out of the works expenditure account. This item is one of £1,295 to "special expenditure on dynamo reconstruction, &c, during year." As will be seen we have included this £1,295 with the £1,000 paid to depreciation and reserve. The working profit for the year was £8,140, and this with a balance of £652 from 1897 has enabled an ordinary dividend of 8 per cent. to be paid after satisfying the interest charges.

Arrangements are in progress for increasing the capacity of the station and also for giving a continuous current supply for power and other purposes. To meet the expenditure thus entailed an issue of 8,000 new shares has been made.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	1899	Jan. 6	Kensl'gton & Knightsbr' (Co.)	'99	Mar. 3
Ayr (Municipal)	1898	Nov. 11	Kingston-upon-Hull (Mun.)	1898	Aug. 19
Bedford (Municipal)	,,	Mar. 4	Kingston-on-Thames (Mun.)	,,	Mar. 25
Belfast (Municipal)	,,	Sept. 23	Lancaster (Municipal)	,,	Oct. 21
Birmingham (Company)	,,	Dec. 16	Leeds (Company)	1899	Mar. 3
Blackpool (Municipal)	,,	Oct. 7	Leicester (Municipal)	,,	Jan. 20
Bournemouth (Company)	,,	June 3	Leyton (Municipal)	1898	Sept. 23
Bolton (Municipal)	,,	Dec. 9	Liverpool (Municipal)	,,	Aug. 12
Bradford (Municipal)	,,	May 20	Manchester (Municipal)	,,	July 29
Brighton (Municipal)	,,	May 6	Newcastle and District (Co.)	,,	Dec. 2
Bristol (Municipal)	,,	July 29	Newcastle-upon-Tyne (Co.)	,,	April 29
Burnley (Municipal)	,,	Sept. 16	Northampton (Company)	,,	April 15
Burton-upon-Trent (Mun.)	,,	April 15	Norwich (Company)	,,	Dec. 2
Bury (Municipal)	,,	Nov. 25	Notting Hill (Company)	1899	Mar. 17
Cambridge (Company)	1899	Mar. 10	Nottingham (Municipal)	1898	Oct. 23
Cardiff (Municipal)	,,	Jan. 6	Oldham (Municipal)	,,	Nov. 18
Charing Cross (Company)	,,	Mar. 17	Oxford (Company)	,,	April 1
Chelsea (Company)	,,	Mar. 31	Portsmouth (Municipal)	,,	Nov. 4
Cheltenham (Municipal)	1898	Oct. 7	Preston (Company)	,,	Oct. 28
Chester (Municipal)	,,	Oct. 14	Reading (Company)	,,	Sept. 16
Clerkenwell (Company)	,,	Mar. 18	Richmond (Company)	,,	Mar. 4
Derby (Municipal)	,,	Dec. 9	Scarborough (Company)	,,	April 1
Dewsbury (Municipal)	,,	Nov. 25	St. James' & Pall Mall (Co.)	1899	Feb. 24
Dover (Company)	,,	Mar. 11	St. Pancras (Vestry)	1898	May 13
Dundee (Municipal)	,,	Nov. 4	Sheffield (Company)	,,	Dec. 16
Eastbourne (Company)	,,	July 22	Shoreditch (Vestry)	,,	May 27
Edinburgh (Municipal)	,,	Oct. 14	Southampton (Municipal)	,,	June 3
Exeter (Municipal)	,,	Aug. 5	Southport (Municipal)	,,	Dec. 23
Glasgow (Municipal)	,,	Aug. 12	Stafford (Municipal)	,,	Oct. 21
Guildford (Company)	,,	May 13	Sunderland (Municipal)	,,	Aug. 19
Halifax (Municipal)	,,	Nov. 13	Taunton (Municipal)	,,	Aug. 5
Hammersmith (Vestry)	,,	June 10	Tunbridge Wells (Mun.)	,,	July 22
Hampstead (Municipal)	,,	Sept. 9	Walsall (Municipal)	,,	Nov. 11
Hanley (Municipal)	,,	April 8	Wandsworth (Company)	,,	Mar. 18
Harrogate (Municipal)	,,	Dec. 30	Westminster (Company)	1899	Feb. 24
Harrow (Company)	,,	Sept. 9	Whitehaven (Municipal)	1898	Dec. 23
Hast'gs & St. Leonard's (Co.)	,,	April 29	Windsor (Company)	,,	Dec. 30
H'use-to-H'use Co. (K'ns'gt'n)	1899	Mar. 31	Wolverhampton (Municipal)	,,	July 15
Hove (Company)	,,	Mar. 10	Woolwich (Company)	1899	Jan. 13
Huddersfield (Municipal)	1898	Mar. 25	Worcester (Municipal)	,,	April 7
Islington (Vestry)	,,	June 24	Yarmouth (Municipal)	1898	June 17

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	BRADFORD.		NEWCASTLE-UPON-TYNE.	
Undertaking Worked by	Bradford Corporation.		Newcastle-upon-Tyne Electric Supply Co. (Ltd.)	
Date of Commencement of Supply	September, 1889.		1889.	
System of Supply	3-wire with batts. on one side only, other supplied		Alternate-current transformers in houses and	
Chief Engineer	A. H. Gibbings.	[through motor-generator.	R. C. Jackson.	[sub-stations
YEAR ENDED	DEC. 31, **1897.**	DEC. 31, **1898.**	DEC. 31, **1897.**	DEC. 31, **1898.**
QUANTITIES—				
Units generated	1,104,496	1,568,459	1,054,660	1,275,233
,, **SOLD (TOTAL)**	993,588	1,419,306	660,906	803,789
,, sold to consumers	977,120	1,387,015[d]	631,798	774,788
,, sold for public lighting, &c.	16,468	32,291	29,108	29,001
,, used on works	21,658	33,369	18,356	18,884
UNITS SOLD PER 8 C.P. LAMP CAPACITY	11·0	16·4	24·5	19·8
Maximum supply demanded	1,123 kilowatts	1,589 kilowatts	—	853 kilowatts
Number of public lamps	12 arc	20 arcs, 11 glow	14	14
Number of consumers	620	—	—	788
Connections to mains in 8-c.p. lamps	60,000	—	40,000	53,500
CAPACITY OF PLANT IN 8-C.P. LAMPS	90,000	86,600	27,000	40,600
CAPACITY OF PLANT IN KILOWATTS	2,803	2,769	890	1,300
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£120,000 / £42·9	£165,194 / £59·7	£100,000 / £112	£100,000 / £76·9
Share	— / —	— / —	100,000 / 112	100,000 / 76·9
Loan (including Debenture charges)	120,000 / 42·9	165,194 / 59·7	— / —	— / —
RECEIVED (TOTAL)	126,290 / 45·0	170,096 / 61·5	71,295 / 80·1	78,149 / 60·1
Share	— / —	— / —	46,295 / 52·0	53,149 / 40·9
Loan (including Debenture charges)	124,712 / 44·5	167,312 / 60·43	25,000 / 28·1	25,000 / 19·2
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	−4,712 / −1·68	−4,902 / −1·77	53,705 / 60·4	— / —
Share (unissued)	— / —	— / —	53,705 / 60·4	46,851 / 36·1
Share (uncalled)	— / —	— / —	nil	— / —
Loan (including Debentures)	−4,712 / −1·68	−4,902 / −1·77	— / —	— / —
REPAID (TOTAL)	5,700* / 2·04	6,525* / 2·36	nil / —	— / —
RESERVE OR SINKING FUND	1,461 / 0·521	2,392 / 0·864	2,200 / 2·47	7,700 / 5·92
DEPRECIATION FUND	— / —	— / —	81,733 / 91·9	98,183 / 75·5
EXPENDED (TOTAL)	141,872 / 50·7	170,225 / 61·5		
Lands and buildings	27,203 / 9·70	27,861 / 10·06	81,073 / 91·1	— / —
Plant	49,744 / 17·8	57,363 / 20·70		
Mains	58,498[a] / 20·9	74,056 / 26·7		
Miscellaneous	6,427[e] / 2·30	10,946[e] / 3·955	660 / 0·742	— / —
BALANCE OF CAPITAL ACCOUNT	−15,582 / −5·57	−130 / −0·047	−10,438[e] / −11·7	−20,034[e] / −15·4
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£19,444 / 4·690d.	£22,204 / 3·754d.	£12,680 / 4·600d.	£14,642 / 4·375d.
Revenue from supply	18,553 / 4·480d.	21,299 / 3·603d.	11,100 / 4·030d.	12,965 / 3·873d.
,, meters, &c.	498 / 0·120d.	641 / 0·108d.	983 / 0·359d.	1,079 / 0·322d.
,, public lighting	— / —	— / —	588 / 0·214d.	588 / 0·176d.
,, sale of lamps, &c.	95 / 0·023d.	106 / 0·018d.	2 / 0·001d.	1 / —
,, miscellaneous sources	298[b] / 0·072d.	159 / 0·027d.	3 / 0·001d.	9 / 0·003d.
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£8,210 / 1·980d.	£9,525 / 1·610d.	£5,804 / 2·110d.	£6,504 / 1·944d.
WORKS COSTS	5,710 / 1·380d.	5,970 / 1·009d.	4,225 / 1·530d.	4,515 / 1·349d.
Generation of electricity	*3,889 / 0·939d.*	*4,694 / 0·794d.*	*3,517 / 1·280d.*	*3,947 / 1·180d.*
Fuel (including cartage, &c.)	1,555 / 0·375d.	1,932 / 0·327d.		
Oil, waste, water, stores	426 / 0·103d.	461 / 0·078d.		
Wages at station	1,254 / 0·302d.	1,562 / 0·264d.	3,517 / 1·280d.	3,947 / 1·180d.
Repairs and maintenance at station	654 / 0·158d.	739 / 0·125d.		
Distribution of electricity	*1,653 / 0·398d.*	*1,148 / 0·194d.*		
Wages, &c.	532 / 0·127d.	263 / 0·045d.		
Repairs, renewals of mains, &c.	1,121 / 0·270d.	885[g] / 0·150d.		
Public lighting	*168 / 0·041d.*	*128 / 0·022d.*	708 / 0·257d.	568 / 0·170d.
Attendance	168 / 0·041d.	128 / 0·022d.		
Renewals	— / —	— / —		
MANAGEMENT AND PROPERTY CHARGES	2,500 / 0·603d.	3,555 / 0·601d.	1,579 / 0·574d.	1,989 / 0·594d.
Royalties	— / —	— / —	*nil* / —	— / —
Rent, rates, taxes	*779 / 0·188d.*	*1,142 / 0·193d.*	*310[a] / 0·113d.*	*391[a] / 0·117d.*
Management	*1,721 / 0·415d.*	*2,413 / 0·408d.*	*1,269 / 0·461d.*	*1,598 / 0·478d.*
Salaries	780 / 0·188d.	1,025 / 0·173d.		
Stationery, &c.	138 / 0·033d.	142 / 0·024d.		
Establishment charges	485 / 0·117d.	459 / 0·078d.	1,269 / 0·461d.	1,598 / 0·478d.
Law charges, &c.	318[c] / 0·077d.	787[f] / 0·133d.		
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£11,234 / 8·98%	£12,678 / 8·12%	£6,400[b] / 8·10%	£8,140 / 9·05%
Sum carried to Depreciation Fund	2,685 / 2·15%	3,249 / 2·08%		
Sum carried to Reserve or Sinking Fund	3,338 / 2·67%	4,730 / 3·03%	1,200 / 1·52%	2,295[f] / 2·55%
Net interest on loans (incl. Debenture charges)	2,913 / 2·33%	3,350 / 2·15%	1,450 / 1·84%	1,476 / 1·64%
BALANCE FROM LAST ACCOUNT	7,546 / 6·03%	9,425 / 6·04%	110 / 0·139%	652 / 0·725%
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	9,425 / 7·54%	10,327 / 6·62%	3,797[c] / 4·81%	5,021 / 5·58%
Deficit	— / —	— / —	— / —	— / —
ORDINARY DIVIDEND PAID	— / —	— / —	7% / —	8% / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	42·2%	42·9%	45·8%	44·4%
Expenditure per kilowatt capacity	£2. 18s. 7d.	£3. 8s. 10d.	£6. 10s. 5d.	£5. 0s. 0d.
REVENUE PER KILOWATT CAPACITY	**£6. 18s. 10d.**	**£8. 0s. 5d.**	**£14. 5s. 0d.**	**£11. 5s. 2d.**
Expenditure per 8-c. lamp capacity	1s. 10d.	2s. 2½d.	4s. 3½d.	3s. 3d.
REVENUE PER 8-C.P. LAMP CAPACITY	**4s. 3⅜d.**	**5s. 1½d.**	**9s. 4½d.**	**7s. 2½d.**
REVENUE PER 8-C.P. LAMP CONNECTED	**6s. 5⅝d.**	—	**6s. 4d.**	**5s. 5⅝d.**
Price charged for lighting, per unit	5d.	4½d.[h]	4½d.[d]	4½d.[g]
Price charged for power, per unit	2½d.	2½d. to 1d.[h]	3d.	2d. to 3d.
Price charged for public lighting	nil	—	£42.	By contract.

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THE WEHNELT INTERRUPTER.

In days gone by, a new discovery or invention was frequently left almost unheeded by the scientific world until the inventor himself had developed it, and had, with the utmost pains, succeeded in convincing others of its value and importance. Nowadays, the mere publication of the result of an investigation or an experiment will sometimes suffice to awaken general interest, and will incite scientists, from those at the top of the tree down to the humblest students, to repeat the experiments and to extend them, seeking, if a new principle has been discovered, a wider bearing for it, analogies to it, and further elucidations of it; and, if it be a new invention, endeavouring to extend its utility and application. Whether these workers are impelled solely by the true spirit of philosophic inquiry, viz., by the desire to dive further into the secrets of nature, or whether their wish is the more worldly one of having their names associated in some way or another with what may be a great invention, it would be invidious to ask. It is enough that the motive is there, and may produce valuable results. Although the discovery by Dr. Wehnelt of the electrolytic interrupter cannot be compared in importance with, for instance, that of Röntgen rays or of the means of practically employing Hertzian waves for telegraphic purposes, it is eliciting almost as much experimental investigation as the former, and even more than the latter. The reason, evidently, is that Wehnelt's apparatus can be reproduced simply and cheaply, and that the results to be obtained from its two pieces of metal dipping in dilute sulphuric acid are almost as unexpected and startling as was the discovery of the amount of energy contained in one element of Volta's *couronne de tasses.*

The form of interrupter used by Wehnelt himself consisted of an anode of platinum and a cathode of lead, contained in a beaker of dilute sulphuric acid. It being essential that the exposed surface of the anode should be small, a platinum wire sealed into a glass tube and projecting a few millimetres into the acid was employed, the tube being filled up with mercury. This simple cell, placed, instead of the usual interrupter, in series with the primary of an induction coil, effectually broke the circuit automatically over a thousand times a second. Twelve volts sufficed to make the cell work as an interrupter, but to get these high frequencies of interruption a larger voltage was necessary, the frequency increasing with the

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voltage. The apparatus has only been altered as to small matters of detail by subsequent experimenters. Most have found that the glass tube which surrounds the anode breaks off, owing either to the intense heat or to the mechanical force acting on it, and an ebonite tube or a tube with an ebonite stopper has been substituted. M. D'Arsonval, however, prefers to employ a test-tube in place of the beaker, and to bring the platinum wire through the glass at the bottom. The use of a copper wire soldered to the platinum, in place of the mercury connection, has also been preferred, and some have constructed multipolar interrupters, while Prof. Silvanus Thompson has found that the regularity of interruption is improved by causing a jet of air to flow rapidly past the anode. From the first, Wehnelt observed that inductance in the circuit, so far from being a disadvantage, actually helped the effect, and that a higher voltage was necessary if no inductance was added. This was confirmed by subsequent experimenters, and gave rise to the explanation that the phenomenon was essentially one of resonance. Prof. Thompson, in his letter published in our columns, was among the first to explain how this was so. The evolution of the gas on the small surface of the anode sufficed to cause the initial instability, and the capacity of the anode, together with the self-induction in the circuit, kept up an oscillatory current. M. Blondel has found, however, that investigation into the cause of the Wehnelt effect was one eminently suited to his oscillograph, and the result of his researches, which we publish in another column of this issue, appears to afford a good explanation of the recondite phenomenon. Some other remarkable observations remain to be elucidated, however. Mr. Campbell Swinton has found that the fatigue, which sets in after about a quarter of an hour's working, is not due to the heating of the electrolyte, as it is not eliminated by placing the cell in a water bath, and Dr. D. K. Morris has succeeded in temporarily removing the fatigue by merely reversing the current. Mr. Beattie has measured the frequency by observing with a dynamometer the condenser current flowing into a condenser shunted across the cell, and he finds that it does not correspond with the note emitted by the arc. Mr. Beattie necessarily assumed a simple periodic current, and the discrepancy is explained by an examination of M. Blondel's curve. Mr. Hill's observation that hydrogen as well as oxygen can be collected at the anode and his explanation of it may be also noted. Possibly this may imply a reversal of the current, but with equal probability, we think, it may be associated with the remarkable reversal of the ions of H and O observed by Prof. J. J. Thomson in the electrolysis of steam.

Coming now to the probable usefulness and applicability of Wehnelt's device. Prof. Lodge, at the Physical Society, dispelled the idea that the new interrupter would improve Hertzian wave telegraphy to any extent, but its effect on X-ray work appears invaluable. All workers testify to its decreasing the time of exposure required, and to its eliminating the troublesome flickering observed on the fluorescent screen. Then, as pointed out by Mr. Brooks in our last issue, and also by Prof. Elihu Thomson, it renders possible the use of alternating current mains for working the induction coil, with the same simplicity as when utilising the continuous current supply, and its importance in this respect to the medical profession is hard to over-estimate. In other directions also the Wehnelt interrupter is likely to prove of value. Alternating or rapidly-interrupted currents are frequently required for lecture demonstrations in buildings supplied only with continuous current. Prof. Elihu Thomson has also worked a welding transformer by its means, and he even describes how a Wehnelt electrolytic musical box may be constructed, which last may prove useful as a lecture room experiment, but will have, we sincerely hope, no direct practical utility. Prof. Fleming has found, at the expense of considerable repairs to his Tesla coil, that a Wehnelt interrupter in the primary circuit of the first induction coil greatly exalts the electromotive force at the secondary terminals of the Tesla coil.

In addition, therefore, to providing a pretty scientific toy, Wehnelt's discovery is destined to be of great value, both in aiding pure scientific investigation and as a useful adjunct in at least one of the most important recent applications of electrical science.

REVIEWS.

Electro-Dynamics. The Direct-Current Motor. By C. A. Carus-Wilson. (Longmans, Green and Co., London. 1898.)

Since his Paper on "The Design of Electric Railway Motors for Rapid Acceleration" was read before the Institution last year, the author's general method of treating electric motor problems is well known to electrical engineers. The work, the subject of this notice, may be characterised as a more complete discussion of the general subject of the continuous-current motor from the same standpoint as was taken up in the Paper referred to. A certain knowledge, by the student, of the use of the elements of design of motors is taken for granted, and the first chapter rapidly gets under way with a discussion and definition of the quantity christened by the author the "induction factor." The first and third chapters are thus taken up. Between them is sandwiched a chapter on "The Conditions of Uniform Motion," which is quite interestingly written, and contains on pages 24 and 25 a very clear discussion of the essential identity of the two kinds of communication of energy, viz., as heat and as work. Next, the peculiarities of shunt and series-wound motors are separately discussed in so far as they affect traction problems. Chapter VI., treating of "Efficiency," is a useful discussion of the subject, and deals clearly with the practical testing and with the analysis of the various losses in motors.

The "Force Factor" is another term for which the author is responsible. There seems more sanction for the introduction of this special term than for "Induction Factor" from the importance which the former quantity bears in relation to electric traction and the adequate rating of motors; this factor really stands for the quantity "watts per revolution per second." The author takes the view that this latter expression, as also "volts per revolution per second"—the equivalent of what he calls the "Induction Factor"—is misleading or inappropriate, as involving the idea of motion, whereas in his treatment of the subject the static conditions of the traction motor is of almost primary importance. There is a valuable chapter dealing with the subject of motor control; the examples and quantities used to illustrate the discussion in this chapter, and, indeed, throughout the book, are so often taken from actual practice, or the results of actual tests, that the various data and curves have an intrinsic interest and value apart from their primary function.

We are surprised to note that the word "tension" is exclusively used to denote what we usually term pressure, and that resistance or "C. R." drop is referred to as "heat drop." We congratulate the author on the general lucidity and the freedom from errors or misprints, and not least on the instructive data which he has included in the book. While, probably, practised engineers will prefer to interpret the expressions and symbols into forms they are more accustomed to before using them; nevertheless, the work should prove very useful on this special subject, and an excellent course to the student.

Canalisations Electriques. Lignes Aériennes Industrielles. By R. V. Picou. (Paris: Gauthier-Villars and Masson and Cie.)

In the present state of the electrical industry there is room for technical books with a narrow scope, dealing more fully with some special point in connection with electrical engineering than a treatise of more general character can do. An

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excellent example of this specialised literature is the small volume before us, which forms one of an "Encyclopédie Scientifique Aide-Mémoire," published under the direction of M. Léauté. As the sub-title implies, the book is not devoted to electrical networks generally, but only to overhead lines; and for some reason, which we fail to understand, the word "industrielles" seems to confine the author to electric light and power lines, and to exclude telegraph and telephone conductors. The subject treated is still further narrowed by the omission of any reference to that special branch of line construction employed on tramways. Even with this limited range, however, this book should prove most useful, as it instructs the reader thoroughly in the mechanical design of a pole-line, and contains practical hints as to the choice of the material and its erection. There are, of course, some points in the book which are open to criticism, and others which may not coincide with the views and practice (limited, we allow) in this country. Among the former we may mention the unscientific mode of expression, applied to a lightning conductor, "C'est sa self-induction seule qui s'oppose à l'écoulement du fluide"; and among the latter, a paragraph on the needlessness of soldered joints in most cases.

Specification. No. 3. February—May, 1899. (London: The Proprietor of "The Builders' Journal and Architectural Record."

This publication, hitherto a quarterly, is now, commencing with the present number, to be issued half-yearly, the publishers finding that the immense amount of labour involved in the production of a work of over 600 pages renders it quite impossible to continue on the original plan. An additional number of interesting and useful articles appear in this issue. One of these, entitled "A Country House Electric Light Installation," by K. S. MacKinlay, is thoroughly good for its length, being well and concisely written. The section, entitled "Electrician," has been enlarged from about eight pages to about twenty-one. The new matter is chiefly the Board of Trade, Fire Office, the London Building Act and other regulations relating to electric lighting.

Of less direct interest to electrical engineers is a technical description with sections of the Leyton pressed sludge and dust destructor, by William Dawson, M I.C.E., the engineer and surveyor to the Leyton District Council. There are also some valuable hints anent pile-driving in the form of a report by the committee of the American Association of Railway Superintendents of Bridges and Buildings. Although the matter contained in this number is probably double that in the preceding number, the bulk of the book has been kept within limits by utilizing the blank pages hitherto left for notes. There is no doubt that the work as it is will prove a valuable acquisition to engineers, architects and surveyors.

INDUCTION MOTOR DIAGRAMS.

BY C. C. HAWKINS, M.A.

(*Concluded from page 612.*)

If the above results be now examined from the basis of a single resultant field actually existing, it is seen that not only is the maximum field passing through the armature reduced below that which would be due to the primary current alone, *i.e.*, is reduced to the value corresponding to e, but that it is again reduced to the value corresponding with $e \cos \phi_a$, and its phase is shifted backwards, so that the lines enter the armature with a lag ϕ_a behind the normal to the wattless magnetising current be, and with a still greater lag behind the normal to the total primary current. So long as there is an induced E.M.F. in the armature there are no actual lines produced by the armature current across the air-space in the resultant field, but the effect of leakage may be conveniently considered on the basis of two superposed fields, as if the armature current actually produced lines in the air-space and so had self-induction. Really the lag of entry continues to approach 90deg. until standstill of the motor occurs, and the resultant field through the armature becomes weaker and weaker as it becomes more and more distorted. The field wires do, however, actually have self-induction, the E.M.F. thereby produced being at right angles to the *total** field-current and increasing simply in proportion to it.

In Figs. 22-27 are drawn a number of diagrams for the same motor as in Part I., in which $R_f = 0{\cdot}75$, and $R_a a^2 = 0{\cdot}5$, the number of phases of the field and armature circuits and their numbers of turns being taken into account by the ratio of transformation a, so that whatever back E.M.F. is produced in the field, the induced E.M.F. in the armature is reckoned on the same basis. The variable that must be fixed for each diagram is the speed of the armature or which amounts to the same, the slip which determines the frequency f_1 of the armature currents.

With no current in the secondary, a magnetising current of 26·3 amperes produced such a field that the total back E.M.F. due to it is 100 volts. Out of the total number of lines, it has been assumed that 15 per cent. leak through the air without entering the armature, so that the self-induced E.M.F. in the primary is to the useful back E.M.F., as 15:85. Thus, for each ampere of magnetising current, we have a useful back E.M.F. of $\frac{85}{26{\cdot}3}$ volts $= 3{\cdot}23$ volts; and for each ampere of total current (any eddy-current component excepted) we have a self-induced E.M.F. of $\frac{15}{26{\cdot}3} = 0{\cdot}57$ volts.

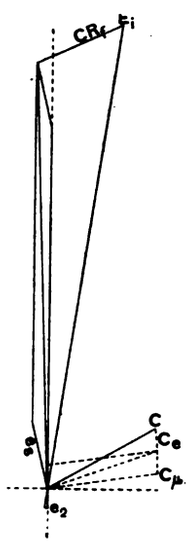

FIG. 22.—No load. 968 revs.
$x = 8°$. $\phi = 51{\cdot}6°$. $a = 8{\cdot}5°$.

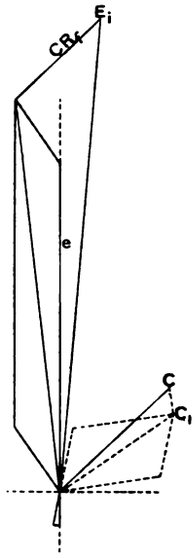

FIG. 23.—900 revs.
$x = 6{\cdot}25°$. $\phi = 41{\cdot}8°$. $a = 5°$.

The impressed E.M.F. is to be 100 volts, while the speed of synchronism is 1,000 revolutions per minute. Let the motor be 6-pole, so that the frequency of the field is $f = \frac{pN}{60}$ $= \frac{3 \times 1{,}000}{60} = 50$ cycles per second. Since the self-induced E.M.F. with no current in the secondary is 15 volts, and is $= 2\pi f C_\mu L$, the inductance of the field is $L = \frac{15}{2\pi \times 50 \times 26{\cdot}3} =$ ·00182. The inductance of the armature, L_a, reduced to the primary system, must with drum-winding be practically the same as that of the field, and we assume it therefore to be the same, viz., $L_a a^2 =$ ·00182. Take any speed of the armature, say 800 revolutions, then the slip is $\frac{200}{1000} = 0{\cdot}2$, and the frequency of the currents in the armature is $f_1 = sf = 0{\cdot}2 \times 50 = 10$. If ϕ_a be the angle of lag in the armature, $\tan \phi_a = \frac{2\pi f_1 L_a}{R_a}$, and in the present case with both L_a and R_a reduced to the primary system, $\tan \phi_a = \frac{2\pi \times 10 \times {\cdot}00182}{{\cdot}5} = {\cdot}228$ whence $\phi_a = 12{\cdot}85$deg. Take any value of the useful back E.M.F. in the field, say 85 volts, then the induced E.M.F. in the armature will be $85 \times s = 85 \times {\cdot}2 = 17$ volts, and the ohmic E.M.F.

* *See* preceding note.

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will be $17 \times \cos 12{\cdot}85\text{deg.} = 17 \times {\cdot}975 = 16{\cdot}58$, whence $C_p = \frac{16{\cdot}58}{{\cdot}5} = 33{\cdot}16$ amperes. Draw a line OC_a at 12·85deg. to the vertical line Oe_3 (Fig. 24) and upon them mark off the values of the ohmic and induced E.M.F. Prolonging OC_a through O to C_p, the power component of the primary required to balance the secondary current must lie along OC_p and have a length = 33·16. Hence, along a line inclined to the vertical at an angle of 12·85deg., plot $C_p = 33{\cdot}16$, and along a line inclined to the horizontal at the angle of hysteretic advance $\beta' = 8{\cdot}5$deg., plot the magnetising current $C_\mu = 26{\cdot}3$, which is required to give the useful back E.M.F. of 85 volts. Compound the two, and the resultant OC_1 of 49 amperes is obtained. This current acting round the leakage circuit will produce a self-induced E.M.F. $= 15 \times \frac{49}{26{\cdot}3} = 28$ volts. No eddy-current component has as yet been introduced since any such component is directly balanced by the actual eddy-currents and does not magnetise the field. The current of 49 amperes which magnetises the leakage paths must itself be ahead of the leakage magnetism by a certain angle x owing to the hysteresis;

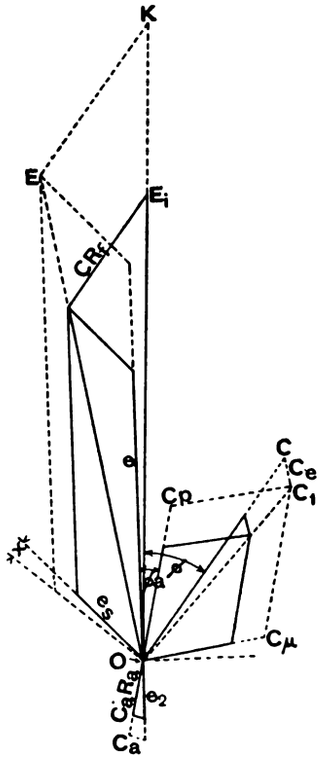

FIG. 24.—800 revs. Maximum efficiency. $x = 5°$. $\phi = 35{\cdot}2°$. $\alpha = 2{\cdot}5°$.

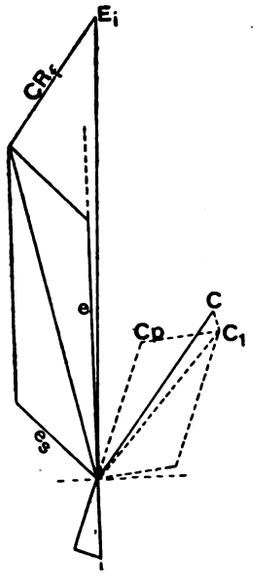

FIG. 25.—700 revs. Maximum H.P. $x = 4{\cdot}5°$. $\phi = 34°$. $\alpha = 2°$.

hence the self-induced E.M.F. is less than 90deg. ahead of the current by the same angle x. This angle by which it falls behind 90deg. cannot, however, be determined until the total back E.M.F., to the square of which the hysteresis watts are proportional, is known. An approximation must, therefore, at first be made by assuming some angle of lag for the total magnetism, less than 8·5deg. Since the inclination of the current OC_1 to the vertical is 43deg., the maximum angle between e_s and e would be 90deg. − 43deg. = 47deg., if there were no hysteresis loss due to the leakage lines; the resultant of e and e_s would then be $\sqrt{85^2 + 28^2 + 2 \times 85 \times 28 \cos 47\text{deg.}} = 106$. The actual angle between e_s and e must be something less than 47deg., and the total back E.M.F. will be rather more than 106 since e and e_s are more nearly in phase. If the total back E.M.F. be 107·5, the total hysteresis watts will be $388 \times \left(\frac{107{\cdot}5}{100}\right)^2 = 448$. Out of this we have already accounted for $85 \times 26{\cdot}8 \sin 8{\cdot}5°$ or $388 \times \frac{85}{100} = 330$, hence the difference still to be accounted for is $448 - 330 = 118$. This must be equal to the product of the self-induced E.M.F. and the projection of the current OC_1 upon it, *i.e.*, $28 \times 49 \cos(90\text{deg.} - x) = 118$, whence $\cos(90\text{deg.} - x) = \frac{118}{28 \times 49} = 0{\cdot}086$, and 90deg. $- x =$ nearly 85deg. Hence plot e_s 85deg. ahead of the current, and compound with e, whence we obtain the resultant total back E.M.F. OE = 107·5 volts.

The eddy-current loss like the hysteresis loss is proportional to the square of the total back E.M.F.; it will, therefore, be $562 \times \left(\frac{107{\cdot}5}{100}\right)^2 = 650$ watts. The eddy-current component must be in phase with the total back E.M.F., and will be $= \frac{650}{107{\cdot}5} = 6{\cdot}05$. From the extremity of OC_1 a line $Ce = 6{\cdot}05$ (Fig. 24) must, therefore, be drawn parallel to OE the total back E.M.F., and this must be compounded with the previous component of 49 amperes. Thus the resultant total primary current OC is found to be 53 amperes. The loss of volts over the primary resistance is then $53 \times 0{\cdot}75 = 39{\cdot}8$ volts. From the extremity of the total back E.M.F. OE draw a line EK parallel to OC, and along it plot the loss of volts = 39·8. Join OK, then OK is the E.M.F. that must be impressed in order to give the back E.M.F. of 85 volts, &c. It scales, however, 137, so that the whole diagram must be reduced in the proportion of

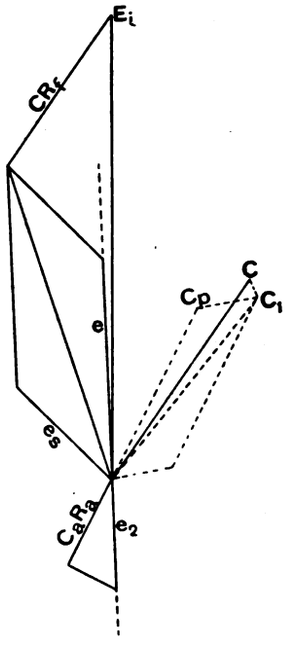

FIG. 26.—500 revs. Maximum torque. $x = 4{\cdot}25°$. $\phi = 35{\cdot}9°$. $\alpha = 2{\cdot}5°$.

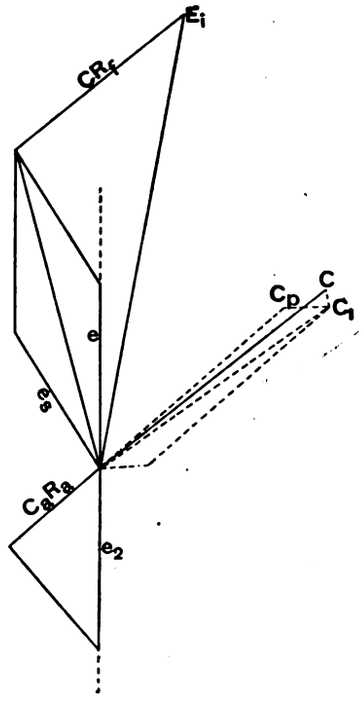

FIG. 27.—Standstill. $x = 3{\cdot}75°$. $\phi = 40{\cdot}6°$. $\alpha = 10{\cdot}5°$.

100 : 137, as shown by the similar triangles marked in heavier black lines. To begin with the secondary, the induced E.M.F. will be 12·4 instead of 17, and the ohmic E.M.F. will be 12·1 instead of 16·58. The magnetising current C_μ and the power component are reduced to 19·2 and 24·2 amperes respectively, and the total current to 38·7. The useful back E.M.F. is now 62 volts instead of 85, and the self-induced E.M.F. corresponding to 38·7 amperes of total current, or 36 amperes without the eddy component, is 20·5.

The advantage of plotting the various quantities as in Fig. 24, so that the current lines fall to the right of the diagram and the E.M.F. lines to the left, is that the projection of the current lines on the volt lines gives the various items of work involved. Thus, the projection of OC_1 on e gives the work done in the armature, including a share of the hysteresis loss in the field due to the useful lines. The projection of OC_1 on e_s gives the remainder of the hysteresis loss: if e_s were at right angles to OC_1, there would be no work therein involved, the total back E.M.F. and the projection of OC_1 on the line of total back E.M.F. being inversely altered. But now the projection of OC_1 on the total back E.M.F., gives

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Table II.

No. of fig.	Speed.	Tan ϕ_a.	ϕ_a. Deg.	e.	C_μ.	C_p.	OC_1 = result. of C_μ and C_p	e_s.	Resultant of e and e_s.	Eddy current component.	C per phase.	ϕ. Deg.	Power factor cos ϕ.	Input per phase.	C^2R_f.	Hysteresis per phase.	Eddies per phase.	Torque per phase $\propto$ watts transmitted to arm. $= e C_p \cos \phi_a$.	$C_a{}^2R_a$ per phase.	Friction per phase.	Brake watts per phase.	% effic.	Slip.	x. Deg.	a. Deg.
22	968	0·0366	2·1	75·2	23·25	4·8	24·8	14·15	89·0	5·0	26·6	51·8	0·618	1,643	530	308	445	359·5	11·5	348	0	0	0·032	8·0	8·5
...	950	0·057	3·25	73·3	22·7	7·3	25·0	14·3	87·0	4·9	27·6	48·7	0·66	1,826	572	294	426	534·0	26·0	342	166	9·1	0·05	7·2	7·75
23	900	0·114	6·5	69·0	21·4	13·7	28·5	16·3	83·5	4·7	31·25	41·8	0·745	2,330	730	268	392	940·0	94·0	324	522	22·4	0·1	6·25	5·0
24	800	0·228	12·85	62·0	19·2	24·2	36·0	20·5	78·05	4·37	38·7	35·2	0·817	3,160	1,120	236	344	1,460·0	293·0	288	879	27·8	0·2	5·0	2·5
25	700	0·342	18·9	56·0	17·3	31·8	41·5	23·7	74·5	4·18	44·8	34·0	0·829	3,710	1,500	215	312	1,685·0	500·0	252	933	25·2	0·3	4·5	2·0
26	500	0·57	29·65	47·6	14·75	41·4	50·0	28·5	71·5	4·0	52·4	35·9	0·810	4,245	2,050	200	285	1,710·0	855·0	180	675	16·0	0·5	4·25	2·5
...	250	0·855	40·5	42·4	13·15	48·3	58·0	33·0	71·0	3·98	59·0	38·3	0·785	4,635	2,600	197	283	1,555·0	1,160·0	90	305	6·45	0·75	4·0	6·5
27	0	1·14	48·75	39·4	12·2	52·0	61·0	34·8	70·9	3·97	62·2	40·6	0·76	4,725	2,900	193	282	1,350·0	1,350·0	0	0	0	1	3·75	10·5

the work done in the armature plus all the hysteresis loss in the field due to both useful and leakage lines, and the projection of C on the total back E.M.F. gives all the work done

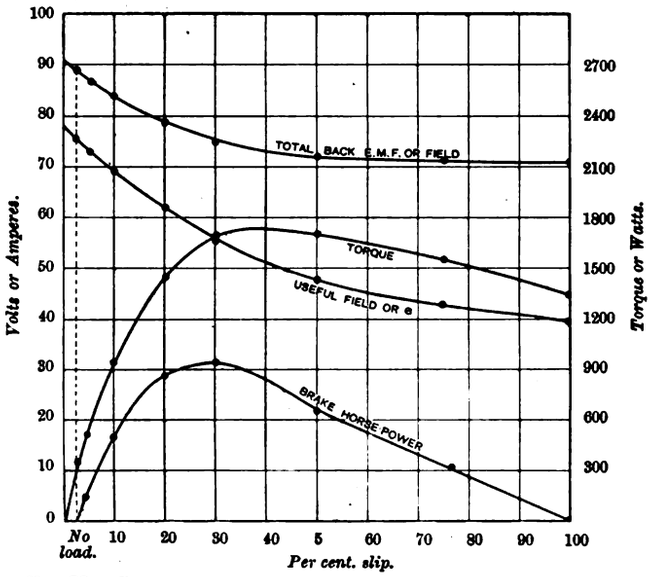

Fig. 28.—Current, torque and H.P. per phase, with magnetic leakage.

(including the eddy-current loss) other than heating the primary winding. Finally the projection of C on E_i gives the total energy consumed in all ways.

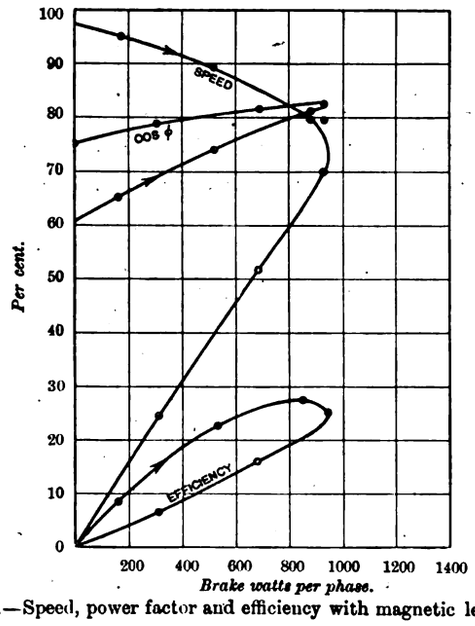

Fig. 29.—Speed, power factor and efficiency with magnetic leakage.

For loads within the working range of the motor, e_s is small, and little error is involved in plotting C_0, as was previously done in part 1 when magnetic leakage was absent, but for overloads when the angle of lag of the secondary current is large, the more precise method above described is necessary. It will be seen that for small loads C_e is virtually a prolongation of $g_h e$, the power component of the magnetising current, but as the angle of armature lag increases, the inclination of C_e to $g_h e$ increases. Further, the eddy component does not decrease so fast as the magnetising current, since the total field does not decrease nearly so fast as the useful field (*cp.*, Fig. 28). In fact, from no-load to standstill the eddy component only decreases from 5 to 3·97, and there is appreciable error in regarding the eddy component as in phase with e rather than in phase with the resultant of e and e_s.

From a number of such diagrams for various speeds, all the characteristics of a given induction motor can be derived (Table II.) and plotted as before (Figs. 28 and 29). It will be found that ϕ is large at no-load, and gradually decreases up to a certain point, when owing to the leakage and self-induction of the primary, it agains begins to increase. Hence,

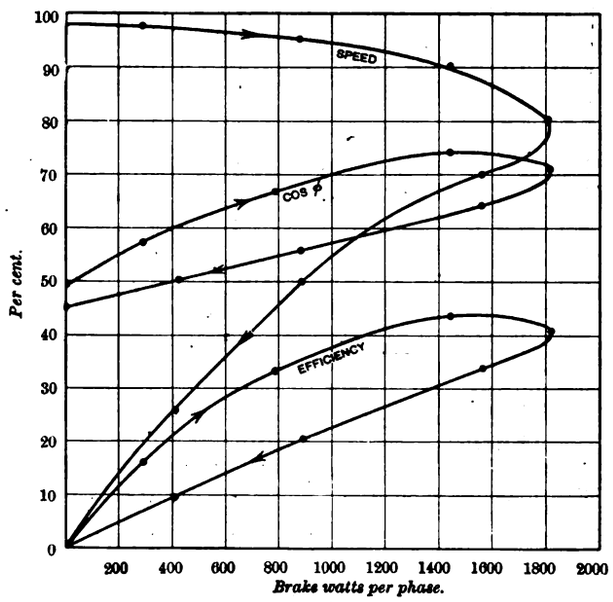

Fig. 30.—Speed, power factor with magnetic leakage, and with $R_a\, a^2 = Rf = \cdot 25$.

at a certain load, there is a maximum value of the load-factor cos ϕ, although this does not necessarily coincide with the point of maximum efficiency. At no-load there is but a small angle between E_i and e, but as the speed decreases E_i advances up to or beyond e and attains a maximum point of advance, after which it again recedes. The total watts transmitted to the armature per phase $= e\, C_p \cos \phi_a$, and the torque per phase, which is proportional to the former, reach their maxima at the same time, and this is for the load and speed when the impressed E.M.F. is furthest ahead of e, or if it is never ahead of e, is least behind e; *e.g.*, in our case when $a = 2°$ or E_i is only 2° behind e. A comparison of Figs. 28 and 29 with Figs. 17 and 18 shows the immense effect of leakage in reducing the power-factor, torque, efficiency, and brake watts of the motor; it further alters the relative position of their maxima.

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It has been shown that cos ϕ, instead of increasing continuously (as it does when magnetic leakage is absent), reaches a maximum and then declines. With the data of our imaginary motor, however, its value at standstill is still above its value at no-load, yet in practical motors this is not the case, but the curve of cos ϕ relatively to brake horse power curves round and descends below its ascending values. The reason for this is to be found in the lower values of resistance and consequent greater armature lag in the practical case of an efficient motor. Thus, if the resistances of armature and field-winding be reduced to 0·25 each, and all else is left unaltered, we obtain the curves of Fig. 30, corresponding to those of Fig. 29. This single instance serves to show how much information can be gained from induction motor diagrams as to the relative effect of altering one at a time the values of the data.

THE MILAN-MONZA ELECTRIC RAILWAY.

The problem of substituting electric traction for steam on the railways in Italy has been actively discussed during last year by the Italian Government and the leading Italian railway companies. It is now contemplated by the latter to carry out practical experiments on several trunk lines of secondary importance, in order to ascertain the value of the various systems proposed. The first application has been made on the Milan-Monza line, which is a line common to the Mediterranean and the Adriatic Companies. Accumulator traction has been substituted for steam, and the inauguration of the new system took place a few weeks ago. We give herewith a brief description of the plant, which is now in regular operation.

The power house is situated in the central railway station at Milan. The supply current is three-phase, at 3,600 volts pressure and 42 periods, and is derived from the network of the Edison Company. It actuates a Schuckert motor generator, consisting of a three-phase induction motor of 100 H.P. and 400 revolutions, directly coupled to a continuous-current dynamo of 67 kilowatts at 250 to 350 volts. From the switchboard the continuous current is led to the car house (70 metres distant) for charging the batteries.

The line is about eight miles long, and is entirely operated by motor cars, each containing a battery of 130 traction cells and a small battery for lighting. The cars have been supplied by Messrs. Grondona, Comi and Co., of Milan, and are of the double-truck type, with two covered platforms at the ends; their dimensions are: 60ft. long over all, 9ft. 6in. wide, and 8ft. 4in. high. The body of the car is divided into two first-class and two second-class compartments, and contains 64 seats and standing-room for 26 passengers. The compartments are inter-communicating, entrance being made by the end platforms. At the extremity of each platform is a cab for the motorman.

The motor equipment consists of two 50 H.P. single-reduction motors, series-wound and four-polar, the reduction being in the ratio of about 1 to 8; the suspension is of the usual type, but with a double spring at each end. Each truck has a motor operating one of the axles, while the other axle is idle. There are two controllers on each car, and each consists of two independent commutating cylinders—one for connecting the circuits, and the other for inserting resistances.

Two sets of 65 Hensenberger cells form the battery. These are usually connected in series, giving an average discharge pressure of 235 to 275 volts. With accumulators fully charged, a length of 31 miles may be run at the regular speed of 29 miles per hour. The accumulators are placed in boxes under the floor of the car, and the possibility of gases penetrating to the interior of the car is fully avoided. In addition, while the car is in the motor-house for charging, an electric pump is employed for extracting the gases from the interior of the boxes.

Braking the car is effected by a hand-brake and a Westinghouse air-brake; the latter is supplied by an electric compressor, which supplies also the acoustic signals. The cars are completely lighted by electric lamps. There is a 10 c.p. lamp in each single room, a 16 c.p. lamp on each platform, and a 16 c.p. lamp in the motorman's cab. Externally the car has five lamps of 25 c.p., coloured according to the usual rules of the Italian railways. The lighting current is supplied by a small battery, placed near the principal one.

The motor-car, without passengers, weighs 58 tons in all, of which 16 represent the weight of the accumulators. This corresponds to about 1,800lb. per seat. A regular speed of 29 miles per hour is maintained in service, but in the tests the cars have reached a speed of 38 miles without difficulty. The whole electrical equipment of the power-house and the motor-cars has been supplied by Messrs. Schuckert and Co., of Nuremberg.

THE HISSING OF THE ELECTRIC ARC.

The following is an abstract of the first day's discussion in connection with Mrs. Ayrton's Paper at the Institution of Electrical Engineers on Thursday, March 23rd:—

The PRESIDENT (Mr. J. W. Swan), after complimenting Mrs. Ayrton on her Paper, which formed, he thought, quite a model of scientific method in research, said that he felt much astonished at the great progress that had been made, and the perfection that had been realised in the arc method of electric lighting. He remembered how the very first arc lights spluttered and hissed; and the trouble in connection with these was not entirely, as Mrs. Ayrton had pointed out, due to defects in the lamps themselves, but due in a very considerable measure to defects in the carbons. Carbons at that time were cut square or octagonal, and were made out of some hard substance such as was now found in gas retorts. Considering the many circumstances which tended to its instability, arc lighting had reached a wonderful point of perfection; he should have thought it was almost finality, had not Mrs. Ayrton shown that it was possible to advance still further. Amongst other practical applications of this discovery—for he could speak of the work of Mrs. Ayrton in no other terms than as a discovery—he thought they would no longer use the fluted carbons that had been used in connection with lighthouse illumination.

Prof. SILVANUS P. THOMPSON said that they now had a practically new definition of the term "hissing arc." Apparently there were several things that a hissing arc did. It made a noise, it showed a greenish colour (this was also a discovery of Mrs. Ayrton's); it spurted; it produced mushrooms; it covered the surface of the crater for the time being with a kind of cloud or nebula, and it was accompanied with a very distinct drop of potential. But which of these things was to be taken as the criterion? He had always thought the noise should be taken as the criterion, and he was not altogether sure that it was not still to be taken. But yet, after all, the drop in potential appeared to be most important in Mrs. Ayrton's mind, because she had pointed out again and again how in some cases the potential dropped and in others it did not. They had seen put upon the screen two arcs side by side, one of which was open and the other enclosed. When the current was increased through both of them, and they heard a hissing noise, they were told that it was the open arc that was hissing and not the enclosed, while to all appearances it was the enclosed, because it had spurted all over the place. It was very difficult how to tell what was a hissing arc and what was not, and he hoped Mrs. Ayrton, in her reply, would make it quite clear. There had been a remark made early in the Paper, referring to the discussions at different times upon the physics of the arc. They had been told to look in diagram 1 at the last line comparing the 1 mm. arc, and Mrs. Ayrton had pointed out that if they had the arc in the silent state they might increase the current up to 14 amperes and no more; after that they might have a hissing arc with 17 amperes, but that they could not possibly have an arc either silent or hissing at 15 amperes. Now this fallacy—for fallacy it certainly was—had been supported by Professor Ayrton, but Mrs. Ayrton herself now supplied the antidote. They used to be told that if they had an arc, and kept the potential difference constant, and then lengthened the arc, the current increased instead of decreasing; but he ventured to point out that it was a fallacy. What they did was to lengthen the arc, and at the same time they did something to the external circuit to prevent the potential falling, and what they did was to increase the current in order to keep the potential up, and the result was that they had a larger current for a longer arc. He thought Mrs. Ayrton rather underrated Mr. Trotter's work; Mr. Trotter had obtained very similar results to Mrs. Ayrton some years ago, although he (the speaker) did not know that they had been mentioned in any Paper on the subject. He had intended to refer to the question of the shapes of carbon, but Mrs. Ayrton's researches had proved that square carbons were to be deprecated. It was now definitely proved that the hissing of the crater was intimately connected with the access of oxygen complicating the effects at the crater surface, yet there was a great deal behind that to explain why that complication should of itself set up the instability and the drop of potential.

Mr. W. M. MORDEY said that Mrs. Ayrton had not made quite clear to him whether instability was always an accompaniment of hissing, or not. If it was not, then they need not mind having an arc that did hiss. He mentioned this because of the reference to fluted carbons in lighthouse illumination. He had only been in a lighthouse once when the lights were on, and the arc was hissing the whole of the time. But it was, nevertheless, a good, steady, useful light, and they must remember that these fluted carbons added to the useful effect of the arc by allowing the light to get out. One of the drawbacks of arc lighting was that the light was given off from the surface of the crater, and only to a very small extent usefully

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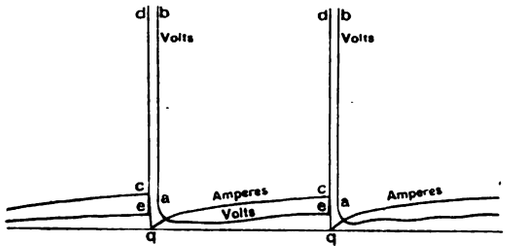
directed its rays to the objects that had to be illuminated. It was on that account that Sir James Douglas (a former member of the Institution) introduced, when he was the engineer to Trinity House, that form of fluted carbon which he believed was always used in the lighthouses round our coasts. However, he thought there was still a large field to be explored in connection with fluted carbons and alternate current arcs, and he hoped Mrs. Ayrton would give them a Paper on the physics of the alternate current arc generally, as well as on the hissing. He would like to mention a point in connection with alternate current arcs that had attracted his attention, which, perhaps, Mrs. Ayrton might be able to explain at the end of the discussion. There was seen, with alternate current arcs, a dark band halfway between the carbons reflected on the globe. It was seen on an ordinary 14in. globe as a dark band of about 1½in. or 2in. wide. With a low period alternate current, say 50 per second, there was a regular steady pulsation that was not connected, so far as he could see, with the periodicity. The periodicity was far too high to be noticed with the eye, but if this band was watched it would be seen to increase and decrease in breadth—perhaps 25 per cent. or 30 per cent. of its total breadth—at a rate of 400 or 500 times a minute. As there were with a 50 period current 6,000 currents a minute, there could be no connection whatever between this slow and regular beat and the periodicity itself. He had tried by various experiments to ascertain the cause of it, but without success. It was nothing to do with the mechanism, because it happened when the carbons were clamped perfectly steady. His last point was would Mrs. Ayrton explain the cause, if it were known, of the more granular appearance of the luminous surface of the carbons in the enclosed arc.

THE WEHNELT ELECTROLYTIC INTERRUPTER.*

BY A. BLONDEL.

The action of the curious Wehnelt interrupter, recently presented to the Académie by M. D'Arsonval, has not yet been fully explained. It has been well established by experience that the essential condition for its oscillatory working is that the circuit be inductive.† Without self-induction, the interrupter immediately stops working, the anode gets red, and a very weak current passes



continuously. The self-induction of the coil, or a supplementary inductive coil suffices to produce the phenomenon, and the frequency of the latter may be varied from one to several thousands per second by varying the inductance. One may, therefore, think, with the numerous writers who have already expressed their opinion, that it is a question of resonance between the self-induction and the capacity of the condenser formed by the polarised anode. This capacity may, for instance, reach one or two microfarads with a platinum wire 10mm. long and 0·5mm. diameter.

But this interpretation, based on the hypothesis of sinusoidal variations for alternating currents, would not explain how the increase of electromotive force, working on a circuit of invariable composition, can increase the frequency. Neither does it seem to be confirmed by a direct study of the current curve. For example, the curve in the figure, copied from curves of current and electromotive force taken by means of my 5,000 period oscillograph, by MM. Duris, Farmer, and Tchernosbitoff under my direction, indicates a single oscillation. The experiment was made at 40 periods, with a self-induction of from 0·2 to 0·3 henry in series with the interrupter. The latter had a wire similar to that already referred to. The pressure of the battery was 33 volts, the current 5 to 6 amperes; the pressure at the terminals of the cell increased to 75 volts. The figure shows that the current is first established as in all inductive circuits; the electrolysis continues to increase until the production of the gaseous envelope around the anode, then directly it is completed there is a sudden interruption of the current, and, at the same time, an enormous increase in voltage, projecting the spot outside the field of vision. Then both the current and the pressure resume their initial values and the action begins again. The precaution which we have taken, to give to the circuit a slower proper period than that of the oscillograph, permits us to think that these indications may be relied upon.

* From the *Comptes Rendus*, April 4, 1899.

† This necessity has also been indicated by Dr. Fleming, M. Pellat and others.

Under these conditions the phenomenon of interruption only occasions one single aperiodic impulse. The energy $\frac{1}{2}LI^2$ accumulated in the self-induction, and liberated by the interruption of the current, causes the condenser formed by the polarised anode in the electrolyte to be charged at high potential. This condenser destroys itself by discharging in an arc which is formed between the platinum and the electrolyte, and drives away the dissociated oxygen. The anode is therefore immediately freed from gas, and is again in contact with the liquid which condenses the vapour, if any remains, and permits the current to flow again immediately. This action may be approximately compared with that of a hydraulic ram or a pulsometer. This explanation allows one to understand the necessity of a certain proportion between the self-induction and the anode without it being necessary to liken the phenomenon to a true resonance. One understands also why the employment of a high voltage, which increases the rapidity of the electrolysis, can increase the frequency. Finally, the form of the volts curve suffices to explain the large increase of the mean pressure at the terminals of the cell, pointed out by MM. Wehnelt and Pellat. The oscillograph used did not lend itself to an examination of the action at high frequencies, but one may fairly believe that the phenomenon preserves the same character whatever the frequency. The explanation which I have proposed may, therefore, be general.

ADDITIONAL OBSERVATIONS WITH THE WEHNELT INTERRUPTER.*

BY ELIHU THOMSON.

Alternating-Current Circuits.—The interrupter will even work on alternating currents, provided the period natural to the interrupter is high enough to allow the current to rise to the critical value during the half wave or during one alternation. By placing the interrupter in series with the primary of an induction coil and connecting them across the alternating circuit, a torrent of sparks appeared between the secondary terminals at full separation. This was replaced by the noisy arc when the terminals were closer together. Furthermore, the sparks, when obtained, appeared to be undirectional, another good point in favour of the interrupter when used with alternating currents. Hence there is no obstacle to the use of alternating current in working an induction coil without condensers in exciting Crookes' tubes by the discharges. This fact renders unnecessary the high-frequency apparatus and double-focus tubes commonly used with alternating currents, and reduces the apparatus to a simple induction coil and interrupter. It will probably be best to use a piece of platinum foil as a cathode in place of a lead plate, as this will add to the permanency where the current reverses, as in alternating-current excitation.

Interrupter in Parallel.—It is found that two, three, or four of the platinum-point anodes may be worked in parallel in the same acid bath, and that their limiting currents need not be equal, while the sharpness of interruption, even in this case, is not apparently impaired. Several interrupters worked in parallel act as a unit, and take up a rate due to the total current, or, at least approximately, to the sum of the single currents of the interrupters. The musical scale may be sounded by varying the grouping of various sizes of platinum-point anodes properly adjusted.

Inductances.—Interrupters may be made to work with a fraction of an ampere at low or high rates, depending on the inductance in circuit and the voltage. The inductance of the whole circuit, including the dynamo, is to be taken, unless a battery, a condenser or a dead-resistance load is across the terminals in addition to the branch containing the interrupter. The presence of the battery in shunt, or of the condenser, if large enough, or of the dead-resistance load, if sufficient, may practically annul the effect of the inductance of the dynamo circuit, leaving the inductance coil in series with the interrupter to alone control the rate of interruption with any given surface of platinum anode. In one instance two incandescent lamps connected across the mains near the interrupter brightened considerably when the interrupter was working. The rate of interruption was high, and was reflected into the supply leads as a high periodicity superposed on the continuous current.

Different Rates Simultaneously Produced.—Two or more interrupters, working at different rates, may be supplied from the same source. Part of the inductance in circuit may be common to the interrupters, and part be in branches through each interrupter, as before suggested.

Variation of Inductances.—Several ways of controlling the rate of interruptions may be employed. The writer has used an inductance coil with a switch for varying the turns of wire in circuit, and this has been placed in circuit with the primary of an induction coil and its interrupters. In one instance, a small transformer was made with an iron wire bundle for a core, 8in. long and three-

* Abstract from the *Electrical World* of New York.

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fourths of an inch in diameter. Wound on a bobbin surrounding this core was a coil about 3½in. long, consisting of eight layers of No. 22 wire. This was the primary put in circuit with the interrupter. Outside the primary turns was a single layer of No. 12, 45 turns in all, or about 20ft. of wire. By closing the coarse secondary through a resistance which could be varied, the pitch of interruptions could be controlled, and, if desired, the musical scale sounded. Again, the wire core could be pushed in or drawn from the axis of the coil with the same effect, making this a sort of electrical trombone. Further, numerous taps were taken from the secondary layer, and these enabled more or less of the secondary to be closed, or partly closed through resistances or inductances to secure different rates or pitches. Similarly, in another case the taps were taken from the primary coil, no secondary being used, and the active length varied, which varied the rate. The sounds so produced are not very musical, but are definite enough in pitch to enable a tune to be played, and the device could doubtless be automatically operated by contact made through perforations in a moving paper roll.

Electric Welding.—A small-sized, open-core welding transformer was operated with entire success, and the same arrangement enlarged and otherwise adapted to the purpose can doubtless be employed on a much larger scale in commercial work. This would enable welding work to be done wherever the direct-current service is to be had.

New Method of Working.—The writer has tried with success the following method of working an induction coil: A Wehnelt interrupter was put in circuit with an inductance across a 110-volt circuit, direct current. In shunt to the interrupter only, the primary of the induction coil was connected through a condenser.

Repulsion and Rotation Experiments.—The new interrupter also furnishes a means whereby actions hitherto regarded as requiring alternating currents for their satisfactory demonstration may be produced from direct currents or circuits. The now familiar phenomena of repulsion of rings, plates, or the like, rotations of discs, &c., are readily reproduced.

Open and Closed Magnetic Circuit Cores.—The cores for the coils used with the interrupter should naturally be of the open-magnetic-circuit type. They may approach the closed-circuit type, having a moderate air gap cut in them. Closed magnetic circuit cores may, however, be employed in the following way, devised by the writer: A polarizing winding, in addition to the other windings, is provided. It magnetises the core when the interrupter opens the circuit, oppositely to the effect of current in the winding in circuit with the interrupter or primary coil. The relations between the turns is such that the current through the interrupter overpowers the polarising current, the latter reversing the magnetism of the core at the time of interruption. The effect is similar to that of an alternating current in reversing the core magnetism rapidly. If a secondary coil be provided upon the same closed core its turns, sections, &c., can be adapted to the effect desired to be produced.

THE WORLD'S TELEGRAPH AND TELEPHONE WIRE.

The following table, giving the approximate mileage of the telegraphic and telephonic systems of the world at the end of 1898, was included in the Paper on "Telephones," read by Mr. John Gavey before the Society of Arts, on the 12th inst. It is compiled from official documents supplied to the Bureau International at Berne:—

	Lines.				Wire.			
	Telegraph lines.		Telephone lines of States and private companies.	Totals.	Telegraph lines.		Telephone lines of States and private companies.	Totals.
	State Administrations and private companies.	Railway companies.			State Administrations and private companies.	Railway companies.		
I.—Countries subject to Internat. Telegraph Convention:	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.
European	490,200	179,570	169,300	839,070	1,604,300	623,200	852,800	3,080,300
Extra-European	167,300	64,620	14,290	246,410	406,100	205,300	119,230	730,630
II.—Countries not subject to the Convention:—								
North America — Western Union Co.	233,000	...	...	233,000	1,003,400	...	...	1,003,400
North America — Postal Telegraph Co.	18,640	...	...	18,640	108,730	...	...	108,730
North America — Other Offices	...	248,500	186,400	434,900	...	745,600	2,175,000	2,920,600
South America	15,533	9,300	3,107	27,940	29,820	27,960	31,070	88,850
Africa, Asia and Australia	24,853	27,950	9,320	62,133	74,560	83,880	24,850	183,290
III.—Submarine cable companies	167,800	...	...	167,800	169,600	...	...	169,600
	1,117,526	529,950	382,417	2,029,893	3,396,510	1,686,940	3,203,950	8,285,400

CORRESPONDENCE.

GOVERNMENT TELEPHONES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have just seen a cutting from your issue of the 7th inst., and I have to ask that you will kindly permit me to notice it. In doing so I know I am writing to a supporter of the Post Office Telephone Department and also of the National Company. In the paragraph in question you refer to an American correspondent having sent me the telephone rate at Baltimore. I said nothing about a correspondent having sent me this. I took the rate from a document used in the proceedings before the Senate Committee of the New York Legislation in February, 1895, in which it is stated that the £16 rate in Baltimore for a radius of two miles is a legal rate fixed by the Legislature. It does not mention whether the wires are single or double.

You say, "Mr. Provand appears to be quite unaware about the charges in Manchester, Liverpool and other large towns." I know the National Company's rates, so far as they publish them. Glasgow has a single-wire exchange. The rate is £10 within half-a-mile of the exchange, rising to £25 at greater distances. I have before me a receipt for £20 paid for a wire, the distance from the exchange being less than two miles. This, therefore, is far higher than the Baltimore rate. You say that the National Company in London charge £10 for private houses. I am writing from a private house to which they refuse to supply me with a wire for £10, and ask several pounds more. You do not appear to know the National Company's tariff.

I have taken no pains to convince you that the rates of telephone service in New York are maintained by corruption. I have simply quoted facts in connection with the proceedings taken before the State Legislature in regard to the rates. As a consistent friend of monopoly in this country you naturally support it in New York. There the rates are maintained by corrupt methods, here by the Post Office Telephone Department. The result is the same to the public, *i.e.*, extortionate rates and bad service. The remark in the last sentence of your note, to the effect that permitting municipalities to supply telephone service is not likely to lessen the danger of corruption, is simply an insult to our municipalities, by inferentially comparing them with Tammany in New York. Notwithstanding the opposition of the supporters of monopoly, and of the Post Office telephone blunderers, the Government Telephone Bill will pass and licences will be issued to such municipalities as ask for them and comply with the necessary conditions. The result will be that telephone service in this country will be as good and as cheap as it is in many other countries. I look for the departure of the National Company from Scotland altogether within a few years, from inability to compete in the supply of a good service at a fair price.—Yours, &c.,

A. D. PROVAND.

2, Whitehall-court, London, S.W., April 13, 1899.

[The Baltimore tariff we quoted is that charged at the present time. The English tariffs we quoted are those

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charged to the majority of subscribers in the respective towns. We have not supported monopoly in New York, and have offered no opinion as to whether the telephone rates there are maintained by corrupt methods. Mr. Provand himself is responsible for introducing that element into the discussion—which must now close.—ED. *E.*]

AMERICAN NOTES.

NEW YORK, *April 8.*

Air Brakes for Electric Cars.—The Third Avenue Railroad Co. expects to brake their cars with a brake operated by compressed air, a slow-speed electric motor being used to effect the compression. The current will be automatically shut off when the air brake is applied.

Electrically-Operated Pumps.—Quite a number of cities are in the market for electrically-operated pumps for water supply.

The Rapid Transportation Question.—A scheme of greatest importance for this city, which has been the theme of fruitless discussion in engineering circles for years, is the providing of cheap and rapid transportation facilities for the people of the city. Only those who have to come and go on our elevated roads or surface lines, especially in the "crush" hours, have any idea of the discomfort attendant upon travel to and fro. A company, under the leadership of the Metropolitan Street Railway Co., offer to construct an underground rapid transit system. A proposition has been already submitted to the Rapid Transit Commission. The project involves the construction of a tunnel five miles long, to be followed by viaducts and tunnels alternating according to the configuration of the ground until the upper section is reached. It is proposed to make this distance at fast express speed, viz., 15min. The estimated cost is not given, though such figures as $200,000,000 have been mentioned.

Municipal Electricians.—The municipal electricians will hold a convention in this city September 4, at which it is said 180 cities will be represented.

Telephone Charges.—A strong fight has started in the United States against exorbitant telephone charges, and the legislatures of several States are taking a hand in it.

Briskness of Electrical Business.—The general business conditions are improving rapidly. The prosperity now prevailing is bringing out capital. The papers are full of announcements of new enterprises, of combinations, of consolidations, of advances in wages. The railway interests are enormous buyers, and are largely re-equipping the roads. Locomotive works are crowded, car shops are refusing orders, and, in fact, all manufacturing concerns are crowded with work. Copper has advanced under the heavy demand, but it looks as if it had reached high-water mark. The announcements of the discovery of new and rich copper deposits fill the daily Press. Boston and New York capitalists appear to be infatuated with the business. European interests also are in the rush for these properties, and some of them are undoubtedly of exceptional value.

LEGAL INTELLIGENCE.

Castner-Kellner Alkali Co. (Limited) v. Commercial Development Corporation (Limited).

The Master of the Rolls and Lords Justices Rigby and Vaughan Williams yesterday (Thursday) delivered judgment in this case on the appeal of the defendants from the order of Mr. Justice Bigham on August 3 last. The case has been fully reported in *The Electrician* of July 15 and 22, and August 2, 1898, and March 3 and 10, 1899. The action was brought by the plaintiffs, the registered owners of letters patent No. 20,259 (1894), granted to Carl Kellner for an invention of improvements in electrolytic apparatus for decomposing alkaline salts, and for an injunction restraining defendants from manufacturing or selling caustic soda or other alkali in infringement of these letters patent. The apparatus the defendants proposed to use was patented by M. Rhodin in 1896, and the plaintiffs alleged that this apparatus was in fact identical with one form of the Kellner patents, and their case was that the defendants had added nothing to the Kellner patent which was the one sued upon. Defendants, who denied the infringement, also attacked plaintiffs' patent on the ground of disconformity. Mr. Justice Bigham decided that the plaintiffs' patent was not bad on account of disconformity, and that the defendants had infringed their patent, and granted the injunction asked for. Hence the present appeal by defendants.

The MASTER OF THE ROLLS, in giving judgment, said that the action was brought for infringement of patent, but it was brought under very unusual circumstances. In the first place, the plaintiff's patent (Kellner's, 1894) had never been used for any commercial purpose, nor indeed, at all, except, perhaps, by way of experiment. Its non-use was not explained by the fact that, although new and novel, it had been superseded by a later invention. But such was not the case. The patent sued upon had not been used, because a prior patent belonging to the plaintiffs had been found to answer their purposes better; but this prior patent was not relied upon by the plaintiffs in the action. In the next place the defendants had not yet begun work, so that no infringement, in fact, by what they actually did could be proved. They had, however, constructed some apparatus according to another patent (Rhodin's, 1896), and they had admitted that they intended to use this apparatus; but it was obvious that, if in practice it were found desirable to depart from some of the directions contained in that specification, such departure might have a very material bearing upon the question whether the defendants really infringed the plaintiffs' patent. His lordship made this observation because Rhodin's specification referred to the slow rotation of one of its component parts, whereas it seemed plain that much better results were obtained by quick rotation of the same part. If defendants' apparatus were at work his lordship was satisfied by the evidence that the part to which he was referring would be rapidly and not slowly rotated. But if this were so, the effects produced would be so different that the question of infringement would, in his opinion, assume a totally different aspect. Again, when the defendants began to work they might find it better to keep what were called their bells stationary, and to rotate the trays and troughs in which they stood. They were under no obligation to work precisely as told by Rhodin. But if such modification were made the question of infringement would be totally different from what it was if they were to assume that the defendants intended to make no departure from the directions contained in Rhodin's specification. Again, when comparing the processes described in Kellner and Rhodin's specifications, Mr. Terrell made a very important admission in favour of the plaintiffs. He admitted that if there was no distinction between a rotary movement and a to-and-fro movement, described in Fig. 1 of Kellner's specification, then there was no practical distinction between his apparatus and plaintiffs'. This admission was not referred to by Mr. Justice Bigham, and it was very important, as plaintiffs' patent was for an apparatus and not merely for a method for making soda. But to treat this admission as an admission by the defendants as they would use it would necessarily amount to an infringement of the plaintiffs' patent, even if it was valid, appeared to him to be pushing the admission much further than was put to the learned counsel who made it, or to his clients, who would suffer the consequences of it. He paused there, to consider the first point which arose in this case, and that was the nature of Kellner's invention as disclosed in the specification. The invention was for an improved apparatus, and the real nature of that invention was quite clear. It was an apparatus for making an open-mouthed vessel containing an electrified solution of salt over a stationary layer of mercury, covered over fresh water. The vessel was to be moved in such a way that the electrified salt solution should be in contact with part of the mercury for a time and then be shifted to another part, whilst the mercury was acted upon by the salt water and converted into an amalgam of mercury and sodium, or be brought into contact with the fresh water, so as to decompose the amalgam into mercury and soda in solution. That was Kellner's invention, and, so far as he could judge, it was novel and useful. Kellner showed in his provisional specification one mode of carrying it out—namely, by a to-and-fro motion of the vessel or bell containing the salt solution; but it was quite competent for him to point out in his complete specification any better method of presenting the mercury first to the salt water and than to the fresh, provided he kept the mercury as quiescent as possible. His last point, therefore, was one of the essential features of his invention—the means of having a stationary mercury cathode, the shifting of the bell, and the non-shifting of the amalgam formed in it; the care taken to make openings in the lower ends of the bells, so as not to displace the mercury, and the descriptions showing how to work the apparatus whilst the mercury cathode itself remained at rest, so that the aim of the inventor was to keep the mercury as quiet as possible, consistently with the moving of the bells of salt water over its surface. This was very important, in order to distinguish Kellner's invention from Castner's prior invention, in which the mercury was moved rapidly from the mouth of one compartment containing salt water to the mouth of the other containing fresh water. His lordship had carefully studied Kellner's specification, and also the evidence of the experts called on both sides, and, notwithstanding what was said about there being no practical difference between moving a bell through mercury and moving mercury under a bell, he was satisfied that any process by which the mercury was intentionally moved or disturbed, otherwise than to the least possible extent, by moving bells of salt water over it, was outside and not fairly within Kellner's real invention as disclosed in his original specification. There he differed with Mr. Justice Bigham. His lordship did not attach importance to Fig. 6 in the complete specification, in which the position of the salt water and the fresh water were reversed. That was a modification consistent with the real invention described in the provisional specification. Further, he was not prepared to hold (especially having regard to the admissions made by Mr. Terrell, as already mentioned) that the mere substitution of a rotary motion for a to-and-fro motion of the bells would not be equally within Kellner's invention, as described in his provisional specification, provided, always, care were taken

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to keep the mercury still; but the clause No. 3, and Figs. 7 and 8 to which it referred, was, in his opinion, an entire departure from the essential feature of his invention, as originally described. Here the mercury was intentionally not kept as still as possible, but might be moved and disturbed to any extent. This was quite inconsistent with the original idea. An invention for an apparatus for keeping the mercury still was not an invention for an apparatus for keeping the mercury moving. Clause No. 3. covered both inventions, and was such a departure and such an extension of Kellner's real invention as to render the patent sued upon invalid as it stood. Very possibly the defect could be cured by a disclaimer, but whether, when so cured, the patent would be infringed by the defendants it would be quite improper now to decide. If he was right in thinking that the defendants' apparatus could not be worked with advantage unless the mercury was kept in rapid motion and and not kept as still as possible, the plaintiffs would be well advised to reconsider their postion before they commenced a fresh action on an amended specification. In his opinion the judgment ought to be reversed, and judgment entered for the defendants with costs, and the plaintiffs must pay the costs of the appeal.

Lord Justice RIGBY concurred in a judgment of some length.

Lord Justice VAUGHAN WILLIAMS said he was in the unfortunate position of having to differ from his learned brothers. He explained his reasons for so doing in an exhaustive judgment, which he then withdrew.

Judgment was then entered for the defendants in accordance with the finding of the majority of the Court.

Radford v. Tasker and Sons.

At the Coventry County Court, last week, Mr. E. R. Radford, of Leicester, sought to recover £50 as commission from Messrs. W. Tasker and Sons, electrical engineers, Andover. Plaintiff said he was engaged by a manager for defendants to attend to their Coventry depôt at a fixed salary and a commission of 3 per cent. on all orders passing through the branch. Defendants denied that the person referred to had power to made the arrangement which plaintiff set up as justifying his claim. Judgment was eventually entered for plaintiff for £37. 10s., and costs.

PARLIAMENTARY INTELLIGENCE.

COUNTY OF LONDON AND BRUSH PROVINCIAL CO.'S BILL.

The Select Committee of the House of Commons, presided over by Sir William Coddington, which has had under its consideration a group of Bills relating to projects for extending the use of electricity, both for lighting and power purposes, in the Metropolis, resumed its labours on Tuesday.

Mr. PEMBER, Q.C., for the promoters, now stated that he wished to make an announcement which he thought might have the effect of shortening the labours of the Committee. It would be to some extent a complaint against the Board of Trade. Provisional Orders had been asked for by the promoters to give them power to supply electricity to the districts of Fulham, Battersea, Bermondsey, Rotherhithe, Lewisham, Lee, Greenwich, Eltham, Poplar, Bethnal Green, Hackney and Stoke Newington. These Orders were applied for months ago, but as late as April 4th, when the Committee, &c., were dispersed for the holidays, letters in regard to all these applications were received to the following effect :—

"Dear Sir: With reference to the application made by you on behalf of the County of London and Brush Provincial Electric Lighting Co. (Limited) for the above-mentioned Order, I am directed by the Board of Trade to state that they are not satisfied that the consent of the local authorities should be dispensed with in respect to any of the districts included within the area of supply."

It was not, therefore, the intention of the promoters to further proceed with the applications for these Orders, which were made in October last. The Board of Trade, therefore, could have, months ago, written the letter he had read, as they knew that the consents had not been obtained. He did not know whether it was possible for anyone to give the Board of Trade a wigging, but he only wished he could do it. (Laughter.) The promoters had written to the Board of Trade enquiring whether local inquiries could not be held, but the Board had made up their mind. The Bill would, in consequence, have to be amended, and the representatives of the various districts had been told that their further appearance before the Committee would be unnecessary. The promoters, would, however, still ask for powers to lay mains through Shoreditch, Bethnal Green, Islington, Whitechapel, Battersea and Lambeth.

Mr. WORSLEY TAYLOR, Q.C. (for the L.C.C.), said Mr. Pember's announcement had come to himself and his clients with great surprise, though he must leave his learned friend to settle his quarrel with the Board of Trade. What had taken place showed the exceeding inconvenience of the course adopted by the promoters in promoting a Bill, the lesser half of the objects of which were disclosed within its four corners, whilst the greater half were concealed. He did not know what attitude the L.C.C. would now assume towards the Bill.

The CHAIRMAN said the action of the Board of Trade in putting off their refusal of the Provisional Orders for so long seemed to the Committee rather discourteous, but they (the Committee) had no jurisdiction in the matter.

Counsel for a number of the petitioners against the Bill asked for costs, but the Committee reserved its decision on this point.

Mr. WORSLEY TAYLOR said he proposed to take no further action on the Bill, but to reserve the right of the L.C.C. to appear at a future stage. He would suggest, however, that it might be well for the Committee to throw out the Bill, so as to enable the promoters next year to come forward with a new and more carefully-considered measure. If the preamble were passed it would be well to put in the Bill a clause conferring on the L.C.C. powers of purchase.

Mr. STATHAM (for the Lambeth Vestry) asked the Committee to reject the application for a roving commission to open up the streets of Lambeth. At present there were three companies supplying electric light in the district, and in December, 1897, the Vestry had entered into an agreement with the promoters of the present Bill, under which certain privileges were conferred.

Mr. JOHN SMITH (vestry clerk of Lambeth) held that the fact that the Vestry had entered into an agreement with the promoters showed that there was no ill-will on the part of the Vestry. He objected to the proposal in the Bill to give the Board of Trade a veto as between the Vestry and the promoters in the matter of the opening up the roads.

Mr. C. TAGG (clerk to the Camberwell Vestry) pointed out that in return for consent to the proposals of the promoters in 1895, it was agreed that the Vestry should have powers of purchase. There were no purchase powers in the present Bill. There was no power under the existing purchase clause to purchase a generating station.

By Mr. PEMBER: Then, if you are not able to purchase the big generating station we propose to put up in Camberwell—which will be large enough to supply outside areas with energy as well as Camberwell—you would be in the same position after the passing of this Bill as you are in at present?—That is so.

The Order of 1896 gives you power to purchase the works authorised by the Order?—Yes; and though there is no generating station mentioned, we hold that there ought to be.

Mr. TALBOT (for the Camberwell Vestry) said, in 1895, the Vestry had gone very carefully into the matter, and had agreed to give consent to the promoting company's application for a Provisional Order, on the condition of the acceptance of the purchase clause, conferring on the local authority the right to acquire the undertaking after 21 instead of 42 years; and also the additional power to buy at any time, by paying £133 for every £100 of capital expended on the undertaking, with a 5 per cent. dividend on the capital of the company for the extra period. It was also contemplated that a generating station should be erected in Camberwell, proportionate to the demands of the district, but the company now proposed to erect a station of such dimensions that if at any time the local authority purchased they would be unable to acquire anything but the mains, as the station would be one supplying other districts as well. This he asked the committee to refuse its assent to.

Mr. E. MANVILLE, the consulting engineer to the Vestry of Shoreditch, testified to the crowded state of the roads in Shoreditch, owing to many large water and gas mains, together with the mains of the National Telephone Co., the Hydraulic Power Co. and others. In the last financial year the Vestry had supplied by their undertaking, 1,030,000 units of electricity in Shoreditch, of which 761,000 units had been taken by consumers. The cost of production was a little over 1¼d. per unit. This low rate was due to the fact that the heat generated by the destruction of the dust and refuse was used for the production of electricity. Only one quarter of the steam power required at the electric station was obtained by the use of coal. With the exception of the Edinburgh station the Shoreditch station was the most economically worked in the kingdom. Owing to the smallness of the area to be supplied—about one square mile—the service was carried out under favourable circumstances. He could not say whether the local rates were paid on the generating station. The accounts did not include interest on capital.

Dr. H. M. ROBINSON (clerk to the Vestry of Shoreditch) gave similar evidence, and stated that the electric undertaking was now paying rates the same as any other undertaking in the district. The electricity department was credited with 2s. for every ton of refuse destroyed.

The CHAIRMAN said he did not consider that the figure 1·28d., given as the cost per unit for the production of the electricity, was a fair one. A credit of 2s. per ton was given for destroying the dust; but the electric undertaking was not debited with anything for the use of the steam produced in so doing and used for generating purposes.

Mr. VESEY KNOX (for the Shoreditch Vestry) contended that that Vestry, having set up an electricity undertaking of their own at a cheaper rate than was the case elsewhere in the metropolis, were entitled to be treated with the greatest consideration. He asked the Committee to refuse the powers now asked for.

On Thursday the Committee met, and the CHAIRMAN said: The Committee do not think it necessary to hear further evidence in opposition to this Bill, as they have decided that they cannot pass the preamble. The applications made for costs the Committee have considered, and have decided not to allow.

Annual Meeting of the Verband Deutscher Electrotechniker.—The seventh annual general meeting of this Society has been arranged to take place in Hanover from June 8th to 11th. Members wishing to read Papers, or to exhibit apparatus, &c., are requested to communicate with the Secretary at 8, Monbijouplatz, Berlin, N., as soon as possible, and to state, at the same time, whether their Papers will be illustrated by experiments. The Papers themselves should be sent in by the middle of May at the latest.

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ELECTRIC LIGHTING SCHEMES FOR THE CITY OF LONDON.

On Tuesday Sir Courtenay Boyle, K.C.B., resumed the inquiry into the applications for Provisional Orders for the supply of electric current to the City of London area, made by the Charing Cross and Strand Electricity Supply Corp. (Limited), the Metropolitan Electric Supply Co. (Limited), and the Smithfield Markets Electric Supply Co. (Limited). The counsel employed in the enquiry were the same as set out in our issue for March 31.

At the commencement of proceedings Sir COURTENAY BOYLE asked whether the Corporation proposed to submit evidence from the City engineer.

Mr. GRAY (for the Corporation) explained that at a meeting of the Court of Common Council, held the previous day, a series of resolutions were passed, the effect of which was that the City engineer would be called.

Mr. D. J. ROSS said he was associated with the late Col. Haywood in the first installation of electric light in the City in 1870. He was familiar with the laying of the mains in the City in 1890-92, and knew that the work seriously interfered with the traffic and caused a great amount of public inconvenience. The operations were on a very large scale, and £30,000 was spent in relaying pavements. He believed the cost of electric current would be cheapened if there was competition within the City. In nearly all cases the space beneath the footways in the City were filled with pipes and tubes, and if other mains were laid they must be placed beneath the carriage way, a fact which would add to the public inconvenience. Under the agreement with the City of London Company the Corporation claimed 1d. a lamp in case of a failure. The fines paid by the company in 1892 came to £119, in 1893 £136, in 1894 £138, in 1895 £137, in 1896 £362, in 1897 £352, and in 1898 £156. Unless all the circumstances connected with that competition were known it was difficult to express an opinion as to the public advantage to be derived from competition.

Mr. POPE (for the City of London Company) said the attitude of the City Corporation was one of the most important factors in the question, and he assumed that this attitude was correctly described by the resolutions which that body had adopted on the previous day. He would not discuss the question whether the agreement between the company he represented at that inquiry and the late Commission of Sewers was a valid agreement or a binding one, that was a matter between the Corporation and the City Company. He contended that the consent of the local authority to a Provisional Order was a condition precedent to the granting of the Order, and that there must be special circumstances to induce the Board of Trade to pass over such consent. The advantages of competition did not constitute such special circumstances, as this was common in every case. The resolutions adopted only the previous day by the Corporation surely meant that the City desired to be left alone, the existing arrangements being undisturbed. If the agreement between the Corporation and the City Company had been rendered void, the position of both bodies was an awkward one, as some of the most onerous conditions were determined, not by the Provisional Order of the Company, but under the agreement. Among other matters was the question of street lighting, which was determined, not by the order, but by the agreement. No case had been made out against the City Company. The service could not be a bad one, as in the public supply the occasional default had involved a penalty of only £36 in six months upon a total payment of £12,000. This could not, he urged, be held to justify the Board of Trade in disturbing the relations between the local authority and the City company.

Mr. FITZGERALD (for the Metropolitan Company) said the Corporation had acted consistently throughout, and it was obvious from the resolutions just adopted that it desired to leave the matter in the hands of the Board of Trade to be dealt with in manner it might think best for the public interest. He asked the Board of Trade to say that the Metropolitan Company was the most capable of the three applicants to compete with the existing supply within the City.

Mr. SHIRESS WILL (for the Charing Cross Company) contended that the Corporation clearly meant by its resolutions that the Board of Trade should not stand still, as nothing could be gained by such action.

Mr. BALFOUR BROWNE (for the Smithfield Markets Company) said his clients were best able to supply the City and to meet the wishes of the Corporation, as they were the only one of the three applicants already within the City district.

Mr. GRAY said he was instructed to state that the Corporation did not recognise the Smithfield Markets Company in any shape or form. The Corporation desired to take a position of absolute neutrality in the matter in accordance with a resolution passed on Feb. 23.

Sir COURTENAY BOYLE said the inquiry would now close. The subject would receive the utmost careful consideration of the Board of Trade, which would communicate with the Corporation before coming to any decision.

THE CITY OF LONDON ELECTRIC LIGHTING CONTRACT.

A special meeting of the London Common Council was held on Monday to receive reports as to the legality of the contract with the City of London Electric Lighting Co. and also as to the attitude to be observed by the Council at the Board of Trade inquiry into the applications of three electricity supply companies for Provisional Orders for the City district. After having decided to discuss the matter with open doors, the report of the City Solicitor, embodying the opinion of counsel (Mr. W. O. Danckwerts), was read by the Town Clerk. The Streets Committee now recommended that this report and opinion should be referred back to them, with authority to take further opinion of counsel. The solicitor stated that the question had reference to the alleged breach of section 42 of the Sewers Act (1848) by Alderman Sir Joseph Savory, who had become interested, as a shareholder in the Brush Company, in the electric lighting contracts entered into by the Commission of Sewers and that company. Mr. Danckwerts was of opinion that section 42 of the 1848 Act was still in force and applied to the Corporation, to whom the powers of the Sewers Commission had been transferred. He was of opinion that the section was operative not only with regard to the time at which the contract was made, but to the whole currency of the contract, so that a contract would even be affected by an alderman or common councillor becoming concerned or interested therein after it had been made or entered into. Cases had been before the courts which settled this point, and from these decisions it was clear that a shareholder in a company was so interested or concerned in a contract made with the company in which he was a shareholder, the result being that section 42 of the Sewers Act rendered null and void any contract made between the Sewers Commission and a company which during the currency of the contract had as a shareholder anyone who was a commissioner of sewers or an alderman or councillor. Sir Joseph Savory was a shareholder in the Brush Co. apparently during the currency of contracts with the commissioners, and the contracts so became null and void. He appeared also to have been a shareholder in the existing City of London Electric Lighting Co., as were also other commissioners and common councilmen; and the contracts between the Corporation and the Company were, in his (Mr. Danckwerts) opinion, null and void. If that were so, they could be set up either by fresh contracts or by legislation. The matter might be legally tested by bringing an action against the Company for a declaration, and it might also personally be tested by proceeding for penalty. The City solicitor said if the Corporation were satisfied with Mr. Danckwerts' opinion, and did not deem it necessary to have it justified by that of one of Her Majesty's counsel, the Corporation ought to take immediate steps in the matter. Of course, the opinion was not binding on the City of London Company, and it was not likely that the Company would for one moment admit its accuracy. Should an immediate test be deemed desirable, it would be an easy matter to ask the opinion of a court of law on the subject. If, on the contrary, the Committee were of opinion that advantage ought not to be taken of what was considered by some a technical breach, and by others a serious breach of the statutory provisions alluded to, the Company would still have to be approached with a view to an early removal of the disability under which the Company was working, supposing the opinion he had read to be correct. Mr. Algar, who moved the adoption of the report, and, further, that it should be referred back to Committee in order that further legal opinion might be obtained, said the majority of the Committee was satisfied with the opinion. During the conference with counsel a question was raised as to whether, if a member of the Court had taken at any time a share in the City Company, the contract would become null and void, and counsel replied: "Certainly; but the Company has it within its power to pass a resolution to the effect that no member of the Court of Common Council should be capable of holding shares in the Company." Having regard to the serious position in which the Corporation was placed the Committee now asked the Court to allow them to take the opinion of a Queen's counsel in order to ascertain whether Mr. Danckwerts' opinion would be confirmed. Mr. Alpheus Cleophas Morton made a lengthy speech. He said the characters of the members of the Court of Common Council should be kept clear of all conspiracies and all improper acts, and he hoped the time had come when the Court could deal with the City Company, who had acted so wrongly with the Court. The Company commenced by surreptitiously putting down pipes in the City streets for the purpose of letting them to the National Telephone Co. If the commissioners had done their duty they would have compelled the Company to pull them all up again. The report was then adopted and the Committee was authorised to obtain a further opinion.

The next matter discussed was the report of the Streets Committee relating to the Board of Trade inquiry, and to the request of Sir Courtenay Boyle, K.C.B., to be furnished with the views of the Corporation and the evidence of the engineer with regard to the three applications for Provisional Orders to supply electricity within the City. It was recommended that the following propositions should be adopted:—

(*a*) That evidence be tendered, on the resumption of the inquiry, by the engineer and by the electrical engineer.

(*b*) That if, notwithstanding the terms of the agreement with the City of London Electric Lighting Co., the Board of Trade see fit to exercise the power conferred upon them by section I. of the Electric Lighting Act (1888), this Court is of opinion that the Board should not grant more than one Provisional Order, as a multiplication of the systems of supply would be prejudicial to the interests of the Corporation when the time came to take over the undertakings.

(*c*) That this Court is of opinion that the Board of Trade should not dispense with the consent of the Corporation unless in the case of an applicant who is prepared to accept the insertion in the Provisional Order of such terms and conditions as will secure the immediate and future interests of the private consumers and the public.

(*d*) That, should the Board decide to grant competition in the City, it should be subject to the Corporation having the right to purchase the undertaking (whether within or without the City) on terms to be previously agreed upon.

(*e*) That provision should be made in any Provisional Order to guard against the possibility of combination between two competing undertakers.

After considerable discussion it was decided not to give expert evidence at the inquiry, and to inform Sir Courtenay Boyle that the Corporation did not desire to express any preference for any one of the companies. Recommendations (*c*), (*d*) and (*e*) were then adopted without debate.

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TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"Laboratory Notes and Forms."—With the above title we have ready the New Edition of a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free; abroad 11s.

"The Students' Guide to Submarine Cable Testing."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition now ready.*

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s. *New edition ready May 1, 1899.*

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves."—By Dr. O. J. Lodge, with many original illustrations. *Enlarged Edition*, 2s. 6d. net, 2s. 9d. post free.

"Electromagnetic Theory."—By Oliver Heaviside *Vol. I.*, 12s. 6d. *Vol. II. ready May 1, 1899.*

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"The Manufacture of Electric Light Carbons."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s. 6d.; post free, 1s. 9d.

"The Bibliography of X-Ray Literature and Research, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of genera as well as special information bearing upon the whole subject of electrica discharge research. Price 5s., post free; abroad, 5s. 3d.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. Prospectus on application.

"Electrical Engineering Formulæ," a pocket-book, by Messrs. W Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. A fine large paper edition with wide margins for notes can also be supplied. Price 12s. 6d.; post free, 13s.; abroad, 13s. 6d. *New Edition in the press.*

"The Alternate Current Transformer," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *New Edition.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"The Electrician" Primers.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"The Potentiometer and its Adjuncts": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s. post free; abroad, 6s. 6d. Digest post free.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free; abroad 13s. 6d. Prospectus post free.

"Armature Windings of Electric Machines."—By H. F. Parshal and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

IN THE PRESS.

"The Electric Arc."—By Mrs. Ayrton.

"The Manufacture of Carbons for all Electrical Purposes."—By Francis Jehl.

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. II. ready May 1, 1899.*

"Secondary Batteries, their Design and Manufacture."—By E. J. Wade.

"Primary Batteries: Their Construction and Use."—By W. R Cooper.

"Practical Telephony."—By Dane Sinclair and F. C. Raphae

"'The Electrician' Wireman's Pocket-book."—By F. C. Raphael.

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The "Big Blue Book" for 1899 is Now Ready. The Directory Division has been corrected up to Feb. 8, 1899, and all the latest new names, changes of address, &c., will be found included. The Handbook Division has been much extended, many valuable tables having been added. The volume contains, also, the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways, finally corrected to Feb. 9, 1899. The price of the Directory and Handbook remains the same—10s., post free 10s. 9d.; abroad, post free, 12s. (United States 13s. 6d.).

TENDERS INVITED.

As advertised elsewhere, the *Epsom* District Council invite tenders for the supply and erection of: (*a*) Lancashire boilers and fittings, economiser, feed pumps, &c.; (*b*) pipework, &c., in engine and boiler house; (*c*) steam dynamos and motor boosters; (*d*) storage batteries; (*e*) main switchboard and connections; (*f*) overhead travelling crane; (*g*) underground mains and conduits; (*h*) arc lamps and posts; (*i*) street glow lamps and accessories; and (*k*) station lighting. Specifications, &c., may be obtained from the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C., on and after the 10th inst. Tenders to the clerk (Mr. E. G. Wilson), High-street, Epsom, by noon of May 8.

The *Hampstead* (London) Vestry invite tenders for the supply of two 500-kilowatt steam alternators, five Ferranti or similar type switchboard panels, boilers, feed-water heaters, feed pumps, a 40-kilowatt exciter, water softening plant, air pump and condenser, economiser, overhead travelling crane, &c. Further particulars are set out in an advertisement, and specifications, &c., may be obtained at the office of the clerk (Mr. Arthur P. Johnson), Vestry Hall, Hampstead, N.W., where tenders must be lodged by noon of May 18.

The Electric committee of *Belfast* invite tenders for mechanical stokers, economisers, pipe work and condensing plant. Specifications, &c., may be obtained from the city electrical engineer (Mr. Victor A. H. McCowen). Further particulars are given in an advertisement, and tenders must be sent in to the town clerk (Sir Samuel Black) by noon of Thursday, April 20.

The *Belfast* Electric committee also invite tenders for laying conduits and building junction boxes and for laying cables. An advertisement contains further particulars. Specifications, &c., may be obtained from the city electrical engineer (Mr. Victor A. H. McCowen), and tenders must be lodged at the office of the town clerk (Sir Samuel Black) by noon of Thursday, 27th inst.

The Town Council of *Reigate*, Surrey, require tenders for (1) two water-tube boilers, economiser, brickwork, and flues, (2) steam exhaust and other pipes, steam pumps, &c., (3) two 100 kilowatt and one 20 kilowatt steam alternator, 8-ton overhead travelling crane, and sub-station equipment, (4) switchboard and instruments, (5) mains, lamp-posts, lamps and fittings. Specifications, &c., can be obtained from Mr. F. Hastings Medhurst, consulting engineer to the Council, 13, Victoria-street, London, S.W., on and after April 10, and sealed tenders must be delivered to the town clerk (Mr. Clair J. Grece), 84, Station-road, Redhill, Surrey, not later than noon of Monday, May 1. An advertisement on another page gives further particulars.

As advertised elsewhere, the *Salford* Electric Light committee invite tenders for the supply of 3,220 yards of 0·2 high tension concentric lead-covered cable, compound insulation. Specifications, &c., may be obtained from the electrical engineer (Mr. Chas. L. Turner), Walness-road, Broughton. Tenders (addressed to chairman of Electric Light committee) must be delivered at the office of the town clerk (Mr. Samuel Brown), Town Hall, Salford, by 9 a.m. of Friday, 28th inst.

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The *Darlington* Corporation invite tenders for the supply and erection of:—(1) Lancashire boilers, with mechanical stokers; (2) engines, dynamos, pumps, pipes, &c, Green's economiser and tools; (3) storage battery; (4) switchboard and boosters; (5) arc lamps; (6) feeders, mains and arc light leads, including roadwork. Further particulars are given in an advertisement. Plans and specifications can be obtained at the office of the borough surveyor. Plans can also be seen at, but not obtained from, the office of the consulting engineer (Prof. Alex. B. W. Kennedy), 17, Victoria-street, London, S.W., and tenders must be lodged with the town clerk (Mr. Hy. G. Steavenson), Town Hall, Darlington, by May 8.

As advertised elsewhere, the *Edinburgh* Corporation invite tenders for twelve months' supply of:—(1) steam coal, (2) arc lamp carbons, (3) cast iron pipes, pavement box frames, &c. Specifications may be obtained from the borough electrical engineer (Mr. F. A. Newington), 5, Dewar-place, and tenders must be lodged with the town clerk (Mr. Thos. Hunter, W.S.), City Chambers, Edinburgh, not later than 24th inst.

The Vestry of the parish of *St. Mary, Battersea* (London), require tenders for the supply and erection of (1) feeders, distributing mains, and arc light leads (including laying and jointing); (2) watertube boilers; (3) steam dynamos and engines. Further particulars are given in an advertisement, and specifications, &c., may be obtained from the vestry clerk (Mr. W. Marcus Wilkins), Municipal-buildings, Lavender-hill, London, S.W. Specifications and drawings may also be seen at, but not obtained from, the office of Prof. Alex. B. W. Kennedy, 17, Victoria-street, London, S.W., and tenders must be sent in to Mr. Wilkins on or before noon of Wednesday, June 7.

The *South Shields* Corporation require tenders for steam and water pipes and valves and a 15-ton hand-power overhead travelling crane. Tenders to town clerk by 20th inst.

The *Poplar* (London) District Board of Works invite tenders for engine and pump room equipment and all electrical plant except battery; boiler house equipment; battery and battery stands; and public street lighting. Tenders to Mr. Potts by 10 a.m. April 25.

The *Tynemouth* Corporation invite tenders for boilers, &c., economisers and fittings, ejector-condenser, circulating pumps, tanks and pipework and water cooler, pumps, feed pipes, &c., travelling crane, traction switchboard, lighting switchboard, accumulators, cables, and traction steam dynamo. Tenders to the town clerk by noon of April 15.

The Great Northern Railway Co. (Ireland) invite tenders for cables for feeders, returns, potential lines, &c., 6 motor and 6 trailer cars, overhead construction, and battery and booster. Tenders to secretary by April 20.

The *Peterborough* Corporation invite tenders for the supply and erection of Lancashire boilers and economiser; steam dynamos, balancers and boosters; secondary battery and accessories; switchboard and instruments; piping, tank, condensers and pumps; and insulated cables. Tenders to town clerk by April 20.

The *Hull* School Board invite estimates for the installation of the electric light at the central higher-grade school and school of science. Tenders to clerk by 25th inst.

The *West Ham* Council invite tenders for two 1,500 I.H.P. engines, two 800 kilowatt alternators and exciters, Tenders to town clerk (Mr. Fred. E. Hilleary) by 4 p.m. of April 25.

The Gas and Electricity committee of the *Stockport* Corporation require tenders forstorage battery of 750 ampere hours' capacity. Tenders (addressed to chairman) by 19th inst.

The *Reigate* Town Council invite tenders for the electric lighting of their proposed isolation hospital. Particulars from surveyor, and tenders to town clerk by 19th inst.

The *Dublin* Corporation invite tenders for the supply, fitting and connecting of electric light fittings suitable for a 200 volt supply. Specifications from city engineer and tenders to town clerk by 20th inst.

The municipal authorities of *Almodóvar del Campo*, Ciudad Real, Spain, require tenders for the electric lighting of the streets for 20 years. Tenders by May 5.

TENDERS RECEIVED AND ACCEPTED.

The Gloucester Town Council, at their last meeting, considered reports of the Electricity Supply committee and the consulting engineer (Mr. Robert Hammond), and accepted the following tenders for additional plant required for the electricity works :—

British Insulated Wire Co. (public arc lighting)	£969 16
Blake and Knowles (condensers and air pumps)	567 0
Stanton Ironworks Co. (cast iron water pipes)	400 0
Ashton, Frost and Co. (steel steam, exhaust pipe and drain pipes)	1,185 0

The Aberdeen Town Council have accepted the tender of Messrs. Macartney, McElroy and Co. for the supply of overhead line construction, tram-cars and accessories, switchboard, instruments, &c., for the Woodside electric tramway, at £7,793. The tender of the British Insulated Wire Co., for feeder, pilot and test cables, has been accepted at £5,340. Including the contract for the permanent way and road work, the whole of the contracts amount to £32,153.

The Canterbury Council have accepted, on the recommendation of the Lighting committee and their consulting engineer (Mr. Robert Hammond), the following tenders for additional plant and mains :—

R. Taylor and Sons (one boiler complete and mechanical stokers)	£707 10
India Rubber Company (one 150 kilowatt steam dynamo, steam, exhaust, &c., pipes, condenser, and accessories, centrifugal pump and motor, tools, painting, &c.....	2,622 0
Western Electric Co. (underground mains, cables, &c.)	1,314 0

The tenders for switchboard extension are still under consideration.

The Bury (Lancs.) Town Council have accepted the following tenders :—

Ashton, Frost and Co., for the supply and erection of three electric motors at the sewage works. Eighteen tenders were received.

W. Lord, for the supply and erection of Lancashire boiler with steam and other pipes. Two tenders received.

Scholes and Sons, for the wiring of the sewage works. Twelve tenders received.

The following tenders have been obtained by the Fulham Vestry for the supply of generating plant, mains, &c., in connection with their electric lighting scheme, and have been referred to the Electric Lighting committee and the consulting engineer (Mr. F. H. Medhurst) for analysis and report :—

British Insulated Wire Co.....	£51,542	8	6	S. Z. de Ferranti (Limited)	£49,339	17	2
John Fowler & Co...	50,815	2	6	Brush Co.	47,282	0	0
Johnson and Phillips	49,927	6	0	General Electric Co.	45,718	7	10

The tenders were not publicly invited, the above firms being asked to submit estimates privately.

The following tenders were accepted by the Hammersmith (London) Vestry at their meeting on Wednesday evening :—

Babcock and Wilcox, three water tube boilers, £3,320.
J. Musgrave and Co., two vertical steam engines, £7,284.
Siemens Bros. and Co., two alternators, £5,684.
Callender's Co. cables, at schedule prices.
James Ritchie, cast iron pipes at schedule prices.

The Liverpool Corporation have extended the contract with the Callender company for the supply, laying and maintenance of electric light mains for two years.

The Burton Town Council have accepted the tender of Tinkers (Limited) for the supply of additional boilers at the electricity works for £1,980. Originally the Council were recommended to accept the tender of Messrs. Edwin Danks and Co., but the labour members objected to the acceptance of the tender as they alleged the firm did not pay the standard rate of wages. The actual result is that the Council pays £285 more by the acceptance of a fresh tender. The tender of Messrs. Westwood and Wright has also been accepted for the supply and erection of ironwork at the station.

The Rothesay Town Council have accepted the tender of Messrs. Lowdon Bros. for the supply and erection of two 20 H.P. coupled engines and dynamos, switchboard, cables, arc lamps and posts, feed pumps, steam and exhaust pipes, &c., at £2,501. 19s. 2d.

The tender of Messrs. James Carrick and Sons has been accepted by the Brighton Town Council for the supply of a 20-ton travelling crane at the electricity works at £415. Messrs. Carrick and Ritchie also tendered at £498.

The Dundee Tramways committee recommend the Council to accept the following tenders :—Cooper and Greig, four Lancashire boilers and seatings, £3,058; Lowdon Bros., two 450 H.P. steam dynamos and one 700 H.P. steam dynamo, £9,700. The steam dynamos are to be Willans'—Thomson-Houston sets.

The Plymouth Town Council have accepted the tender of the Edison and Swan Co. for the supply of sub-station transformers at schedule prices, and arc lamp carbons at £5 per 1,000 pairs. The tender of the Brush Co. for the supply of street-box transformers at schedule prices has also been accepted.

The Winchester Town Council have accepted the tender of Messrs. E. H. Gudgeon and Co., for wiring the public offices, public library and art school, at £214. 7s. 8d.

APPOINTMENTS VACANT AND FILLED.

The Gas committee of the Keighley Corporation require an electrical engineer to prepare specifications, &c., of an electric lighting scheme. Further particulars are given in an advertisement, and applications (addressed to the chairman of the committee) must be sent to the town clerk (Mr. George Burr) by May 1.

The Leyton District Council require a draughtsman for their electricity department to work under the instructions of the Council's chief electrical engineer. Salary £100 per annum, rising to £150. Some further particulars will be found in an advertisement. Mr. R. Vincent, Town Hall, Leyton, is clerk to the Council.

The Belfast Electric committee require an assistant electrical engineer. Further particulars are given in an advertisement, and applications must be lodged with the city electrical engineer (Mr. Victor A. H. McCowen), Central Station, East Bridge-street, Belfast, by Tuesday, 25th inst.

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The Salford Corporation require an assistant electrical engineer. Salary, £160 per annum. Applications (addressed to chairman of Electric Light committee) must be delivered at the office of the town clerk (Mr. Samuel Brown) before 9 a.m. of Tuesday, 18th inst. See advertisement.

The Hull Electric Lighting committee require two junior assistants. Applications to city electrical engineer (Mr. A. S. Barnard), Electric Light Station, Dagger-lane, Hull, by April 20. See advt.

The Sheffield Corporation require a mains superintendent, at a salary of £250 per annum. Applications to the manager and engineer (Mr. Wm. Johnson), by 27th inst. See advertisement.

The Central London Railway Co. require a traffic superintendent and an accountant. Applications to secretary, 16, Great George-street, S.W., by 29th inst.

Mr. H. Haskayne, assistant superintending engineer of the South Wales district Postal Telegraphs, has been appointed superintending engineer of the North Western district at Manchester, in succession to Mr. John Doherty, who recently retired. Mr. Haskayne joined the old United Kingdom Telegraph Co. at Liverpool in 1863, and after six years' service went to Leeds, where he remained until 1870. When Government took over the telegraphs Mr. Haskayne was transferred to the commercial branch, but in 1874 he was appointed to the engineering department. In 1892 he was promoted to the position of assistant superintending engineer of the South Wales district under Mr. J. Gavey.

Dr. J. T. Nicholson, of Montreal, has been appointed lecturer in the engineering department of the Manchester Municipal Technical School.

BUSINESS NOTICES.

Under the title of the Helios Electrical Construction Co., a company has been formed to represent in this country the well-known firm of Helios, Cologne, one of the oldest electrical concerns in Germany. The company has offices at 49, Cannon-street, E.C., and has appointed Mr. A. C. Eborall (who was at one time with Messrs. Brown, Boveri and Co.), as their chief engineer. We are informed that the company will have special facilities for quick deliveries of lighting and power plant.

Owing to the parliamentary and preliminary work in connection with the Midland Electric Corporation for Power Distribution being nearly complete, Mr. G. L. Addenbrooke has closed his Wolverhampton office, and future communications should be sent to 53, Victoria-street, London, S.W.

Messrs. Pratt and Keith, of Aberdeen, have added an electrical department to their business, and Mr. Alex. Lindsay has been appointed electrical engineer.

BANKRUPTCIES, LIQUIDATIONS, &c.

The following are among the creditors in the bankruptcy of Daniel W. Paine, electrician, 84, Gloster-road, Brighton :—

A. Bunting	£33	General Electric Co.	£16
Fuller and Co.	30	H. M. Salmony and Co.	15
Crystal Lamp Co.	28		

The liabilities are returned at £162. 3s. 8d.

At a meeting on 5th inst., at 31, Bedford-row, London, W.C., it was resolved to wind up the Electrical Time Recording Co. (Limited) voluntarily. Mr. A. B. Clifton is liquidator.

Claims against R. C. Douglas, of Mayfield, Urban-road, Sale (formerly trading as the Manchester Electric Co. at Haworths-buildings, Cross-street, Manchester), must be in by 21st inst. Mr. C. J. Dibb, Byrom-street, Manchester, is trustee.

Electrical Standardizing, Testing and Training Institution.—The new session of this institution has just commenced. Particulars of the course of study will be found set out in an advertisement on another page.

Electric Launches.—Messrs. Laing, Wharton and Down will supply, post free, a well illustrated brochure describing the "Vril" launches, motors, controllers, &c. The particulars given will prove especially interesting to yacht owners.

The "Engineering Magazine."—The contents of the April issue of this magazine include: "Commercial Aspects of Electric Traction in Great Britain;" "America and Germany as Export Competitors and Customers;" "Machine-shop Management in Europe and America;" "The Monitor, the Battleship, the Cruiser, and the Destroyer;" "The Merits and Permanency of the Masonry Arch Bridge;" "The New Terminal of the Orleans Railway at the Quai d'Orsay;" "Depreciation as an Element of Machine-shop Cost-keeping;" "The Development of Wood-working Machinery;" "The Prospective Expansion of American Shipbuilding;" and "The International Association for Testing Materials." The usual review of the engineering press is also given. Copies of the magazine may be had at 1, 2 and 3, Salisbury-court, Fleet-street, London.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from March 31 to April 11, with the ports of destination :—

Argentina—Buenos Ayres, £1,875 (including £517 telegraph material); *Australasia*—Melbourne, £773 (telegraph material); Nelson, £115 (telegraph material); Newcastle, £480; Sydney, £2,753 (including £741 telegraph material); Wellington, £1,962 (including £1,715 telegraph material); *Belgium*—Ostend, £116. *Chili*—Boca, £15. *China*—Shanghai, £295. *Denmark*—Copenhagen, £49. *Egypt*—Alexandria, £5. *France*—Boulogne, £18. *Germany*—Hamburg, £110. *Holland*—Amsterdam, £20. *Hong-Kong*, £182. *India*—Bombay, £311 (including £133 telegraph material); Calcutta, £430; Madras, £330 (including £134 telegraph material). *Japan*—Yokohama, £390. *Java*—Ballek Pappen, £290 (telegraph cable). *Malta*—£1,501 (including £1,450 telegraph instruments). *Portugal*—Lisbon, £80 (telegraph material). *South Africa*—Cape Town, £523; Durban, £1,248; East London, £3,461; Port Elizabeth, £1,045; Zanzibar, £26 (telegraph material). *Straits Settlements*—Singapore, £171 (including £132 telegraph material). *Sweden*—Stockholm, £780 (telegraph material). *West Indies*—Trinidad, £13. Total (for 12 days) £19,367, against £16,127 for two days last year (April 6 and 7).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

All-British Cable Schemes.—In *The Times* of April 1 there appeared a letter signed "Colonial," which contained the following statement, among others :—

"Some years ago the Pender group effected an amalgamation of office in Hong Kong, with the Great Northern Telegraph Co. of Copenhagen, whose cable connects with the Russian Government Telegraph Administration. It would seem that the Danish Company handed over its right in that agreement to Russia, inasmuch as the Company's representative in London declared in an interview some months ago that the cable worked from the joint office and introduced as a Danish cable is now Russian property. Consequently the Pender group are responsible for the existence of this dangerous anomaly—that Russian officials are admitted to an important telegraph office, in an outpost of the empire, through which all telegraphic communications with our Government, public, and Press must necessarily pass! There, at any rate, the door is wide open. It will not do for the Pender group to plead ignorance of the intimate relations existing between the Danish Company and the Russian Government; that was a matter of common knowledge in China long before the amalgamation."

Mr. F. C. C. Nielsen, representative of the Great Northern Telegraph Co. in this country, has replied as follows in *The Times* of the 11th inst. :—

"The letter of April 1, signed 'Colonial,' states that the Great Northern Telegraph Co.'s 'representative in London' declared in an interview some months ago that the cable worked from the joint office (in Honk Kong), and introduced as a Danish cable, is now Russian property. Permit me to point out—first, that I am not aware of having had any 'interview' with anybody on the subject referred to for a whole year, or not since April, 1898, and the gist of my observations on that occasion to a representative of the *Westminster Gazette*, as quoted in that paper of April 27, 1898, was quite the reverse of the statement attributed to me by 'Colonial'; secondly, that I never made, nor could have made, any such statement—(1) because, as pointed out at the said interview, one of the very objects of the joint working arrangement of the two companies in the Far East was to leave the leadership and control of the Hong Kong station to the British Company (the Eastern Extension Telegraph Co.); (2) because the cable from Hong Kong to Amoy, and further to Shanghai, Japan and Siberia is and always has been the property of the Danish Company (the Great Northern Telegraph Co.), in whose service there is not a single Russian, but a number of Englishmen, and whose shares are more largely held in this than in any other country, while not a single share is held in Russia. As to the relations of the Company with foreign Governments, they are, happily, as intimate with the British as with the Russian and other Governments on whose territories our cables are landed. The other invidious insinuations of 'Colonial' I may safely leave unanswered; they are beneath notice."

It is announced that the Canadian Government has decided to introduce a Bill by which Canada agrees to pay $\frac{5}{8}$ths of the cost of laying a submarine telegraph cable from Vancouver to Sydney, so soon as the Imperial Government is prepared to contribute a similar proportion, leaving the Australian colonies to complete the cost. Sir Charles Tupper and Sir M. Bowell have jointly congratulated the Canadian Premier (Sir William Laurier) on the Government proposals.

Argentina.—In a report on the trade of the Argentine Republic for 1898 attention is drawn to the great progress of electric lighting and power schemes in Argentina. Buenos Ayres is crossed and recrossed by electric tramways, and three extensive electric lighting concerns have been established—one British, one German and one French, making four companies in the Buenos Ayres district, all in full working order. The two electric tramway companies are both British, but a German company has recently bought up the Metropolitan Tramway Co. and intends to convert the line into an electric one. The number of passengers carried on the Buenos Ayres tramways in 1898 numbered 106,000,000, while the railway running into the city carried only 11,000,000 passengers.

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Bath.—By a narrow majority of one the question of constructing electric tramways has been shelved by the Surveying committee.

Blackburn.—The Council have decided to apply for sanction to borrow a further £25,500 for electric lighting and tramway purposes, to cover the requirements of the lighting and tramway department during the present year.

Bootle.—The date of the formal opening of the electricity works has been fixed for the 20th. The Electric Light committee intimate that they hope to bring forward at the next council meeting a scheme for the supply of current throughout the borough.

Bournemouth.—The Board of Trade have intimated to the Council that they are prepared to grant them a provisional order for public lighting only. The Town Clerk has been instructed to urge the Board to grant the order as drawn, and, if necessary, to hold a local inquiry.

Bradford.—At a meeting of the Bradford and District Trades and Labour Council, held last week, a delegate from the Electrical Trades Union asked for assistance in fixing a standard rate of wages for electric wiremen, who, in Bradford, were said to be in a very poor way in regard to wages. Some of the largest firms in the town (the delegate asserted) paid the least wages. The men thought that 8d. an hour was quite little enough, but they had had to accept 4½d. Electric light wiremen had to keep themselves respectable, and were liable to be called upon to work in very different places—from a coal mine or a workshed to a gentleman's house. The average wages paid to wiremen in other towns were considerably in advance of those paid in Bradford, and in Leeds and Manchester it was 8½d. per hour. Mr. Hayhurst said every electric light wireman who came into Bradford had to obtain the permission of the Electricity committee of the City Council before he could start work. The difficulty of the City Council was that they could not fix on any standard which the Electrical Trades Union had established. It was decided to hold a conference on the subject.

Burton-on-Trent.—At the recent inquiry into the Council's application for a loan for electric lighting extensions, a Mr. Wardle appeared in opposition, and passed certain criticisms on the system of supply and the management of the electricity undertaking. A lengthy report in reply has now been prepared and issued by the engineer and manager of the gas and electric light works (Mr. F. L. Ramsden), in which he deals with Mr. Wardle's comments *seriatim*. Mr. Ramsden first deals with the system of supply, and points out that in 1892, when it was decided to engage in electric lighting, their system was only adopted after careful consideration, and of the 14 firms who tendered for the supply of plant, 11 recommended the alternating current system, and two the continuous. The failures of the light had not been caused through any fault in the system but through the unsuitability of the insulating material of the high-tension mains. If it should be decided to establish electric tramways in Burton, they could, by the addition of suitable plant, supply the current as well and as cheaply as if they had the continuous-current system, and it would have been quite as necessary to put down special plant for tramways if they had originally adopted the latter system. Figures are quoted from the statistics given in *The Electrician* supplement sheet table (published in January) in order to refute Mr. Wardle's assertion that the alternating-current system is obsolete. The questions of the site of the station, machinery, mains, voltage, public lighting, financial results and extensions are also fully dealt with. Mr. Ramsden intimates that as soon as the additional plant has been fixed he will bring forward a "free" wiring scheme for the consideration of the Council. As to the objections to extensions, Mr. Ramsden has no difficulty in proving the futility of Mr. Wardle's statements. Our feeling in reading Mr. Ramsden's exhaustive report is that he has taken his critic too seriously, for not every self-constituted critic of electricity supply is thus honoured. Some of Mr. Wardle's statements were so utterly absurd as to carry their own refutation.

Caldas (Spain).—The local electric light company (a French concern) has taken advantage of a waterfall about one kilometre above this town to erect electricity works for lighting the towns of Padron, Carril, Villagarcia and Cambados. A contract has been entered into with the councils of these towns for public lighting, and an electric tram-line is to be constructed from Villagarcia to Cambados, a distance of 11 kilometres. It is anticipated that the lighting works will be opened early in June.

Cherbourg.—After an extensive trial of the Serpollet system of steam tramway traction, it has been decided to substitute electric tramcars on the overhead trolley system on the local lines. A telephone service is also to be installed.

Chesterfield.—The Council has received from an electricity supply company an offer to supply electricity in bulk at 2½d. per unit. The Council has appointed a special committee to consider the offer, and the committee thinks it could supply current at 1d. per unit. The question will be discussed at the next Council meeting.

Colchester.—The borough surveyor is engaged in the preparation of a report as to the advisability of providing additional electric lighting plant to meet the anticipated increased demand for current during the next two years.

Douglas (Isle of Man).—An electric lighting scheme, estimated to cost £12,000, has been decided upon by the Council. The Electric Light committee are to submit details of a project on the lines laid down by Prof. Fleming in his report to the Council.

Durham.—Like other local authorities, the Durham Council are endeavouring to induce the Board of Trade to allow the customary transfer clause to be inserted in their provisional order.

Eastbourne.—The borough surveyor has been authorised to prepare a scheme of electric tramways or light railways for this town.

Electrical Trades Union.—We are informed that it has been agreed to institute an apprenticeship system in connection with this union, and to admit electric traction employés as a separate section. It has been decided to increase the unemployed, strike and funeral benefits, and to add sick benefit. The fifth conference of the Union was held at Manchester on March 31 and April 1.

Electricity v. Gas.—At the annual meeting of the Scottish Gas Managers at Glasgow last week the president (Mr. William Young, of the Hamilton gas works) said that incandescent gas lighting still kept electricity in the background as an economical light, though, for the sake of being sole purveyors of light, Corporations who were at present owners of gas works would sooner or later have to supply the two illuminants or allow a company to come in and supply electricity. Mr. M'Gilchrist, of Dumbarton, did not know how it was that the producers of electric current were rushing away to the north when they had a much larger field before them in the south. He thought there was nothing to fear from electric light in the north. As a gas manager he would be very well pleased if an electric light company would go to Dumbarton and take up the lighting of the streets, because they could do that with more efficiency, and it was not a source of profit to a gas manager.

Electric Light at Buckingham Palace.—In the House of Commons on Monday, on the vote for works at the Royal palaces and Marlborough House, Mr. Caldwell asked when the electric light installation at Buckingham Palace, which was estimated to cost £11,000, and on which £3,500 had already been expended, was to be completed. The First Commissioner of Works (Mr. Akers-Douglas) explained that the amount which they were taking this year for the extension of the electric light in Buckingham Palace was an amount on account. A further sum would probably have to be expended before the service was complete. This matter was very carefully gone into by a committee two or three years ago from the point of view of safety from fire, and it was decided that, as far as possible, electric light should be used.

Farnworth (Lancs).—The Electrical committee is considering the terms of the Bolton Council to supply electricity "in bulk" in this district.

Fraudulent Bankruptcy.—At the Old Bailey (London) the Common Serjeant, on Wednesday, sentenced Claude Theodore James Vautin, electro-metallurgist, &c. (who pleaded guilty to an indictment charging him with having within four months before the presentation of a bankruptcy petition against him quitted England with a sum of £4,380 with intent to defraud his creditors) to six months' imprisonment without hard labour. Application was made that the money recovered should be handed over by prisoner's trustee in bankruptcy for the benefit of the creditors, and the Common Serjeant said no doubt the police would do this if formal application were made,

Fulham (London).—The Vestry have applied to the London County Council for a loan of £100,000 (to be repaid in 42 years) for electric lighting purposes.

Garston (Lancs.).—A hitch has occurred in the negotiations for the transfer of the Council's provisional order. The British Insulated Wire Co., to whom it is proposed to transfer the order, insist upon the Council taking the risk of the transfer being approved by the Board of Trade, a condition which the Council object to. On the completion of the transfer the company offer to pay all costs, but the Council require a depost of £200, and this the company are not willing to deposit.

Greenock.—Mr. John Young (manager of the Glasgow tramways) has been requested to prepare a report on the tramways in this town.

Harrogate.—The Council have taken up a loan of £15,750 from the Prudential Assurance Co. for electric lighting purposes.

Hereford.—An inquiry has been held here into the application of the Council to borrow £20,000 for electric lighting purposes. The town clerk (Mr. Carless) supported the application, and said that in 1823 the cost of public lighting by oil was £118. 2s. 6d. per annum, and in 1824 they entered into a contract for gas lighting

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t a cost not exceeding £150 per annum. A number of tradesmen in the high town had private electric lighting installations, and the result was to create a demand for current for private lighting. A site for the generating station in Widemarsh-street had been acquired for £1,650. The continuous-current three-wire system of distribution would be adopted, and it was proposed to supply current at 220 volts. The estimated cost of the installation was £19,976.

Infirmary Lighting.—The Mill-road Infirmary of the West Derby Guardians is now lighted electrically. The plant has a capacity of 1,400 16 c.p. lamps. The boilers were supplied by Messrs. Fawcett, Preston and Co., and the steam engines by the Mirrlees, Watson and Yaryan Co., of Glasgow. A Chloride storage battery of 900 amp. hours' capacity has also been provided. The wiring work was executed by Messrs. Woodward and Craig, and the whole of the work has been carried out to the specification of Mr. Thomas L. Miller, of Liverpool.

Kilmainham (Dublin).—The Council has appointed a committee to consider and report upon the offer of the Municipal Industries Syndicate to supply electric current in the district. Mr. C. W. Sax attended on behalf of the syndicate at the last Council meeting to explain the syndicate's proposals.

Liverpool.—At the Council meeting, last week, Mr. Crean drew attention to a resolution of the Electric Power and Lighting committee, according to which, out of £84,000 standing to the credit of the committee, £9,000 was to be devoted to reserve and renewal, and £1,000 was to go in reduction of rates. He proposed the matter be referred for the reconsideration of the committee. Mr. John Henderson, who seconded, said that he fully expected that, in consequence of the reduction made in the price of current, to find a large diminution in the profits, but there was apparently an available balance of only £8,000, compared with £14,000 in the previous year. He found, however, that there was an extraordinary charge of £6,000 for the change of pressure supply. Notwithstanding the reduction in the price, the receipts were positively £4,000 or £5,000 more, and, instead of a net profit of £8,000, as it appeared in the account, it was really £13,000. Was not the electrical undertaking intended to relieve the ratepayers? If, however, profits were to be dealt with in this way, the ratepayers were not likely to get much benefit. In reply, the chairman of the committee (Mr. Petrie) stated that their policy was to bring electricity into closer competition with gas. In spending a large sum on their generating station they must get more consumers, and the only way to do that was by getting more people connected with their mains.

The City Council have sanctioned the revised scale of charges for electric current set out in our issue of 24th ult.

Lowestoft.—At an inquiry into the application of the Council to borrow £30,000 for electric lighting, the town clerk said that tenders had already been obtained (and provisionally accepted) for the supply and erection of plant and mains. The consulting electrical engineer (Mr. W. C. C. Hawtayne) submitted plans and specifications. The continuous-current three-wire system of distribution was proposed, and current would be supplied at a pressure not exceeding 500 volts. For street lighting it was intended to erect 32 arcs, and two 32 c.p. incandescents would be attached to each of the pillars for use after midnight. The aggregate capacity of the plant would be 225 kilowatts, in addition to which a 400 ampere hour accumulator battery would be provided. The estimate of capital outlay was as follows: Buildings, £4,000; generating plant (including boilers, engines, dynamos, accumulator, battery, switchboard, pipework, pumps, engine room overhead, travelling crane and station lighting), £7,973; underground mains for private lighting, £8,162; public lighting, £757; meters and house service connections, £2,000; engineering and legal expenses, £1,500; contingencies and unforeseen, £500; extension to Belle Vue Park, seven arc lamps and private distributing mains, £480; also Grand Hotel, Kirkley, 13 arcs for private distributing mains, £2,800; total, £28,172. There was no opposition.

Manchester.—As the Corporation will shortly be called upon to supply electric current for traction purposes, the question of the provision of separate generating plant for the tramways, as recommended by Mr. Parshall at Glasgow, is exciting some interest in civic circles. The city electrical engineer (Mr. C. H. Wordingham), however, is of opinion that, as the plant employed at Manchester is capable of supplying current for lighting and traction, it is not necessary to provide special traction plant. The combination of the lighting and traction undertakings rendered it possible to have a larger generating station with less cost for attendance per unit generated; it reduced the losses from idle plant, &c.; and the cost of supervision was minimised. Under a dual system the repairing staff would require to be duplicated. Combination would also effect a reduction in the amount of spare plant required, and other economies could also be effected. The position was debated at some length by the Tramways committee on Tuesday, when it was decided to appoint a special committee to confer with the Electricity committee in regard to the generation of electric energy for the tramways, and the committee were empowered to obtain such expert and other advice and assistance as they might deem necessary.

Contrary to the recommendation of their Telephone committee, not to send a deputation to the Chancellor of the Exchequer in support of the application of the Mutual Telephone Co. for a telephone licence for Manchester, the City Council have elected Aldermen Southern and Copeland to attend and support the company's application.

Newcastle-upon-Tyne.—In February last, the borough engineer (Mr. W. G. Laws) was instructed to report (along with Prof. Alex. B. W. Kennedy) as to "whether in the streets in the centre of the city some system other than overhead traction is practicable to be worked in conjunction with the overhead system in the other streets." Before the promotion of the last Tramways Bill, Mr. Laws had reported in favour of cabling the tramways, but the new Tramways committee obtained two other reports—one from the late Dr. John Hopkinson, who strongly recommended the overhead trolley; but as there was considerable objection to the use of this system in the centre of the city it was thought advisable to obtain further information on the matter. Owing to Prof. Kennedy being compelled to visit the United States on behalf of the London County Council, he has not yet been able to visit Newcastle in order to prepare his report. In the report under notice, Mr. Laws strongly objects to the overhead system on æsthetic grounds. So far, he says, no stress has been laid on the æsthetic objection to the overhead wires as an eyesore that would seriously damage the appearance of a fine old town. There was still hope that those whose sense of the fitness of things led them successfully to resist the proposed invasion of the telegraph, telephone and electric light companies (who would cheerfully have spun their unsightly web over the town to save their own pockets) would yet hesitate to do themselves what they rightly refused permission to others to do. After expressing himself in the strongest possible language against the trolley for traction, Mr. Laws says the lighting of the streets should not be run from the same circuit as the trams, or the consequences of temporary failure would be intensified, and "just when the trams were left helpless in the streets, the light that should guide other vehicles would be wanting." He is of opinion that the suggested æsthetic sacrifice was unnecessary, and asks, "Is there any system by which electric traction is possible without the poles and wires?" There were the underground conduit, the surface contact, and the self-contained automotor car; but of each of these there were several modifications, all of which had been tried, and several of them successfully. Mr. Laws refers to Siemens and Halske's conduit system as being in successful operation in Buda-Pesth and other places, while Love's conduit had been installed in Washington and New York. The Simplex had been laid down experimentally at Prescot, and to his mind it was the most promising of the open conduits, and well worth considering. He understood that the first cost of this system was but little in excess of the trolley. The culvert or conduit was so shallow (only 17in. below rail level), that it could be constructed within the thickness of an ordinary first-class paved road, and so avoid the extensive alterations to gas or water pipes that have proved so costly with the deeper conduits. The Love system had a separate conductor for the return current, thus avoiding danger of electrolysis to neighbouring pipes. Of all the conduit systems, these two seemed to him to promise best, and, subject to the technical point of whether they would work in the English climate as well as the underground system did in Buda-Pesth, and was said to do in New York, they appeared to him to be mechanically right. Mr. Laws next deals with the cost of working. They had no information as regarded the Simplex, and only one report as to the Love system, which was as under:—

Operating Expenses per Car Mile for –

	Chicago, 1895.	Chicago, 1898.	New York, 1898.
Cable	5d.	... 5¼d.	... 8¼d.
Horse	12⅜d.	... 13d.	... 9d.
Electric ...	8½d. (trolley).	... 6¾d. (trolley).	... 5½d. (conduit).

If the New York figures were reliable, they showed that underground electric is run at even less than overhead. This required some explanation. When, in 1893, the favourable results at Buda-Pesth were announced, he expressed his doubts as to whether these results would be realised in the English climate. He still held those doubts, though they were to some extent shaken by the New York results. But, if in America conduit could rival trolley, there was no apparent reason why it should not do so in England. Mr. Laws declares that the objections to the surface contact system are fatal, and as to automotive or accumulator systems he observes that if financially possible there was no other system that could offer such advantages. There was no more interference with the streets than in the case of a horse tramway, no underground complication, no overhead abominations. The chief objection to the accumulator system was the great weight of the accumulators, increasing the dead weight to be hauled (always large in electric

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cars) by about two tons. The experiments hitherto made in England had not been financially successful. In Birmingham they resulted in a loss of 2d. per car mile. The whole question hinged on the invention of a suitable storage battery, lighter, more effective, and more durable than anything hitherto tried. That this want would be supplied the rapid progress of electric knowledge led one to believe. That it was being gradually improved one saw. During his visit to Copenhagen in 1897 he found a short automotive line in full work running from Kongens Nytorv to the Jagt Vej, a distance of something over a mile and a half. The fare for the run was ½d. He was unable to ascertain anything about costs of working, being told that they were not made public yet, but came to the conclusion that if with such fares the line could even exist, the system was by no means out of the running. The charging of the batteries was done in the public square of Kongens Nytorv in the heart of the town, from small pillars, less in size than an ordinary hydrant, with a small flexible hose or cable attached. The car, as soon as it reached the terminus, was shunted on to a short siding, the plug of one of these cables stuck into a small hole in the car side, and there it waited its turn for service; a charged car being run out of the forward end of the siding for the next journey. There was no vapour observable, and the cars were even more manageable and handy than the trolley car. Mechanically, the whole of Newcastle could be worked on such a system, from one charging station. The only doubtful point was that of working cost. Mr. Laws thinks that if the council adopt the conduit in the centre of the town, it would be possible to work it in conjunction with the trolley in the outskirts. As to the question of within what radius the conduit or other poleless system should be adopted, he thought that the wider such radius was the better. To sum up, and put my opinion on record (says Mr. Laws) it is this:—Unless expert opinion condemns the conduit as unworkable in this climate, it should be adopted as against the trolley, certainly in the major part of the town. If the council comes to that opinion, the Simplex, or some modification of it, is the most promising, and, failing that, the Love. But again, unless expert opinion condemns the accumulator, as worked at Copenhagen, and it proved to be financially impossible, that is preferable to either conduit or trolley.

The poll of property owners and ratepayers on the proposal to construct an electric tramway in the town has resulted in a majority of 1,207 votes in favour of the Council's Bill—12,633 for, and 11,416 against.

New Pacific Cable Scheme.—The *Standard* of Tuesday contained a communication from its Berlin correspondent giving some particulars of the project of the New York Pacific Cable Co. for laying a submarine telegraph cable between the United States and the Philippines, a distance of 11,000 miles. According to the particulars published, the cable is to touch at Hawaii and the Carolines, thence to the Southern Ladrones and on to Manila. The weight of the cable is to be 28 tons per mile, and a one-sixteenth slack is to be allowed. According to the particulars given, the cost of the cable is to be "$1,000 per mile." The starting-point is to be Monterey, California, the other end being the Island of Luzon. Two years are to be allowed for the manufacture and laying of the cable. The longest section of the proposed cable will be from San Francisco to Hawaii—2,098 miles. Those of our readers interested in Pacific cable schemes will, doubtless, turn to the columns of our contemporary for further particulars.

Perth.—The Council have unanimously decided not to part with their provisional order, and steps are to be taken to establish municipal electricity supply.

Ramsbottom.—The Lighting committee have been authorised to take into consideration the question of taking immediate steps for providing a system of electricity supply.

Shrewsbury.—Four additional arc lamps are to be erected by the Electric Lighting committee and various extensions of the plant and mains, which have been recommended by the borough electrical engineer (Mr. C. M. Johnston), are to be carried out at an estimated expenditure of £4,139.

Southport.—In a report to the Electric Lighting committee the borough electrical engineer (Mr. C. D. Taite) estimates that a sum of £55,000 will have to be spent in providing additional electric lighting and traction plant during the next two years, the greater part of this outlay being due to the proposal of the Council to establish a system of electric tramways. The electricity undertaking is making steady progress. The number of consumers at the end of March was 520, and the equivalent number of 8 c.p. lamps connected was 35,489. The matter was discussed at the Council meeting on Tuesday, when Mr. Taite's proposals were submitted by the committee for the Council's approval. After discussion, however, it was decided to consult with the Finance and Tramways committees before finally deciding the matter.

Stretford.—The Council have applied to the Board of Trade for a two years' extension of the period for complying with their provisional order, obtained in 1897.

Telephone Trunk Line Extensions.—The telephone trunk line system of the country has been extended to Newquay, Cornwall.

The Electrical Industry in Germany.—Seven of the most important electrical firms in Germany have issued a circular to the effect that, in consequence of the higher prices of raw materials, they have decided to increase by 5 per cent. the prices of various electric products. The circular is signed by the Siemens and Halske, Aktiengesellschaft, the Allgemeine Elektricitäts Gesellschaft, the Schuckert Company, the Helios Company, O. L. Kummer and Co., the Lahmeyer Company, Felten and Guilleaume, and some smaller firms.

Tin v. Copper.—A financial contemporary, in referring to the important rise in the price of tin, ascribes this to a development in the use of this metal in substitution for copper in electric installation work.

Train Lighting.—The Board of Directors of the South Indian Railway have considered a report submitted by their agent on various systems of lighting trains, and has approved of the "Stone" system, which was described in *The Electrician*, Vol. XXXIX., p. 808, and has called for an estimate of its cost with a view to its adoption.

Tramways in Spain.—Messrs. Dick, Kerr and Co. have sent us a pamphlet reprint of articles descriptive of the Barcelona and Madrid electric tramways. The illustrations, photographic views, and sectional drawings are excellent.

Wallasey.—An inquiry was held here on Wednesday into the application of the District Council to borrow £10,000 for electric lighting purposes. The present loan was the balance of the expenditure proposed (£27,540) to be incurred in 1897, and was made up of £5,000 for a 300 kilowatt alternator, £1,500 for boilers, £1,200 for cable, £1,000 for service meters, and other minor items. The engineer (Mr. J. H. Crowther) stated that he did not think any portion of the amount would be needed before next year, but the district was rapidly increasing in population, and the demand for current was keeping pace with that increase. The proposed extension would be sufficient to meet their requirements for three years at the present rate of increase. There was no opposition.

Walsall.—In order to encourage the increased consumption of electric current for lighting, the Council have decided to allow an additional discount of 10 per cent. where the yearly consumption is between 10,000 and 15,000 units, and a discount of 12½ per cent. when more than 15,000 units are used.

Will.—The will of the late Mr. William George Forster, for many years a superintendent of the Eastern Telegraph Co., was proved on March 8, by Mrs. Jessie Forster, the widow and sole executrix. The value of the estate is £3,597 16s. 2d.

Worcester.—The Streets committee are to obtain expert opinion as to the advisability of taking over the local tramways, and as to the probable cost of converting the lines to electric traction.

PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. Chapman and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application an asterisk is affixed.*

February 28, 1899.

4,360. E. Vedovelli and C. Priestley. London. Improvements in or relating to apparatus for use in electric traction on the conduit system.

4,370. P. Stevenson. Glasgow. A rise and fall pendant or electrolier for electric light.

4,409. A. Heiny. London. Automatic telephone exchange system.

4,415. H. H. Lake. London. Improvements in apparatus for use in electro-plating. (R. H. Boissier, United States.)

4,416. B. L. Lamme. London. Improvements in direct current systems of electrical distribution. (Date applied for under Patents, &c., Act, 1883, Sec. 103, August 4, 1898, being date of application in United States.)

4,417. F. Jones and F. A. Pocklington. Liverpool. Improvements in or relating to conduits for electric conductors.

March 1, 1899.

4,455. R. Riley, T. Winstanley and S. Riley. Manchester. Improvements in and appertaining to electric street tramways.

4,486. J. E. Kelly. London. Improvements in electric signals and alarms.

4,496. G. Bowron. London. Improvements in or relating to electrical contact-breakers.

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4,498. G. Blank and H. M. Salmony and Co. (Limited). London. Improvements in and relating to telephonic apparatus.
4 512. W. J. Murphy and G. Draper. London. Improvements in and relating to perforators for use in connection with automatic telegraph transmitters.
4,528. A. R. Gould. Manchester, Improvements in electric bells for cycles and other vehicles.

March 2, 1899.

4,595. R. H. Lendrum. Huddersfield. Improvements in apparatus for working tramways by electric power.
4,598. J. Sturgeon. Leeds. Protecting the overhead wires of electric tramways and construction of trolley or current collector adapted thereto.
4,605. A. D. Stevenson and A. V. Gipkins. London. Improvements in electric motor controllers.
4,632. C. J. Reed. London. Improvements relating to the operation of electric motors at different speeds.
4,633. C. J. Reed. London. Improvement in method of and means for operating electric motors. (Date applied for under Patents, &c., Act, 1883, Sec. 103, August 17, 1898, being date of application.)

March 3, 1899.

4,683. H. F. Parshall. London. Improvements in automatic switches for alternating electric-current circuits.
4,684. H. F. Parshall. London. A method of and apparatus for regulating the voltage of electric currents.
4,699. H. F. Clayton. London. An improved ceiling rose for electric lights and the like.*
4,705. A. M. Stansfield. Liverpool. Improvements in connecting boxes or fittings for use with electric conductors.
4,727. A. M. Taylor. London. Improvements in and connected with electric tramway and railway conduits.

March 4, 1899

4,774. F. W. Heaton and H. Smith. Salford. An improved electrical cut out or fuse.
4,778. P. J. Wilkinson and C. P. L. Titherley. Liverpool. An improved electric therapeutic apparatus.
4,783. W. J. Davy. London. Improvements in or connected with electric arc lamps.
4,801. J. H. Holmes and F. Broadbent. London. Improvements in and connected with resistance switches for electric circuits.
4,821. A. G. Brookes. London. Improvements in and relating to motor-suspension for electrically driven vehicles. (T. Stort, Germany.)
4,822. A. G. Brookes. London. Improvements in and relating to motor-suspension for electric auto-motor vehicles. (T. Stort, Germany.)
4,838. C. H. Cole. London. Improvements in portable electric primary batteries.

March 6, 1899.

4,845. L. Zahn. Berlin. Improvements in apparatus for registering the supply of electricity.
4,863. W. Cook and W. Kinzett. Redditch. An improved indestructible insulator for electric engineering purposes.
4,865. B. J. Round, B. J. Round and A. Round, Birmingham. An improved electro-gilding process and apparatus to be used in connection therewith,
4,878. G. Wilkinson. London. An improved case for electrical transformer connections, also applicable to street electric light standards.*
4,879. A. S. Frazer and G. A. Smith. London. A new or improved electric battery cell and elements therefor.
4,931. W. L. Wise. London. Means for generating and impressing semi-cycles of electromotive force on electric circuits for telegraphic and other purposes. (A. C. Crehore and G. O. Squier, United States.)

March 7, 1899.

4,941. J. Eck. London. Improvements in the governing of electric motors.
4,954. J. Butcher. Wolverhampton Improvements in electric clocks.*
5,010. E. F. Moy and P. H. Bastie. London. Improvements in or relating to electrical incandescent lamps.
5,030. O. Imray. London. Improvements in control apparatus for electric hoists and elevators. (A. E. Maccoun. United States.)*
5,041. W. B. Sayers and Mavor and Coulson (Limited). London. Improvements in dynamo-electric machines.
5,042. W. B. Sayers and Mavor and Coulson (Limited). London. Improvements in dynamo-electric machines.

March 8, 1899.

5,096. H. F. Purser. London. An electric opera, field, or marine glass.
5,099. E. Goller. London. Storage plates for accumulators and process for the manufacture of same.
5,100. V. B. D. Cooper and E. Ridley. London. Improvements in and relating to methods for charging accumulators.*
5,104. F. Braun. London. Reinforcement of electrical waves and avoidance of loss by straying reflection, &c., by means of a condenser.
5,111. G. Schünemann and O. Rieder. London. A new or improved electrically-operated gas-tap and apparatus for lighting at a distance.*

March 9, 1899.

5,130. J. G. Statter. London. Improvements in electrical time switches.
5,151. F. B. Cox. Liverpool. An improved envelope for electrical conductors.
5,190. J. M. Overshiner. London. Improvements in telephone switch boards.*
5,191. C. Curwen. London. Improvements in lighting electric lamps.
5,197. H. W. Bowden and W. J. Allbright. London. Improvements in electrical power station switches.
5,199. T. J. Holland and A. P. Laurie. London. Improvements in electrolytic decomposing apparatus.
5,200. T. J. Holland and A. P. Laurie. London. Improvements in the manufacture of porous diaphragms for electrolytic apparatus.
5,211. A. H. Miller. London. Improvements in electric incandescent lamps.
5,217. J. Burke. London. Improved construction of commutators for dynamos and electromotors.*
5,229. The British Thomson-Houston Co. (Limited). London. Improvements in apparatus for making and breaking high potential electric circuits. (E. M. Hewlett, United States.)*

SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1897

26,118. Benjamin. Conduit and aërial electro-locomotor primarily fo laying or drawing in electric mains or other cables for any service
26,743. Maxim. Methods of and apparatus for manufacturing filament for electric lamps.

1898.

533. Hills. Electric arc lamps.
831. Libbey. System of conducting electricity for propelling heating, lighting and telephoning from railway vehicles.
1,803. Codd and Codd. Electric arc lamps.
2,849. A. E. Tanner, F. A. C. Leigh and G. Hill. Electric switches.
3,218. Lake (Cantons). Electric motors and dynamo-electric machines.
3,555. Elieson and Naylor. Combined switch and controller for electromotors.
3,563. Brown. Electric arc lamps.
4,004. Edwards and Beevor. Switches for altering the speed and direction of revolution of electric motors.
4,282. Byng and Angold. Automatic cut-outs for arc electric lamps.
4,306. Northey. Electrodes for secondary batteries.
4,441. Duncan. Electric motors. (Date applied for under International Convention, Jan. 14, 1898.)
4,455. Esmond. Electric railways of the sectional conductor type.
4,549. Leigh (Sprague). Apparatus for electrically controlling the hoisting mechanism of elevators or any other type of machinery.
4,746. Siemens Bros. and Co., Limited (Siemens and Halske Aktien Gesellschaft). Method of and means for measuring the work performed in a rotary phase current system.
4,761. Emmott. Electric controlling and regulating apparatus.
4,764. Andersen, Westengaard and Zerener. Process and apparatus for tanning by the aid of electricity.
4,812. Heyland. Alternating-current electric motors.
4,929. Boult (Snyders). Electric railway conduits and conductors.
5,823. Heyl-Dia. Underground conduit electric railways.
6,145. Von Barby. Process for hardening and rendering tenacious th active mass of electric accumulators.
6,371. Lea. Driving of sewing machines by electricity.
9,339. Edmunds. Electrical switching apparatus.
6,451. Morrison. Apparatus for electro-plating pins and other small objects.
9,607. Tschieret. Electric arc lamp.
9,789. Hirst and Collings. Electroliers and incandescence electric lamp pendants.
9,844. Sturge. Adjustable shade supports for electric and the like fittings.
9,895. Davy and Thomas-Davies. Apparatus for raising and lowering arc lamps.
10,110. Oliver. Electric arc lamps.
15,805. Leimer. Electric accumulators.
16,556. Benedict (Doe). Galvanic batteries.
16,754. Bieberstein. Coin-freed apparatus for the automatic delivery of electric current.
17,191. Schäfer and Lorentz. Overhead conductors for electric railways and the like.
17,659. Lake (Bergmann). Electric meters.
18,051. Childs. Electric fuse.
21,551. Rice. Controlling electric motors and electrically-propelled railway trains. (Date applied for under International Convention, March 26, 1898.)
21,758. Case. Systems of train control for electric motors. (Date applied for under International Convention, April 12, 1898.)
21,759. Potter. Control of electrically-propelled trains. (Date applied for under International Convention, March 31, 1898.)
22,887. Barnikol-Veit and Riebel. Arc lamps.
23,706. Johann Chrisostimus Leissing and Charles Louis Hiebl. Manufacture of dynamo-brushes.
24,371. The British Thomson-Houston Co., Limited (Steinmetz). Regulation of alternating current electric motors, applicable also to distribution systems.
24,559. Morris and Salom. Electrically-propelled road vehicles.
24,708. Burns. Instrument for interlocking railway point and signal levers with electric block or train signalling switch on double lines of railway.
24,949. Siemens Bros. and Co., Limited. (Siemens and Halske Aktien Gesellschaft). Regulating transformer for rotary phase current or polyphase current installations.

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25,058. SOLOMON. Electrical cut-outs.
25,302. JOHNSON (Riker). Means for supplying and controlling the supply of power to electric motors.
25,985. PICHARD. Methods and means of electric ignition for explosion motors.
26,116. HEYS. (Silberberg.) Galvanic batteries.
26,136. LEHNER. Electrical measuring instrument.
26,153. SIEMENS BROS. AND CO. (LIMITED) (Siemens and Halske Aktien Gesellschaft). Telephonic microphone apparatus for electric signalling.
26,251. BLATHY. Construction of electrical transformers with ventilating passages.
26,324. FERGUSON and STUMP. Electric switches.
26,351. WETTER (Maas). Galvanic elements or batteries.
26,401. SCHNÉE. Bath apparatus for treatment with electricity and medicinal substances.
26,629. PENNING-DUPIUS. Current collectors for electric traction.
26,866. THE POROUS ACCUMULATOR CO. (LIMITED) and HOWELL. Means for manufacturing metallic ribbon, especially applicable for battery electrodes.
27,128. VARICAS and VARICAS. Etheric steering apparatus for controlling from a distance the steering gear of ships, torpedoes and other floating bodies electrically.
27,531. BROOKES. Berliner electro-mechanische Werkstätten (Gesellschaft mit beschränkter Haftung.) Graphophones.
27,593. BRITISH THOMSON-HOUSTON CO., LIMITED (Case). Systems of train control for electrically-propelled vehicles.
27,613. HOWARD. Electric fuse holders.

COMPANIES' MEETINGS AND REPORTS.

Indo-European Telegraph Co. (Limited).

The Directors, in their report for 1898, refer to the death of their late colleague, Consul H. H. Meier, of Bremen, who died in November, and who had been connected with the Company since its commencement. The vacancy will be filled by the appointment of his son, Dr. H. H. Meier. The Company's revenue from all sources for 1898 amounted to £134,642. 12s. 11d., compared with £130,347. 3s. 5d. for 1897. The expenses were £74,346. 0s. 5d., against £69,378. 13s. 5d. for 1897. Deducting the above expenses, taking credit for £9,703. 4s. 1d. from 1897, and debiting income tax, there remains the sum of £67,202. 0s. 9d. From this £15,000 has been placed to reserve, and deducting this sum, together with £10,625 interim dividend, there remains a balance of £41,577. 0s. 9d. The Directors propose to declare a dividend for the six months ended Dec. 31 of 17s. 6d. per share, making (with dividend already paid) 6 per cent. and a bonus of 20s. per share, both free of tax, making 10 per cent. for the year, carrying forward £9,702. 0s. 9d.

The lines of the Company continue to work satisfactorily, and the extension of the Wheatstone automatic apparatus, which in part accounts for the extra outlay on expenses and charges for maintenance, has proved successful; the system has also now been established from Emden to Teheran. An additional wire has been erected from Warsaw to Odessa.

The transfer books are closed from 13th to 27th inst., inclusive.

EDWARDS AIR PUMP SYNDICATE (LIMITED).—The first annual report of the directors of the company for the period to Dec. 31 last states that a net profit has been made of £128. 8s. 11d. Additional patent rights for improvements in steam engine air pumps have been obtained in a number of leading European countries. The report states that the syndicate's pump is steadily gaining in popularity with superintending engineers and with consulting engineers, who are more particularly identified with stationary engines for electric light and power plant. The Edwards pump has been specified for some of the largest corporation electrical installations in the Kingdom.

ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL CO. (LTD.).—The directors' report for 1893 states that beyond the increase of the debenture stock from £44,994 to £60,000 and the increase of the loan to the Metall Company to £53,608 there is little alteration in the figures from those of 1897. £4,153 was paid last year to the debenture holders by way of interest. The directors were unable to carry through the negotiations for the sale of a license in Austria-Hungary, and they are of opinion that it is not now in the interest of the company to sell the patents or to grant a licence. The Metall Co.'s accounts show a considerable increase compared with the previous year. The directors have purchased an additional engine and boiler, which greatly increases the steam reserve. The weight of goods of the company's own production sold during the period showed an increase of over 90 per cent. compared with last year, while the output has averaged over 19 tons per week. The directors of the Metall Co. believe it would be in the interest of the company not to pay a dividend, but in view of the long period taken to reach the dividend-earning stage they declared a dividend. The amount to be received by the Austrian company from the Metall company is £7,500, from which has to be deducted the charges (£3,235) of the past year. From the balance the directors recommend the payment of an interim dividend of 7½ per cent., or 3s. per share, free of tax, to the Preference shareholders. The one-tenth of the net profit due to the Ordinary shareholders, being too small for division, will be carried forward.

NEW COMPANIES, STATUTORY RETURNS, &c.

BEDFORD MOTOR-CAR SYNDICATE (LIMITED).—This syndicate was registered on April 6, with a capital of £2,000, in £5 shares, to carry on in Bedford or elsewhere the business of tramway, railway, omnibus, motor-car and van proprietors, dynamo and locomotive builders, &c.

COTSWORTH ARC LAMP AND ELECTRIC LIGHTING SYNDICATE (LIMITED).—This company was registered on April 6, with a capital of £25,000, in £1 shares, to acquire certain British and German patent rights granted to Mr. Haldane G. Cotsworth, for improvements in connection with the manufacture of electric arc lamps, together with the benefit of an 100-hour enclosed arc lamp, a 40-hour double carbon lamp, and a photographic printing lamp, and to carry on the bussness of electricians, electrical and mechanical engineers, electric lamp and apparatus manufacturers, suppliers of electricity, &c. The first subscribers are: Haldane G. Cotsworth, electrical engineer (10 shares), Alfred Haynes (5 shares), G. A. Wright (5 shares), C. G. L. Cator (10 shares), A. Gascoine (5 shares), Arthur Mackenzie (1 share), and P. C. J. Macphee (1 share).

ELECTRIC TIMBER-SEASONING AND PRESERVATION CO. (LIMITED).—This company was registered on April 10, with a capital of £150,000, in £1 shares (of which 60,000 are Preference), to enter into agreements with the Founders' Syndicate (Limited), and with Mr. Walter C. Johnson, to acquire and work certain patents, to handle, store, import, export, prepare, preserve, season, sell and deal in wood, timber and fibrous matters of all kinds, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, and electrical apparatus manufacturers. The first subscribers are:—F. C. Cross, H. Baillie Weaver, C. Brooks, F. D. Head, L. Weaver, E. Choat and G. W. Brown.

FERROLITE ELECTRIC SYNDICATE (LIMITED).—This company was registered on April 5, with a capital of £30,000, divided into 8,000 "A" and 22,000 "B" shares of £1 each, to acquire provisional patents Nos. 22,070, 23,306 and 23,307 (1898) granted to Mr. C. Levetus for improvements in and relating to galvanic and other batteries, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, and manufacturers of and dealers in electrical apparatus. The first subscribers are: E. L. Levetus, A. L. Collins, V. Page, H. C. Sawyer, J. M. Bell, E. J. White, and G. L. Laming. The first Directors are Hyman Levetus and Edward L. Levetus.

LONGFORD WIRE COMPANY (LIMITED).—This company was registered on April 6, with a capital of £100,000, in £1 shares, to acquire the business of the Longford Wire, Iron and Steel Company (Limited), and to carry on the business of wire drawers and weavers, mechanical and electrical engineers, machinists, &c. The first directors are:—John Geddes, J.P., Charles J. Holmes, J.P., John L. Tunstall, Richard T. Fairclough, J.P., and James F. Dutton.

NEILD'S SLEEVE ELECTRIC JOINT SYNDICATE (LIMITED).—This company was registered on April 4 with a capital of £5,000, in £1 shares, to enter into an agreement with Harry W. Neild, to acquire certain British and foreign patents and rights, and to carry on the business of electricians, mechanical engineers, and manufacturers of and dealers in electrical apparatus, telegraph and telephone instruments, cables, wires, &c. The first subscribers are:—J. Myerson, W. H. Harton, H. W. Neild (engineer), C. C. Christopher, F. C. Pallett, C. H. L. Alder, and H. W. Allason.

POOLE AND DISTRICT ELECTRIC TRACTION CO. (LIMITED).—This company was registered on April 5, with a capital of £100,000, in £10 shares, to enter into an agreement with the British Electric Traction Co. (Limited), the Bournemouth, Poole and District Light Railways (Electric) Co. (Limited), and Mr. W. Murphy, and to carry on the business of electricians, electrical and mechanical engineers and contractors, suppliers of electricity, manufacturers of and dealers in electrical apparatus, tramway and light railway proprietors, and carriers of passengers and goods. The first subscribers are: Emile Garcke, George Stevens, C. H. Dade, S. Sellon, Ch. H. Gadsby, W. M. Murphy, and J. Lewis.

YOUNG AND MARTEN (LIMITED).—This company was registered on April 5, with a capital of £275,000, in £1 shares (150,000 Six per Cent. Cumulative Preference), to acquire the business carried on under the style of Young and Marten, and to carry on the business of iron and brass founders, metal workers, mechanical and electrical engineers, machinists, &c.

ANGLO-AMERICAN TELEGRAPH CO. (LIMITED).—The annual return to Feb. 17 has been filed. The capital is £7,000,000 stock, all of which is fully paid up.

CITY OF LONDON ELECTRIC LIGHTING CO. (LIMITED).—The annual return to March 15 has been filed. The nominal capital is £1,200,000, in £10 shares (of which 400,000 are Preference). 60,000 Ordinary and 40,000 Preference shares have been taken up, and the full amount has been called.

NATIONAL TELEPHONE CO. (LIMITED).—The annual return to March 3 has been filed. The capital is £4,000,000, divided into 15,000 First Preference shares of £10 each, 15,000 Second Preference shares of £10 each 250,000 Third Preference shares of £5 each, and 490,000 Ordinary shares of £5 each. All of these have been taken up, and 28,284 of the Third Preference and 44,413 Ordinary have been issued as fully paid. The full amount has been called on the remainder.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LIMITED).—The annual return to March 7 has been filed. The capital is £100,000, in £5 shares, of which 12,370 have been taken up; 412 have been issued as fully paid, and the full amount has been called on 8,958, while £2. 10s. per share has been called on 3,000.

NORTHWICH ELECTRIC SUPPLY CO. (LIMITED).—According to the annual return to March 13 the capital is 25,000, in £5 shares, of which 3,000 have been taken up. The full amount has been called.

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NOTTING HILL ELECTRIC LIGHTING CO. (LIMITED).—The annual return to March 15 has been filed. The capital is £100,000, divided into 6,452 Ordinary, 550 Founders' and 2,998 Preference shares of £10 each. All of these have been taken up, and the full amount has been called and received.

TELEGRAPH CONSTRUCTION AND MAINTENANCE CO. (LIMITED).—The annual return to March 14 has been filed. The whole capital of £448,200, in £12 shares, has been taken up and paid for in full.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 2, 1899). Price of silver 27 7/16d. per oz. (April 13). Consols (2¾ per cent.) 110¾—110⅞ for money, 110 7/16—110 9/16 for account; 2½ per cent. 103—103¼ (April 13), Stock Exchange Settling Days: Consols, May 4; Stocks and Shares Continuation Day, April 25; Ticket Day, April 26; Pay Day, April 27; Mining Share Carry over Days, April 24 and May 9.

CUBA SUBMARINE TELEGRAPH CO. (LIMITED).—The directors recommend a dividend at the rate of 6 per cent. per annum and a bonus of 2s. per share on the Ordinary shares, both tax free, for the half-year ended Dec. 31,

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH CO. (LIMITED).—A dividend for the quarter ended Dec. 31 last of 2s. 6d. per share, together with a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1898, has been declared, payable on 27th inst. The share register will be closed from 19th to 26th inst. inclusive.

A list of 473 Five per Cent. Australian Government subsidy debentures in this company will be found set out in an advertisement on another page. These debentures have been drawn for payment at par, on July 1, by Messrs. Barclay and Co., 54, Lombard-street, London, E.C., and interest will cease on that date.

GLOBE TELEGRAPH AND TRUST CO. (LIMITED).—The financial papers announce that the directors of this company have agreed to recommend an interim dividend of 2s. 6d. per share on the Ordinary shares.

MUNICIPAL ISSUES.—During the week the Portsmouth Corporation invited applications for £188,000 £2. 15s. per cent. redeemable stock at a minimum price of 97. Amongst the securities are the municipal electricity works. The Huddersfield Town Council have decided to create £600,000 Corporation stock for the redemption of existing tramway loans, for electric lighting and other purposes.

METROPOLITAN ELECTRIC SUPPLY CO. (LIMITED).—Mr. James Carr Saunders has been elected a director of this company.

ORIENTAL TELEPHONE AND ELECTRIC CO. (LIMITED).—Subject to final audit, the directors have declared a further dividend of 8d. per share, free of tax, making, together with the interim dividend paid in October last, 5 per cent. for the year ended Dec. 31 last. The register of transfers will be closed from the 15th to the 26th inst., inclusive.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT CO. (LIMITED).—The amount of electricity sold by this company during the quarter ended March 25 is returned at 1,161,987 units, estimated to produce £21,061, against 1,016,642 units, which produced £20,036, for the corresponding period of last year. A further reduction of charges was made from January 1, 1899.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has appointed Wednesday, the 19th inst., a special settling day in £100,000 Four Per Cent. First Mortgage Debenture stock of *Davey, Paxman and Co. (Limited)*, and has also ordered the stock to be quoted in the Official List.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Apr. 8	4,504	+ 742	13	53,308	+ 4,559
Blackpool Corporation...	...	...	...	...	...	...
Blackpool and Fleetwood	„ 8	602	...	14	3,123	...
Bradford Corporation ...	„ 9	351	...	36	9,333	...
*Bristol Trams & Carriage	„ 7	3,588	+ 777	14	36,166	+ 2,733
City & South London Ry.	„ 9	976	+ 92	15	16,251	+ 425
Dover Corp'tion (8 days)	„ 8	264	...	1	264	...
Dublin United (Southern)	„ 7	984	+ 535	14	9,067	+ 3,515
*Glasgow Corporation ...	„ 8	8,793	+ 1,204	...	...	...
Liverpool Corporation						
Dingle Route	„ 1	514	...	20	10,361	...
Prince's Park Route...	„ 1	358	...	11	3,438	...
Liverpool Overhead Rly.	„ 9	1,674	+ 135	15	19,990	- 305
*Sheffield Tramways....	„ 9	1,371	+ 394	14	16,908	+ 3,802
*South Staffs. Trams.....	„ 7	924	+ 315	14	8,589	+ 507

* Partly electrical.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price April 5.		Price Wednesday, April 12.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Week Ending April 12. Highest	Lowest
			TELEGRAPHS.					£ s. d.			
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red) ..	101	104	101	104	3 16 11	January and July	..	..
25,000	10	—	Amazon Telegraph	3	4	3	4	—	June and December..	—	—
£125,000	100	5%	Do. 5 per Cent. Debenture	87	92	87	92	5 6 5	—	—	—
£905,560	Stock	24 0	Anglo-American	65	68	65	68	5 2 0	Feb., May, Aug., Nov.	67½	66
3,047,220	Stock	80/0	Do. Preferred	117½	13½	1 8	119	5 1 8	" "	119	118½
3,047,220	Stock	18/0	Do. Deferred	1½	5	14	14½	6 4 1	—	14¾	14½
225,161	10	3/0	Brazilian Submarine	15½	16½	15¾	16½	4 6 2	Mar., June, Oct., Dec.	16½	15¾
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906) ..	110	114	110	114	4 7 9	June and December	..	..
10,400,000	$100	$ ¾	Commercial Cable Capital Stock	185	195	185	195	4 2 0	Jan., Apr., July, Oct.	190	188
£1,332,523	Stock	4%	* Do. 4 per Cent. Debenture Stock	104	106	104	106	3 15 6	" "	106¾	105
16,000	10	8/0	Cuba Submarine Ordinary (Deferred)	9	10	9	10	7 0 0	February and August	..	..
6,000	10	10/0	Do. Preference 10 per Cent.	18	19	18½	19½	5 2 7	" "	—	—
12,231	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 0 0	April and October ..	..	..
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference ..	10	11	10	11	4 12 10	" "	—	—
£30,000	50	4½%	Do. 4½ per Cent. Debentures	103%	109%	106%	103%	4 3 4	January and July ..	..	..
60,710	20	3/0	Direct United States Cable	12½	13½	12	12½	5 4 0	Jan., Apr., July, Oct.	12 7/16	12 1/16
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red) ..	1 3	106	103	106	4 5 6	June and December..	..	..
£4,000,000	Stock	7%	Eastern Ordinary	179	184	177	182	3 17 8	Jan., Apr., July, Oct.	180	176½
£1,795,000	Stock	3½	Do. 3½ per Cent. Pref. Stock	102	105	102	105	3 7 0	" "	104½	1 2
£1,432,268	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.	125	129	125	129	3 2 9	May and November	..	..
£89,900	100	5%	* Do. 5 per Cent. Debentures, 1889	99	102	99	103	4 18 0	February & August	—	..
250,000	10	2/6	Eastern Extension	18	13½	18	18½	3 15 8	Jan., Apr., July, Oct.	18½	18½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	129	125	129	3 2 3	February & August	..	..
£16,200	100	5%	* Do. 5 p. c. (Austln. Gov. Sub.) Deb. 1910 (reg.)..	99	103	99	103	4 17 1	January and July ..	..	..
£24,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	" "	..	—
£35,100	100	5%	*Eastern and S. African 5 p.c. Mor. Deb., 1900 (reg.)	99	103	99	103	4 17 1	" "	..	—
£46,500	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	" "	..	—
£800,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102	105	102	105	3 17 8	February & August	—	—
£200,000	25	4%	Do. 4% Mauritius Sub. Debs. (red.)	104%	107%	104%	107%	3 15 2	May and November	..	—
180,227	10	1 9	Globe Telegraph and Trust	12¾	13½	12¾	13½	3 17 4	Jan., Apr., July, Oct.	13½	12¾
180,042	10	6%	Do. 6 per Cent. Preference	16¾	17½	16¾	17½	3 9 7	" "	17½	17 1/16
150,000	10	5/0	Great Northern of Copenhagen	30	31	30	31	3 4 6	January and July ..	30¾	—
£97,800	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red)..	100	103	100	103	4 8 0	June and December	..	—
17,000	25	12/6	Indo-European	57	60	57	60	4 3 4	May and November	..	—
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1903.	108	111	108	111	5 8 1	March & September	..	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red)	101	108	105	108	3 14 6	June and December	—	—
11,839	8	4/0	Reuter's	6½	7½	7	8	5 0 0	April and October ..	7⅞	—
3,381	£100 Cert.	6%	Submarine Cables Trust	140	145	140	145	4 4 3	,	141	..
15,609	10	—	West African Telegraph	2½	3½	2½	3½	..	December and July.	—	—
£200,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	4 18 0	March & September	—	—
20,008	2½	—	West Coast of America	½	1	½	1	..	—	½	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	103	106	103	106	3 15 9	January and July .	..	—
88,221	10	1/6	West India and Panama	2	2½	2	2½	—	May and November	2 1/16	2½
84,563	10	6 0	Do. 6 per Cent. 1st Preference..	10½	11	10¾	11½	5 6 8	" "	—	—
4,669	10	6 0	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	" "	..	—
£80,000	100	5%	* Do. 5 per Cent. Debentures	105	108	105	108	4 13 3	January and July ..	..	—
£4,269	15	5 0	Western and Brazilian Ordinary	12¾	13½	13¼	13.	4 9 3	May and November	..	—
33,125	7½	3/0	Do. 5 per Cent. Preferred Ordinary	8½	9	8½	9	4 3 4	" "	..	—
33,129	7½	1/3	Do. Deferred Ordinary	4¼	4½	4¼	4½	—	" "	..	—
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	106	109	106	109	3 14 1	June and December	107¾	..
£100,100	100	6%	Western Union 6 per Cent. Sterling Bonds (red.)...	100	105	100	105	5 14 3	March & September	—	..

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price April 5.	Price Wednesday, April 12.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending April 12.	
						£ s. d.		Highest	Lowest
			TELEPHONES.						
44,000	£5	4/0	Chili Telephone (fully paid)	2½ 3	2½ 3	3 13 4	August	—	—
274,250	£1 10s.	1½d.	Consolidated Telephone Const. & Manufacturing	⅛ ⅛	⅛ ⅛	6 7 0	July	—	—
71,000	1	—	Monte Video Telephone Ord.	½ ¾	½ ¾	5 0 0	October	—	—
84,000	1	6/4	Do. Preference	¾ 1	¾ 1	—		—	—
490,000	5	3/0	National	4½ 5	4½ 5	6 0 0	February & August	4⅝	4½
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	11 13	11 13	4 5 0	" "	13	11½
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	11 13	11 13	4 5 9	" "	12½	—
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	4⅜ 5½	4⅜ 5½	4 15 2	" "	4 13/16	—
1,239,471	Stock	5%	* Do. Debenture Stock 5% (red.)	99 101	99 101	3 9 9	June and December	101	99
71,504	1	0/4	Oriental	¾ 1	¾ 1	5 0 0	April and October	..	..
58,000	5	6/0	United River Plate	4⅝ 5½	4⅝ 5½	5 14 8	July	..	—
£151,782	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	104 107	104 107	4 13 11	June and December	—	—
			ELECTRICITY SUPPLY COMPANIES.						
100,000	1	—	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (10s pd.)	⅜ ½	⅜ ½	—		—	—
6,000	10	7 9½	Bournemouth and Poole Electricity Supply Ord.	13½ 13¾	13½ 13¾	2 16 10		—	—
6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10¾ 11¼	10¾ 11¼	4 4 0		—	—
21,000	5	..	Calcutta Elec. Supply Ordinary (£3 paid)	.. ..	4¼ 4⅜	3 8 2		4⅜	..
80,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	11 12	10¾ 11¼	3 9 7	February & August	11⅜	11¼
20,000	5	2/6	Do. 4½ per Cent. Preference	6 6½	6 6½	3 9 8	" "	—	—
£34,000	5	3/6	Chelsea Electricity Supply Ordinary	7½ 8½	7½ 8½	3 13 7	March	8	7 15/16
£100,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	114 116	114 116	3 18 1	June and December	..	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red.)	101 105	101 105	4 17 7	April and October	—	—
60,000	10	7/0	City of London Elec. Lighting Ord.	17 18	16½ 17½	3 8 7	February & August	18	16½
40,000	10	6%	Do. 6% Cumulative Pref.	15 16	15 16	3 15 0	January and July	15½	—
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	124 129	124 129	3 17 10	June and December	..	..
40,000	10	..	County of London & Brush Prov. Ord.	11 12	11 12	—		11⅝	11
20,000	10	6/0	Do. 6% Cumulative Preference	14 15	14 15	4 0 0	March & September	14½	14
19,661	5	3/6	House-to-House Electric Lighting Supply Ord.	8½ 9½	8½ 9½	3 18 8	—	..	—
12,000	5	3/6	Do. 7 per Cent. Preference	9 10	9 10	3 10 0	March & September	9⅞	—
15,000	5	10%	Kensington and Knightsbridge Ord.	13 14	13 14	3 18 7	—	—	—
10,000	5	6%	Do. 6% 1st Pref.	7½ 8½	7½ 8½	3 14 9	January and July	—	—
110,000	3	—	London Electric Supply Ordinary	3½ 4	3½ 4	—		3 15/16	—
48,050	5	3/0	Do. 6% Preference	6½ 7	6½ 7	4 5 9		6⅞	6 7/8
£100,000	Stock	..	Do. 4% 1st Mort. Deb.	105 107	105 107	3 14 9	Mch., June, Sept., Dec.	—	—
62,500	10	5/0	Metropolitan Electric Supply Ordinary	17 18	17 18	3 15 7	April and October	17⅛	17½
22,500	10	8 d.	Do. (£7 paid)	13 14	13 14	—		18	..
£320,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117 120	117 120	3 15 8	June and December	..	—
6,452	10	6/0	Notting Hill Electric Ordinary	16½ 17½	16½ 17½	3 8 7	March	—	—
10,000	5	5/0	Oxford Electric Ordinary	6½ 7	6½ 7	3 11 5	"	—	—
275,000	1	—	Rand Electric	¾ 1⅛	¾ 1⅛	—		—	—
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.	83 93	83 93	5 8 1		—	—
150,000	£100	22	Royal Electric Company of Montreal Shares	165 185	165 185	4 6 6		—	—
180,900	100	4½%	* Do. 4½% 1st Mort. Debs.	105 107	105 107	4 4 1	April and October	—	—
31,980	5	9/6	St. James and Pall Mall Electric Ordinary	17 18	17½ 18½	3 18 5	February & August	18	17½
20,000	5	8/6	Do. 7 per Cent. Preference	9 10	9 10	3 10 0	" "	..	..
65,000	5	..	South London Electric Supply Ordinary (£5 paid)	3½ 3¾	3½ 3¾	..		3¾	3½
79,900	5	7/0	Westminster Electric Supply Ordinary	15½ 16½	15 16	3 15 0	March & September	16	15½
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
90,000	2	1/2½	Brush Electrical Engineering	1⅞ 2⅛	1⅞ 2⅛	2 13 5	September	2 1/16	1 15/16
90,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2⅛ 2⅜	2⅛ 2⅜	5 1 1	"	2 5/16	—
£125,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	110 114	110 114	3 19 2	February & August	—	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	103 105	103 105	4 6 7	June and December	—	—
£20,000	5	5/0	Callender's Cable Construction	12½ 13½	13⅛ 13½	5 0 0	" "	13 1/16	13
£20,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	114 117	114 117	3 17 5	November and May	..	—
200,000	1	9½d.	Castner-Kellner Alkali Co. (fully paid)	1⅛ 1⅜	1⅛ 1⅜	5 16 5		..	..
50,000	1	—	Chadburn's Ship Telegraph Ordinary	1⅛ 1⅜	1⅛ 1⅜	—		—	—
50,000	1	7½d	Do. 6 per Cent. Cumulative Pref.	1 1⅛	1 1⅛	4 16 0		—	—
32,098	3	1/6	Crompton and Co. (Nos. 1 to 32,098)	3½ 3¾	3½ 3¾	4 0 0	January and July	3⅝	..
£100,000	100	5%	* Do. 5% First Mort. Deb. (red.)	93 101	98 101	4 19 8		—	—
99,261	5	1 9½	Edison and Swan United ("A" Shares) (£5 paid)	2 2½	2 2½	7 1 8	February & August	2⅛	2⅛
17,129	5	2/6½	Do. (£5 paid)	4 5	4 5	6 11 0	" "	—	—
£744,022	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	97 99	97 99	4 1 8	June and December	97⅜	97½
17,460	5	5%	Edmundson's Electric Corporation Ord (fully pd)	5½ 5⅝	5½ 5⅝	4 6 11	Half-yearly	4 7/16	—
112 100	2	1/2½	Electric Construction Co. (Limited)	2⅛ 2⅜	2⅛ 2⅜	4 11 1	January & July	2 5/16	2⅛
25 000	2	2/9½	Do. 7 per Cent. Cumulative Pref.	3 3½	3 3¼	4 0 0	July	3⅛	—
£140,300	Stock	4%	Do. 4% First Mortgage Deb. (red.)	103 103	103 106	3 15 10	January and July	—	—
21,196	1	—	Elmore's Patent Copper Depositing	⅜ ½	⅜ ½	—		—	—
15,000	10	10/0	Henley's Telegraph Works Ordinary	24½ 26½	23½ 26½	5 5 8	February & August	26½	24⅜
8,000	10	7/0	Do. 7 per Cent. Preference	13½ 15½	13½ 15½	3 11 10	" "	18½	—
£80,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	112 115	112 115	3 19 10	" "	—	—
50,000	10	15/0	India Rubber, Gutta Percha, &c., Works	21½ 22½	21½ 22½	4 8 11	" "	22 5/16	22½
£10,000	100	4%	Do. 4% First Mortgage Debentures (red.)	101 105	101 105	3 16 2	March & September	102½	—
87,250	12	24/0	Telegraph Construction and Maintenance	37 41	35 39	4 8 9	March and July	38½	38½
£150,000	100	..	Do. 4 per Cent. Deb. Bonds, 1933	105 108	105 108	3 14 3	..	—	—
£12,400	5	—	Do. Manufacturing Ordinary	9½ 10½	9½ 10½	—		—	—
13,400	5	5/0½	Do. 5% Cum. Pref.	5⅛ 6⅛	5⅛ 6⅛	4 0 0		—	—
£10,000	5	4/0	Williams and Robinson Ordinary	10½ 10¾	11⅛ 11⅝	3 8 1	April and October	11⅝	11½
£30,000	5	3/0	Do. 6% Cumulative Preference	7½ 7⅝	7⅛ 7⅝	3 17 5	" "	7⅝	7⅛
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	106 108	106 108	3 18 8	May and November	—	—
			ELECTRIC RAILWAYS, TRAMWAYS, &c.						
12,000	10	8/0	Blackpool and Fleetwood Tramways	24½ 25½	24½ 25½	3 2 6		—	—
20,000	10	7/-	Bristol Tramways and Carriage	23½ 24½	23⅝ 24½	2 13 1	February and August	—	—
£100,000	Stock	4%	Do. 4% Debenture	120 121	120 121	3 6 2		—	—
80,000	10	1 /0	British Electric Traction Ordinary	19½ 20	18½ 19½	3 2 4		19⅝	18 15/16
10,000	10	6/0	Do. 6% Cum. Pref. (fully pd. & £2.10s. prm. pd.)	13½ 14½	13⅝ 14½	4 4 1		14½	13⅝
£100,000	Stock	5%	Do. 5% Perp. Deb.	127 128	128 129	3 17 7		12⅞	12 15/16
40,000	5	1/6½	Buenos Ayres & Belgrano 6% Cum. Pref. (£3 paid)	3⅜ 3⅝	3⅜ 3⅝	..		3 13/16	3 11/16
27,500	5	..	Do. do. do. (fully paid)	5⅛ 5⅜	5⅛ 5⅜	..		5 7/16	5⅛
£260,000	Stock	5%	Do. do. 5% Deb.	109 112	109 112	4 11 4	..	110⅛	110
£35,250	10	5/0	Central London Ordinary	9½ 10½	9½ 10½	2 18 6	June and December	10⅝	10
178,302	10	1/9½	Do. (£8 paid)	7⅜ 8⅛	7⅛ 8⅛	2 13 2	" "	—	—
£210,000	Stock	3%	City and South London Railway Com. Ordy.	68 70	68 70	3 0 9	January and July	69	68⅜
22,500	10	..	Do. Ordinary (Nos. 1 to 22,500) (£5 paid)	4½ 5½	4½ 5½	..	..	..	..
9,251	10	5%	Do. 5% Perpetual Preference	14½ 15½	14⅛ 15⅛	3 5 7	January and July	14½	—
187,701	Stock	4%	Do. 4% Perpetual Debenture	133 135	131 133	2 19 7	May and November	—	—
20,000	10	7½%	Imperial Tramways Ordinary	24½ 25½	24½ 25½	2 13 6	March & September	—	—
10,000	10	6%	Do. 6% Preference	16 16⅜	16 16⅜	3 12 9	" "	—	—
£100,000	Stock	4½%	Do. 4½% Debenture	118½ 119½	118½ 119½	3 15 4	January and July	—	—
87,500	10	4%	Liverpool Overhead Railway Ordinary	10 10⅛	10 5/16 10 5/8	3 7 11	February & August	—	—
10,000	10	5%	Do. 5% Preference	14⅜ 14½	14⅜ 14½	3 7 3	" "	—	—
118 600	Stock	4%	Do. 4% Debenture	108 109	108 109	3 14 1	January and July	—	—
20,000	5	3/3½	New General Traction 6% Cumulative Pref	5 5⅛	5 5⅛	5 9 1	May	—	—
£540,000	Stock	3%	Waterloo and City Ordinary	109 112	109 112	2 13 7	June and December	111	109½

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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CONTENTS OF THE CURRENT NUMBER.

NOTES	885	EARTH CURRENTS AND ELECTRIC TRACTION	898
Meetings of Scientific Societies	888	The Zipernowski-Déri-Bláthy Transformer Distribution Patents. Illustrated	899
Contemporary Electrical Science. Compiled by E. E. Fournier D'Albe	889	The Hissing of the Electric Arc.—*Discussion*	901
Carbons for Electric Lighting and Other Purposes. By F. Jehl. Concluded	890	Correspondence	902
Large Willans Engines. Illustrated	892	Parliamentary Intelligence	904
Experiments on Alternate-Current Arcs by Aid of Oscillographs. Illus. Continued	893	Legal Intelligence	906
Electricity Works Accounts	896	Trade Notes and Notices	908
		Companies' Meetings & Reports	912
		New Companies, &c.	914
		City Notes	915
		Companies' Share List	916

NOTES.

SHAREHOLDERS in submarine cable companies will be very foolish if they do not take warning by what befell the proprietors in gas undertakings a few years ago. There was a scare, based on the premature belief that electricity would oust the older illuminant; yet gas stocks were never higher than they are to-day. It may be remembered, also, that when Lord KELVIN brought over from France his "million of foot-pounds" of energy, the effect which the Faure accumulator would have on the electrical industry was vastly overestimated. That a decided decrease in the market value of shares in cable companies is attributable to Mr. MARCONI's recent successful experiments may appear ridiculous to those who understand the subject, but it is, nevertheless, fact.

IT would be unwise to say that wireless telegraphy will never be made available for long-distance ocean work, but it may be confidently asserted that the advance in this branch of communication, like all other human progress, must be tentative and very gradual; and that the difficulties to be overcome are numerous and great. On the other hand, many of the cable companies are in the strongest possible position, with very large reserves; and, even if it prove feasible to work without wires, say, between London and Paris—all such messages being carried by the British and French Governments and not by the companies—it would be a thousand pities if timid shareholders were to sacrifice their property now, only to see it, after a year or even a few months, approximate to its former market level. The investing public speak of a "fall" on the Stock Exchange, but they ought to remember that it is, in this case, only themselves who, by panic selling, can largely depreciate for a time the value of their property.

OUR earnest advice, therefore, to holders is to continue to believe that the securities of well established cable enterprises are thoroughly sound investments, and to "sit on" what they have. If they do not, they will only have to blame their credulous acceptance of ill-advised and premature forecasts made by men who possess neither scientific nor practical knowledge of the subject. Those, on the other hand, who have worked with Hertzian wave and other systems of wireless telegraphy—men like Mr. MARCONI, Mr. PREECE, Prof. LODGE and Dr. FLEMING—best know the difficulties, some perhaps in their nature insuperable, which would have to be overcome, and are strongest in the belief that the field for this kind of communication is not that of long-distance telegraphy for which wires will always be found to be most suitable.

THE case for a Pacific cable, and for "all-British" cables generally, was laid before Parliament by Mr. WEBSTER in a temperately worded speech last week. Its one great fault was that it took no account of the manifold objections which have been pointed out, over and over again, as regards these schemes, by practical experts. It is possible that even without subsidies the Pacific cable will be laid, if capital can be tempted to support such hazardous adventure. Up to now, the serious risks, and the certainty that one cable alone would be worse than useless, have combined to favour the longer route with, however, shorter lengths of cables, in preference to the shorter one which would require longer stretches of cable, across the Pacific. Such is the case, so far as concerns the American and Australasian continents. As to the European countries it matters little whether their cablegrams travel westwards or eastwards; but it matters greatly that the route shall be abundantly provided with lines of communication—an advantage which the Eastern cables have always afforded, but which can never be obtained from the Western hemisphere. Mr. WEBSTER's suggestion, that the State should begin cable-laying on its own account in all parts of the British Empire, is based on the erroneous idea that cables landed where the home flag flies are safer than when they touch foreign soil. His financial conceptions are still more speculative. On this aspect of the question we commend to his attention Mr. F. E. BAINES's letter in *The Times* of the 11th inst.

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What it says as to the telephone business and State competition is equally true of cable business. These considerations will have due weight with the British government; and it does not surprise us that Mr. CHAMBERLAIN has not yet come to any understanding on the subject with the Canadian and Australian governments.

RUMOURS have been published concerning the so-called negotiations between the Streets Committee of the City of London Corporation and the City of London Electric Lighting Co. The statements made are only partially accurate. In the course of an informal conversation between officials of the Company and members of the Streets Committee at the recent Board of Trade inquiry, it was pointed out by the former that the Company had always endeavoured to approach the Committee with a view of adjusting in an amicable manner the points of difference which had arisen from time to time, but that the Committee had invariably held aloof from these approaches. We understand that on the same occasion a suggestion was made for a conference between representatives of the two parties, and that the Company have accordingly approached the Streets Committee with a view to talking matters over. A formal acknowledgment agreeing to this proposal has been received by the Company. It may be mentioned that Mr. A. C. Morton, who has taken a prominent part in the opposition to the City of London Company, was present during the informal conversation referred to above.

ONE of the American inventions which we have no desire to see introduced on this side of the Atlantic is the accomplishment of wire-stealing. In the United States this is usually practised on lengths of trolley or other overhead wire, which is cut from the poles, and for which it seems the thieves have found a ready market. In fact, so remunerative has this business become that some of the gentlemen who carry it on have been known to have first gone through an apprenticeship as wiremen, in order to apply their acquired knowledge subsequently—with the sign changed. Some, indeed, have acquired such dexterity as to be able to cut down live trolley wire and safely convey it away. From a case reported in another column, it appears that wire-stealing has commenced in this country in a much less sportsmanlike manner. In no circumstances can one have sympathy with men who enter an electric light company's premises with a false key and cart off new wire in order to sell it for old metal, and we are glad that the sentences imposed on them have been exemplary. It is to be hoped that electrical engineers will profit by the lesson and see that better care is taken of their stores. Money invested in a good lock is cheap burglar insurance.

A RECENT article in the *Lancet* points to the possibility of disease being carried from one house to another by infected air passing through the pipes leading in electric light wires. Our contemporary recommends that the ends of these pipes should be plugged. Of course they should.

A Correction.—In our notes on wireless telegraphy, last week, we stated that Capt. Baden-Powell had, in a letter to *The Times*, somewhat thoughtlessly appealed to the Post Office not to assert its monopoly against this method of telegraphing. This was an error, the passage referred to having occurred in Major Flood Page's letter, and not in that of Capt. Baden-Powell, to whom we apologise for the mistake.

Cable Interruptions.	Date of Interruption.
Cayenne—Pinheiro	Mar. 10, 1899
Maranhan—Para.....	April 10, 1899

Proposed German Submarine Cable.—The Convention recently concluded between the German Empire and Roumania is said to provide, among other things, for the construction of a telegraph line and submarine cable from Berlin to Constantinople, *via* Galicia, Bucharest and Constanza.

A New Source of Platinum.—According to a consular report, quoted in the *Electrical World* of New York, a black sand, rich in platinum, has been found in the Yukon. An analysis, it is said, showed that, taking the price of platinum at $8 per ounce, one ton of sand contains $768 worth of platinum, besides $102 worth of gold.

The Proposed Canado-Australian Cable.—A Reuter's telegram announces that the Hon. William Mulock, the Dominion Postmaster-General, has given notice of a resolution authorising the Canadian Government to enter into an agreement with the United Kingdom and the Australasian possessions to construct, lay and operate a cable between Canada and Australia on certain conditions.

The Proposed Memorial to Clerk Maxwell.—We are asked to state that the subscription list for the proposed memorial to the late Prof. James Clerk Maxwell in the parish church of Corsock, referred to in our issue of October 14th last, is still open. Subscriptions limited to half a guinea will be gladly received and acknowledged by the Rev. George Sturrock, The Manse, Corsock, near Dalbeattie, N.B.

A Large Electric Fan.—What will be one of the largest ventilating fans in the world has been ordered for the purpose of ventilating the Hoosac tunnel. The fan is to be 16ft. in diameter and 8ft. wide, and will be driven by an electric motor. It will have a capacity of drawing 600,000 cubic feet of air per minute. The *Electrical World*, of New York, states that the clearer atmosphere in the tunnel will enable the trains to attain higher speed.

Proposed New Subway in Boston.—A new subway, beginning approximately at the Boston end of the Harvard Bridge and extending to Scollay-square, has been proposed by the Mayor of Boston. The *Street Railway Journal* states that such a subway would cost $2,500,000, and would do away with the necessity of running certain of the surface electric cars, at the same time entirely relieving the congestion which at present exists in and about the present subway.

Wireless Telegraphy to America.—In reply to an inquiry, the Wireless Telegraph and Signal Co. inform us that it is quite correct that they have had negotiations with a syndicate who desire the exclusive rights of connecting England and America by wireless telegraphy. The company is also in close negotiations with a committee appointed by the French Government to make certain experiments with Mr. Marconi's system of telegraphy.

Personal.—Prof. Andrew Jamieson has decided to retire from the position of Professor of Electrical Engineering at the Glasgow and West of Scotland Technical College. It is stated that, owing to the amount of time which he has to give to telegraphic development, he is compelled to devote himself entirely to private consulting work. Prof. Jamieson has been connected with the college for 18 years, and is the senior member of the staff, with a salary of £750. The resignation, we understand, takes effect on July 1 next.

New Use for the Motor Cab.—A novel use for the electric motor cab, or rather for the battery it contains, originates in New York. A surgeon, who wished to make an X-ray examina-

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tion on a patient living in a house where there was no electric supply, recently hired a motor cab, with the request that an arrangement should be attached to it by means of which the battery could be used to work his induction coil. This was immediately done, and a wire was run from a second storey window of the house in question to the cab, and the examination was successfully performed.

New Central Stations.—The electricity supply station at Calcutta, built by Messrs. Crompton and Co., has been set in operation. It is, we believe, the first public electricity supply station in India, although one has been for some time in operation in Colombo, Ceylon.

The electricity supply works of the Bootle Corporation were formally opened by the Mayor yesterday. The supply is a three-wire system at 2 × 220 volts pressure, with Lancashire boilers, Bellis-Parker steam dynamos, a balancing transformer, and ejector condensers.

Electric Light and Harbour Defences.—In the House of Commons on Monday night, in reply to a question by Col. Kenyon-Slaney, Mr. Powell-Williams said that the electric light service in each section of a fortress was under the section commander, through the officer in charge of submarine mining defences, who was a Royal Engineer. The fire commander was under a Royal Artillery officer, who was also under the immediate orders of the section commander. The general officers commanding were responsible for the efficiency of their harbour defences; and there was no reason for supposing that they were dissatisfied with the electric light service.

Iron and Steel Institute.—As previously announced, the annual meeting of this Institute will be held at the Institution of Civil Engineers, on Thursday and Friday, May 4 and 5, commencing each day at 10.30 a.m. The new president this year is Sir William Roberts-Austen. Among the papers down for reading are:—"On the Use of Blast Furnace and Coke over Gases," by E. Disdier (Bilbao); "On the Solution Theory of Iron and Steel," by Baron H. Jüptner von Jonstorff (Austria); and "On Exploring for Iron Ore with the Magnetic Needle," by Prof. H. Louis. The Queen has graciously consented to accept the "Bessemer" gold medal of the institute for 1899 in commemoration of the great progress made in the iron and steel industries during Her Majesty's reign.

Wireless Telegraphy.—In the House of Commons on Thursday last week Sir R. Penrose Fitzgerald asked the President of the Board of Trade whether, in view of the fact of breakages of the telephonic cables between lightships and the shore having taken place from time to time, he would consider the desirability of adopting the wireless system for one or more of the light vessels recommended by the Royal Commission on Electrical Communication, and not connected by cable at the present time. Mr. Ritchie, in reply, said that the possibility of adopting the wireless telegraph system between light vessels and the shore was a very important question, and was receiving very careful consideration, but he was not yet in a position to express an opinion with regard to it. On Saturday last Mr. Ritchie went down to the South Foreland to inspect the arrangements there, and to witness Mr. Marconi's experiments.

Board of Education Bill, 1899.—The Council of the Association of Technical Institutions has unanimously adopted the following resolutions:—

1. In reference to Section 2 of Clause 3, "That, inasmuch as in some counties, and in most county boroughs the funds available are already fully appropriated for the purposes of technical education it is not, in the opinion of this Council, desirable that these funds should be applied to the payment of the expenses of inspecting schools under this section."
2. "That, in the opinion of this Council, having regard to the fact that the funds assigned under the provisions of the Technical Instruction Acts are not more than adequate for the maintenance and development of technical education, it is essential that for the further purposes of secondary education additional funds be provided."

It has also decided to take steps to endeavour to secure that the interests of technical education shall be adequately represented on the consultative committee named in Clause 4 of the Bill.

International Telephone Trunk Line.—Telephonic communication has been opened between Berlin and Brussels and Antwerp. The distance between Berlin and Brussels is 560 miles, and the line consists of two bronze wires, each of 4mm. diameter. A charge of 8 marks is made for a three-minute conversation.

The long distance telephone line from Sydney to Newcastle, New South Wales, a distance of 104 miles, was opened on January 1, 1898. During its first twelve months' existence, the *Australian Mining Standard* states, the receipts have increased every month, the year's working amounting to £774. This, our contemporary says, gives good interest for the cost of construction, and after paying maintenance and all expenses, will leave a small margin. The line is mostly used by the mercantile, shipping and insurance companies for inquiries regarding shipping.

Patents in Germany.—An interesting return has just been issued by the German Patent Office. The number of patents applied for during the year 1898 was 20,321, showing an increase of 11 per cent. over the previous year. Of these applications only 5,570 were successful, an increase of 130 over last year, but less than the numbers granted in 1895 or 1893, which were 5,720 and 6,480 respectively; 4,950 have expired or become void, compared with 4,573 last year, while at the end of the year the total number of patents in force was 19,991 compared with 19,384 at the end of 1897. Of the patents granted since July 1, 1877, 19·5 per cent. only are still in force. The largest increase in applications during the year is in Class 26, which applies to the production of gas and illumination, a large number of applications in this class referring to the employment of acetylene. In Class 21, for electrical apparatus and machinery, the applications had increased from 931 to 1,199.

The Manufacture of Copper Wire in Japan.—Of the large amount of copper produced in the Japanese mines the greater part has heretofore been exported to and worked up in other lands, some of it being returned to Japan as finished articles. The Japanese naturally have endeavoured to establish the complete industry at home, and, according to the *Electrical World* of New York, one large plant, the Furukawa Smelting Works, has adopted electrolytic refining. Its output for one year since has been about 860 tons, and the works are now to be enlarged to four times the size of the old. It is stated that on the completion of these new works the output will not only satisfy all the domestic demand, but will allow of the exportation of the finished product. This means a large production, as the governmental department of communication alone has used in one year about 660 tons for its wires. The energetic Japanese are now investigating the problems involved in the insulation of wire and the lead sheathing of underground cables, as well as the production of silicon bronze, which has already been attempted.

Automobile Club Exhibition and Trials.—The Automobile Club will hold a show from Saturday, June 17th, to Saturday, June 24th, in the Old Deer Park, Richmond, Surrey. Besides an exhibition of motor vehicles and accessories, the programme will include time tests of vehicles on the track, motor cycle races, hill climbing tests, and competitions for motor vans and omnibuses. The following gentlemen have consented to serve as judges in connection with the show:—Prof. C. Vernon-Boys, Mr. W. Worby Beaumont, Mr. Dugald Clerk, Mr. Bryan Donkin, Prof. Hele-Shaw, Major Holden, Mr. W. H. Preece, Sir David Salomons, Mr. James Swinburne, Mr. Boverton Redwood. Already 56 English, one American, and one Belgian firm have notified their intention to exhibit, subject to satisfactory arrangements being made, and a list of 26 French firms is also given as probable exhibitors. Applications for exhibit space should be made before Saturday next, and entries of vehicles intended to run on the track, before May 18. Copies of regulations, forms, and applications for space, particulars of trials, and certificates, &c., may be obtained on application to the secretary, at 4, Whitehall-court, S.W.

Obituary.—We regret to announce the death, on Tuesday last, of Mr. John Frederick Mills, senior superintendent of the Direct Spanish Telegraph Co. Mr. Mills was born on April 7, 1849, and had, therefore, just completed his 50th year. His introduction to telegraphy was in the old Electric and

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International Company's service in 1868. He afterwards passed into the Indo-European Co.'s employ, and served at Teheran, Persia. He joined the Direct Spanish Co. in February, 1874, serving first at the Lizard, then at Falmouth, and ultimately took charge of the London station in Gracechurch-street, on the occasion of its opening on Jan. 1, 1868. Mr. Mills had been slightly ailing for some time, but for the past few days his death had been expected, as he was found to be suffering from a serious internal malady. Mr. Mills was much respected by all who knew him, and the Direct Spanish Telegraph Co. has lost an able and devoted servant.

We regret to announce also the death of Prof. O. C. Marsh, who was for many years an associate editor of the *American Journal of Science*. Prof. Marsh, who was in his 68th year, occupied the Chair of Paleontology at the Yale University, and was Vertebrate Paleontologist to the United States Geological Survey. He died at his home in New Haven after a brief illness.

Alloys of Nickel and Iron.—A paper, giving the results of an investigation into the mechanical and physical properties of alloys of nickel and iron, was read by Mr. R. A. Hadfield, before the Institution of Civil Engineers on 28th March. The addition of nickel, either by conferring greater homogeneity or by some particular combination with the iron or carbon present, or both, appears to confer properties upon the alloy equivalent to an annealing, or, if annealing were employed, to reduce the stress produced by forging; it did this even in the annealed material without injuring or seriously lowering the elastic limit. In this respect, therefore, its presence was of considerable practical utility. The well-known Russian metallurgist, Chernoff, had stated that steel was composed of crystals of metallic iron cemented by carbide of iron, the result being that in the case of nickel-iron alloys the inter-crystalline spaces (a subject which had been fully and carefully investigated by Mr. T. Andrews, F.R.S., as regards ordinary steel) were much more completely filled, and the cohesion consequently rendered more powerful. The points of solidification of the cement and crystals were nearer, thus producing or maintaining a more intimate interweaving of the elements. In support of this theory Mr. Hadfield cited the fact that without doubt nickel-iron alloys showed less tendency to segregation than ordinary steel.

The Nernst Lamp.—Our German contemporaries contain the following communication from the Allgemeine Elektricitäts Gesellschaft, of Berlin, who own the patent rights of the Nernst lamp for all European countries (including England) with the exception of Austria-Hungary, Italy and the Balkan States:—"The tests in the laboratory have led to a provisional result, and the important question of initial heating has, we believe, found a satisfactory solution. In consequence, we have commenced the erection and equipment of a new factory for the production of the raw material in uniform quality, which has hitherto been the difficulty, and to manufacture a lamp to meet the requirements of the public. In reply to numerous inquiries from all sides, we can only put the lamp on the market when the efficiency of the new undertaking can assure the prompt execution of orders. Until then we will test the new lamp practically in the installations at our disposal. Prof. Nernst will probably deliver a lecture on his invention in this month."——It has been pointed out to us that the principle of employing refractory oxides in connection with arc lamps, on which the modifications of the Nernst lamp mentioned in our issue of April 7th depend, was alluded to by Herr F. Grünwald in the *Elektrotechnischer Anzeiger*, of December 16, 1897, and February 27, 1898. The principle is, however, older than this, as it dates back, at least, to the "Lampe Soleil," which was exhibited about 10 years ago.

Social Influence of Electric Power Distribution.—The effect of the introduction of steam-driven machinery was to centralise into factories industries which had hitherto been carried on in the artisans' own houses, and it has often been said that as power could be now economically distributed in smaller units by means of electricity, a reverse decentralising movement might well set in in certain trades. At Saint-Etienne there are about 80,000 looms for weaving ribbon, 15,000 of which are in Saint-Etienne itself, and a like number within a radius of 25 miles. These are for the most part owned by small master weavers, each of whom possess only two or three looms, usually worked by himself and members of his family, and it is only in exceptional cases that the machinery is grouped in large factories. The effect of electrical power distribution there has been, not to decentralise, but to prevent the centralisation which must otherwise inevitably have taken place by the building of steam-driven factories. Since the year 1891 the Electrical Company of the Loire has been developed, and its chief business is to supply power for the looms hitherto worked by hand. The extra-mural system of mains now extends over 24 parishes and has a length of 70 miles, over which three-phase current at 5,200 volts is distributed. Thirty transformer stations reduce the pressure to 190 volts for motive power, and 110 volts for lighting. The current for this network is generated at two water-power stations, having a capacity of 900 and 400 H.P., the former with a steam reserve of 600 H.P. In the town of Saint-Etienne there are three steam-driven stations of 600 H.P., 200 H.P. and 100 H.P., generating current directly at low pressure. The total number of looms worked electrically is 2,500 and the average power each require is ¼ H.P. In addition there is a lamp connection of about 8,000 incandescent lamps and about 100 H.P. which is utilised in small workshops.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, April 21st.

INSTITUTION OF CIVIL ENGINEERS.

4 p.m. Repetition of "James Forrest" Lecture, by Prof. J. A. Ewing, F.R.S.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Rooms of the Chemical Society, Burlington House. Agenda: (1) "On the Effect of a Solid Conducting Sphere in a Variable Magnetic Field on the Magnetic Induction at a Point Outside," by C. S. Whitehead; (2) "Demonstration of Richards' Method of Standardising Thermometers," by R. A. Lehfeldt.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7:40 p.m. Meeting in the Lecture Hall of the Sunderland Literary Society, Fawcett-street, Sunderland.

MONDAY, April 24th.

SOCIETY OF CHEMICAL INDUSTRY.

8:30 p.m. Extra Meeting of the London Section at the Chemical Society's Rooms, Burlington House, when the President (Mr. G. Beilby) will deliver an Address on "The Relations of the Society to Chemical Engineering and to Industrial Research."

TUESDAY, April 25th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Annual General Meeting of Corporate Members only.

WEDNESDAY, April 26th.

INSTITUTION OF ELECTRICAL ENGINEERS.

9:30 p.m. Students' Meeting in the Library.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "Coal Supplies," by T. Foster Brown.

THURSDAY, April 27th.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. Ordinary General Meeting, when the President will deliver his Address.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting, when the conclusion of the discussion on Messrs. Duddell and Marchant's Paper on "Experiments on Alternating Current Arcs by Aid of Oscillographs" will be taken. Paper to be read: "Capacity Measurements of Long Submarine Cables," by J. Elton Young.

FRIDAY, April 28th.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. Ordinary General Meeting. Paper to be read: "Evaporative Condensers," by H. G. V. Oldham.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Some Features of the Electric Induction Motor," by Prof. C. A. Carus-Wilson.

SATURDAY, April 29th.

INSTITUTION OF ELECTRICAL ENGINEERS.

Students' visit to Central London Railway. Particulars will be given on post-cards.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Absorption of Electric Waves.—E. Branly and G. Le Bon recently proved that a metallic enclosure, hermetically sealed, is an absolute protection against the influence of electromagnetic waves. They have since investigated the screening action of certain insulators or feeble conductors such as are met with in the practical work of wireless telegraphy. They operated with hollow blocks of cement, building stone, and sand. In each of the blocks a small cubical chamber was left free, to contain the coherer. It was closed by a thick iron door, through which the wires were conducted. The ringing of a bell indicated the impact of waves upon the coherer. Without a screen, the coherer responded to the exciter at a distance of 40m. and more. It was found that the opacity of the substances tested depended much upon their nature, condition, and thickness. Sand and stone are very transparent, especially in the dry state. Portland cement is very opaque, wet sand almost equally so. To quote a few figures:—Block of cement, with walls 10cm. thick: the bell ceases to sound at a distance of 7m. After drying the distance becomes 12m. The same, 30cm. thick, absolutely opaque while wet. Block of stone, transparent. When wetted for several days the reaction ceases at 25m.

[Branly and Le Bon, *Comptes Rendus*, April 4, 1899.]

Reduction of Phosphate by the Arc.—H. Moissan recently described the preparation, in his electric furnace, of a crystallised calcium phosphide, corresponding to the formula P_2Ca_3. A. Renault publishes his own results, obtained along independent lines. Into an iron or carbon crucible, which serves as a cathode, he introduces a mixture made up of 24 parts carbon and 76 of tricalcic phosphate. The current is introduced by a vertical anode, which is lowered down into the mixture until the arc appears. That requires some 80 or 85 amperes, and as many volts. Vapours containing phosphorus are given off, but these must be absolutely stopped by introducing resistances until the current descends to about 20 amperes. The product obtained is a grey metallic-looking substance, with a reddish crystalline fracture; it consists of calcium phosphide, P_2Ca_3, enveloped in a grey covering of a mixture of carbon and phosphate. The carbon best suited for the purpose is petroleum coke, which contains traces of the heavy hydrocarbons, but does not leave more than about 0·28 per cent. of incombustible residue. The most important property of the phosphide is that it decomposes water, giving non-inflammable phosphuretted hydrogen.

[Renault, *Comptes Rendus*, April 4, 1899.]

Distribution of Terrestrial Magnetisation.—To arrive at a clearer conception of the causes of the unsymmetrical distribution of the earth's magnetism, L. A. Bauer has hit upon the happy expedient of supposing the earth to be, in the first instance, a uniformly magnetised sphere, and then deducting this theoretical magnetisation from the actual magnetisation at corresponding points on the earth's surface. The chart so obtained reveals the existence of three residual magnetic north poles, and three south poles. The strongest of the north poles is situated to the east of Patagonia, the others being in China and the United States. The strongest residual south pole is in the French Congo, and the others are in the Behring Sea and near Tasmania. The most important result obtained is that this distribution of the magnetic irregularities has some connection with the abnormal distribution of temperatures. Roughly speaking, there are secondary north poles in regions which are colder than might be expected from their latitude, while there are secondary south poles in the abnormally warm regions. This would imply that the seat of the abnormal magnetisation is within that layer of the earth's crust which is subject to temperature variations, and that layer is, of course, very thin indeed.

[Bauer, *Terr. Mag.*, April, 1899.]

Diffraction Galvanometers.—The sensitiveness of a galvanometer can, according to P. Weiss, be almost indefinitely increased by constructing it on a smaller and smaller scale, or by employing a greater and greater optical enlargement for reading the angles. But a limit is set by the resolving power of the mirror. A mirror of 1cm. diameter should, according to Foucault's rule, separate two readings 12sec. apart. Practically about 5sec. can be observed, and this, on account of the doubling, means an actual deviation of 2·5sec. But the same author has devised a means of considerably increasing the sensitiveness by diffraction. He uses a mirror 1 by 0·4cm. in area, suspended with its greater length in a horizontal position. The centre of the mirror is blackened, while the ends, 4mm. by 3mm. are left bare. The radius of curvature of the mirror is 4m. It is illuminated by an incandescent filament placed at the centre of curvature. The rays reflected by the mirror produce, at the same distance, the usual phenomenon of diffraction at infinity for the case of two openings. The enlarged image of the filament is seen in the focal plane, traversed by two black fringes, which are sharply defined. On taking the position of one of them as a datum, a micrometric eye-piece will easily discover a displacement of 0·025mm. This is less than a second of arc, and at least four times as sensitive as the usual method.

[Weiss, *Comptes Rendus*, April 4, 1899.]

Electric Lines of Force.—Attempts to illustrate graphically the course of the lines of electric force, after the fashion of Faraday's magnetic lines, usually fail on account of the attraction, charge, and subsequent repulsion of the metallic electrified powder. E. Boudrèaux has, however, succeeded by employing a powdered inferior conductor, sprinkled over a homogeneous and well-insulated non-conducting glass plate. Diamidophenol, crystallised in small needles, answers very well. Cork, elder pith, powdered sugar, and a great variety of other substances may also be employed. The curves are fixed with varnish in the usual way. Three-dimensional curves may be produced in petroleum by means of powdered carbon, but nobody seems yet to have obtained them in air by smoke or dust particles.

[Boudrèaux, *Comptes Rendus*, April 4, 1899.]

New Process of Colour Photography.—Though not marking an advance in electrical science, the grating process of colour photography invented by R. W. Wood is of great general interest. The principle is the following: If the eye is placed in a grating spectrum, the whole grating appears of that colour which impinges upon the eye. If any portion of it has a different interval from the rest, that portion appears of a different colour. If two sets of rulings are superimposed, a mixed colour is seen. The author takes red, green and violet negatives through screens in the usual way, and transfers them to the same position through three gratings which, when superimposed and seen at a certain angle, would give white light. The positive, seen at the same angle, has colours of the original. It can be easily copied.

[Wood, *Phil. Mag.*, April, 1899.]

Electric Charges of Rain and Snow.—J. Elster and H. Geitel have made a series of interesting observations of the electric charges conveyed by rain drops and snowflakes. These observations are not at all easy, being attended by a variety of sources of error. It is not sufficient to catch the drops on a plate or in a vessel connected with an electrometer, since such a plate would be exposed to all the vicissitudes of induction from the earth and the clouds. The authors enclose the plate in a metallic box open at the top. They mount a special conical protector over the plate, to prevent drops reaching it which are spurted from the rim of the box, and may thus have acquired a considerable charge. They also employ a variety of other protective contrivances. Even so, the results obtained are evidently not strictly trustworthy. But one result is very strikingly brought out by simultaneous observations of the aërial potential and the charges of the precipitations. A negative potential of the air is accompanied by a positive potential of the rain drops, and *vice versa*. As the rain goes on the difference increases. For as charges of one sign are withdrawn from the atmosphere, charges of the other sign accumulate in it. The one set of curves is, so to speak, the image of the other.

[Elster and Geitel, *Terr. Mag.*, March, 1899.]

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An Exploring Radioscope.—In surgical radiography the orientation of a foreign body is not definite unless it happens to be situated in the perpendicular from the radiant point on to the sensitive plate. It thus may happen that an operation is made in the wrong place. To avoid this danger, A. Londe has designed what he calls an exploring radioscope. It consists of two rings, one of which is placed above and the other below the body to be examined. The axes of the two rings are made to coincide. An X-ray tube will give shadows of both rings, but these shadows will not be concentric unless the radiant point also lies in the common axis. When this is secured the whole apparatus is shifted until the foreign body appears in the centre of the rings on the screen. Points are then marked on the skin at the centre of each ring, and the operator is then sure that the foreign body must be situated somewhere on the line joining the two points. It remains to find whereabouts on that line it is. To do this the X-ray tube is shifted aside a little, thus throwing the foreign body out of the centre. The subject is then removed and a transparent scale inserted in the axis of the rings. That scale will cast a shadow, somewhere on which the foreign body appears. The scale reading against it marks the depth below the skin.

[LONDE, *Comptes Rendus*, March 27, 1899.]

CARBONS FOR ELECTRIC LIGHTING AND OTHER PURPOSES.*

BY FRANCIS JEHL.

(*Concluded from page 857.*)

X.—SOOT OR LAMPBLACK.

The rational working of a carbon factory demands, also, the establishment of works where the soot or lampblack that is used for high-grade carbons is manufactured. Lampblack, soot or amorphous carbon is largely manufactured by heating on a hearth vegetable or mineral matters composed of hydrocarbons. When the vapours are disengaged they are ignited and allowed to burn by supplying just air enough to keep up the combustion—that is, air enough to keep the flames alive, but insufficient to produce complete combustion of the carbon contained or liberated by the gases. The hydrogen, which these substances contain, being its most inflammable part, burns off, leaving the carbon in a powdered or soot-like form. The smoke resulting from this incomplete combustion is allowed to pass through large chambers, where it settles down or condenses. The above are the principles on which large quantities of soot are manufactured, but when a very fine quality of lampblack is desired, oils are generally burned in special lamps, so that they smoke, and the smoke is allowed to condense in a similar manner to that explained above.

Many varieties of apparatus have been designed for producing soot or lampblack by allowing smoky flames to strike some cold surface, on which condensation is effected immediately; this is, however, not necessary, as the quality and efficiency of production can be effected better by allowing the smoke to condense in chambers. On the whole, however, the writer thinks there is plenty of room for further improvement in soot manufacture, and that the long path taken by the sooty smoke in passing from chamber to chamber may yet be avoided. Perhaps favourable results could be obtained by forcing the smoke through water by means of an exhauster, in which water the soot would settle or float on the surface. It would then, of course, have to be dried or calcinated. Another way would be to let the smoke pass through a small chamber in which water was discharged in a spray. The lampblack slush could be collected from time to time, dried and calcinated. Such methods have the advantage of using a small building instead of the long ones now in use, while at the same time there would be a certainty of collecting all the lampblack produced. However, using water in order to catch lampblack has the disadvantage that it is necessary to calcinate the soot afterwards, or at least thoroughly dry it, which means extra labour. As a general thing, lampblack manufacturers in Germany are constrained to locate themselves in the country or woods, because there is such an escape of soot which settles on everything in the vicinity and blackens or soils the neighbourhood. The woods are, therefore, proper places for such a factory, as even in the country where there are crops growing it does damage, as the soot falls or settles on growing fruit in which it gets embedded, thus spoiling it. No doubt many have already seen ears of corn that were spoilt by soot which fell upon it during growth from some neighbouring factory.

The whole theory concerning the formation of lampblack or soot demands simply two conditions:—

1st. That the substance or material employed should be rich in hydrocarbons, which can be rendered into a gaseous form by means of heat.

2nd. That when such hydrocarbons are burnt, the amount of air supplied should be just sufficient to keep up a dull cold flame, whereby an incomplete combustion is produced by the oxidation of the hydrogen only, thus allowing the particles of carbon that are liberated to pass out of the sphere of the flame and settle elsewhere.

It is one of the characteristic properties of carbon that it unites with hydrogen in various definite proportions, thereby forming a large variety of compounds known as hydrocarbons. Many of these compounds, such as lignite, fats, brown fatty coal, tars, pitches, resins, oils, &c., concern us, as they are used in the production of soot or lampblack.

The combustion, when generating soot, must not be so low that these hydrocarbons cannot get decomposed, nor must the combustion be so high that the carbon particles get oxidised and converted into gas. In fact, the quantity of soot produced depends simply upon the regulation of the air that is supplied to the burning matter. We have also seen that we have two ways of collecting the soot; one way by allowing it to condense in chambers, and the other by bringing the flame in contact with some surface—generally a cool one.

No doubt, if condensing chambers were placed in the path of the flue in all our industrial establishments, a large quantity of soot could be caught, and thus a public nuisance abated. Should the draught be hindered by such chambers an exhauster or blower could be used. For carbon purposes, however, such a material would not amount to much, as it contains too many impurities, unless some cheap process could be devised by which it could be cleaned.

Dr. Köhler mentions that Roberts has calculated the amount of soot that overclouds London on a winter's day to be about 50 tons, and that this figure was confirmed by Sir W. Siemens. He also states that in our ordinary stoves at home 100 kilos. (220lb.) of coal produce about 120 grammes of soot, which seems, on the whole, a very small amount. From these figures, however, we will find that the soot escaping in London alone amounts to about 15,000 to 20,000 tons per year.

The writer has already stated that the soot manufactured for electric light carbons, &c., is generally made from such raw materials as fats, brown coals, tars, pitch, resins, &c. One of the principal materials used, however, is tar, which is obtained in large quantities either from gas works or petroleum distillers; in fact, petroleum distilleries have an abundance of this residual matter rich in carbon, which can be utilised in the production of good soot for carbons. A table giving the composition of petroleum (Russian), and based upon commercial outputs is given in Mr. E. T. Carter's "Motive Power and Gearing."*

Now this liquid fuel is a good material from which to make the lampblack or soot used for high-grade carbons, while the petroleum cokes, of which there are plenty in such distilleries, will serve for second grade goods, electrodes, &c.; in fact, petroleum works could turn their by-products to very good account by establishing a carbon factory. The Budapest petroleum works were considering the subject some time ago, and it may yet be realised. The writer knows that at present benzine, as obtained by the petroleum distillers in Hungary, has hardly any value, and that they do not know what to do with it, although some of it is bought for manufacturing the finer qualities of soot from which lithographic and printers'

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* *The Electrician* Series.

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ink is made. Of course, benzine can only be used in water cooled lamps for making lampblack. If such distilleries are not disposed to manufacture carbons, it would still be to their advantage to produce soot, as they could manufacture that article cheaper than anyone else, with the exception of gas works, where large quantities of tar are also obtained.

The writer wishes to point out the fact that in burning any material, it is of advantage to use only such substances whose flash points are about the same. If a material is used that consists of a mixture of several substances having various flash points, it will be found that, when such a mixture is burned on a hearth, the lighter oils will volatilise and condense in the chambers where the soot also deposits, and the result is that we obtain what is known as "wet soot," which it is necessary to calcinate before using in a carbon factory. If we use such a mixture of oils in a lamp, we shall find that the lighter oils will burn away, while the heavy ones will begin to settle around the wick, which gets partly carbonised and clogs. The writer made some experiments with Russian raw petroleum some time ago, and constructed a special lamp for the purpose of keeping it cool. He found that at first a good soot flame was obtained with regulation, and that only the lighter oils burned away while the heavy ones, whose flashing points are high, remained behind and clogged up the wick, preventing, after a while, the lighter oils from ascending. At the same time the heavy oils began to char, so that the flame was soon extinguished. We see, therefore, it is a matter of some importance to a soot factory to use only such substances that have about the same flash points. Lighter oils should be burned in lamps and heavy ones on hearths. No doubt a process could be devised by which a mixture of hydrocarbons of different flash points could be utilised, and that would be by gradually distilling them in some closed receptacle or retort, converting them into gas, and then burning them with suitable burners.

When employing tar as the raw material, it is necessary that it should be free from water, which would otherwise go over and condense in the soot chambers, while at the same time it interferes with the fire. The tar is in practice warmed up in tanks, and the water settles at the bottom, and by suitable stop-cocks is let off from time to time. The heating of the tar has also another advantage, and that is it makes it more liquid, depriving it of its viscosity. By these means it is easily led through pipes to the hearth where it is burned. It may be mentioned that any old boiler will serve for such purposes. When using oils it is generally unnecessary to heat them, unless they contain matter that may need such heating up. Oils of a low flash point, as has already been mentioned, are generally burnt in lamps, for if burnt on a hearth too much volatilisation matter goes over. Of course, such oils produce a finer quality of lampblack than tar, and are suitable for the best printing inks.

Tar, however, furnishes as good a soot as can be desired for carbons, and as it is cheap, it is largely used. Brown coal also gives a good soot, and is used in many soot factories. As has already been stated, it is very important to produce good regulation of air in a soot works. When too much air is allowed to enter the hearth we obtain good combustion, producing relatively little soot, but one of a fine quality, whereas if too little air is supplied, we obtain more soot, but of a coarser quality. Practice will soon show the amount of regulation that is necessary, and it may be observed that this regulation depends upon the season of the year and state of the weather.

Dr. Köhler gives the following figures relating to the quantity of soot obtained with a given amount of raw material:

100	parts of pitch	gives from	12	to	15	parts of soot.
100	„ tar	„	15	„	18	„
100	„ oil	„	18	„	20	„

The soot is of various qualities, and there remains about 50-60 parts of coke, which is simply used for furnace purposes. Duhamel states that 1,000 kilos. of mineral coal produces about 3·3 kilos. of soot and 400-500 kilos. of coke; Thenius says he received from 400 kilos. of heavy tar oil, 20 kilos. of soot of the first quality, 30 kilos. of soot of the second quality and 20 kilos. of the third and fourth quality. Engler states that in the Black Forest in Germany, where soot is extensively manufactured, they obtain from 100 parts of tar about 25 parts of soot, and from 100 parts of resinous substances 20 parts of soot. Heavy tar oils produce about 25 to 30 per cent. of soot, and petroleum about 20 to 25 per cent. and gas from 4 to 7 per cent. The differences given in the above figures are no doubt due to different modes of operations, that is, the different rates at which combustion is forced in different factories. If we take 20 to 25 per cent. as the efficiency of production we shall be on the safe side. In fact, as soot is used in such large quantities in the manufacture of carbons it cannot be expected that its quality should be similar to that used for fine inks, as no doubt such a difference in quality would show very little in a carbon when burning. The main thing is to obtain pure carbon, and that the cost of producing it will enable the carbon manufacturer to compete with others.

Such hydrocarbons as fat brown coal, tars, pitches, resinous matter and the residuum of oil stills, give us a list of materials that are not expensive and at the same time rich in carbon.

Lampblack, when bought from soot manufacturers, costs about £1. 6s. 7d. or $6.40 per 100 kilos. (220lb.). We can reckon the price of the raw material from which it is produced at—tar at 8s. 4d. or about $0.80 (which is very liberal) per 100 kilos. Taking the efficiency of production at 20 per cent. we would require 500 kilos. (1,100lb.) of the raw material to produce 100 kilos. of soot. This gives us the price the raw material as 16s. 8d. or $4. The writer has calculated that if we add 3s. 4d., or $0.80 per 100 kilos. of soot manufactured, as the costs of labour, interest and redemption it is more than necessary. This gives us the price of soot at about £1 or $4·80 per 100 kilos. We see there is thus a saving of at least about 6s. 7d. or $1.60 per 100 kilos. when a carbon factory manufactures its own soot. This is an important item for a carbon factory, and it is hard for those to compete that have not their own works, as the writer knows from experience. We see also from the above figures that petroleum distillers and gasworks have an especial advantage if they would manufacture soot, as they produce plenty of tar as a by-product. Not alone is there a saving in producing one's own soot, but there is also a considerable saving in freight, as soot factories are at great distance from some carbon works. The writer knows of a carbon manufacturer who pays as much as £30 or $144 for a car load (about 10 tons) of soot. The raw material, however, can be procured generally from a neighbouring town, so that the freight will not amount to much.

A few words may be said in regard to the building of a soot factory. It is advisable never to use any wood in any part of the building where the soot condenses, as the hot gases, in passing through the chambers, will so dry the wood that after a time it will become like tinder and fall or crumble to pieces, while at the same time there may be some danger of it igniting. One may think that such condensing chambers could be easily and cheaply constructed from sheet or corrugated iron; there are, however, some facts that have to be taken into consideration, and in the first place it has been found that soot settles best on rough surfaces, the deposit taking place like snow. Small particles of soot settle on a surface, and, after a while, are formed into flakes, the size of which increases so that they get too heavy to sustain their own weight and fall down. Of course, some of the soot adheres to the walls, and these are also scraped from time to time with a sort of wooden hoe.

When the condensing chambers are constructed of iron, the soot cannot settle well on the smooth sides, for it must be remembered that each flake is composed of several very small particles, which, if they do not settle, will be taken by the draught up the chimney and so escape. Then again, iron being such a good conductor of heat, water and other vapour would easily condense within such chambers, whereas the object in soot making is to have chambers that are always so warm that volatile matter will not easily condense, but will escape by the chimney.

The best, the most practical and economical method is to build the chambers simply with common rough bricks, the sides of which offer a favourable depositing place for the soot. The walls of such condensing chambers should in no circum-

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stances be finished by coating them with plaster. Such a coating would lessen the efficiency of the depositing surface, while at the same time, when the hot gases circulated through, it may crack and fall down and contaminate the soot. A common unfinished chamber of bricks set in good cement is all that is necessary. The best flooring to give such chambers are flagstones solidly and evenly laid, while the interstices should be partly filled with good cement, in such a way that there is no danger of dislodging such cement when the soot is scraped out together; in fact, the scraping of the soot together should only be done with wooden implements somewhat similar to hoes.

It will be noticed that a new factory will generally produce a much better quality of soot after it has been working for some months. This is due to the fact that in the first months of operation plenty of moisture that is in the walls is driven out by the heated gases. This moisture cools the gases, thereby interrupting the draught and lessening their velocity, which causes the material in the hearth to burn without flame, and permits some of the unburnt products to escape and settle in the condensing chambers, where it and the moisture gets absorbed by the soot.

However, after the condensing chambers have been well dried, it will be found that they keep their heat well, and that the quality of soot obtained is much better. In starting the fires at the hearths, they should be permitted to have all the air that is necessary for complete combustion, and at the same time it is advisable not to start too large a fire in the beginning so that a gradual draught is established while the chambers are slowly heated. After a while, when a good circulation is obtained, we can commence by regulating the damper of the chimney so that the flames have a sort of a dark, red, smoky appearance, while the smoke issuing from the chimney should have a light appearance, that is, no dark, black smoke should appear there. Fuel should be supplied to the fire often but little at a time. Care should also be taken that the supply of air be not so decreased that the combustible begins to swell up, as this may allow unburnt matter to escape. It may also be mentioned that these unburnt gases may cause an explosion by mixing with unburnt air and soot. However, under normal conditions no explosion can occur; the fuel must always be supplied gradually, and not too much of it at a time, and care should also be taken when igniting the fire at the commencement. When it is desired to discontinue such fires notice should always be taken before leaving, that no combustible remains on the hearth; in fact, with precaution and a well regulated service everything will work well. Soot factories generally work day and night with the exception of one day or two in the week when the chambers are allowed to cool and the soot is collected and removed.

LARGE WILLANS ENGINES.

Last Friday we had the pleasure of visiting Messrs. Willans and Robinson's works at Rugby, to inspect the first of the 1,000 H.P. engines which has been completed for the Liverpool Corporation tramways. As this engine was described and illustrated by a scale drawing in our issue of April 8, 1898, and again referred to on November 18th last, it will suffice to recall that it is a compound engine of the "8 V" size, indicating 1,000 H.P. as most economical load, 1,200 H.P. as maximum continuous load, and 1,500 H.P. on emergency, when running non-condensing at a speed of 280 revolutions per minute, and with a normal steam pressure of 160lb. per square inch. It will be direct-coupled to a Siemens 10-pole dynamo, which is to have an output of 1,420 amperes at 460 to 550 volts. Fig. 1 is from a photograph of the engine, which is ready to be tested shortly, and was under steam at the time of our visit.

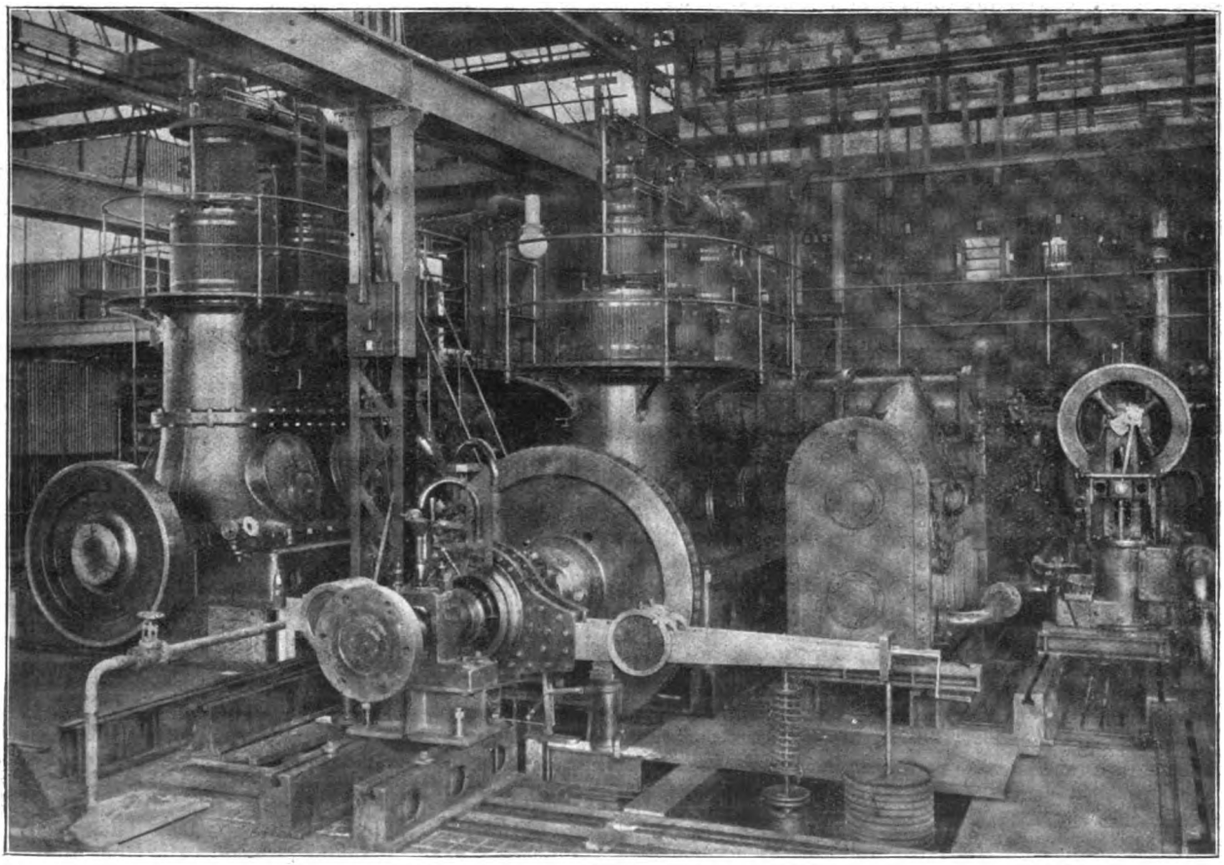

FIG. 2.—470 B.H.P. WILLANS ENGINE FOR CITY AND SOUTH LONDON RAILWAY, COUPLED TO FROUDE WATER BRAKE.

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Tests were also being carried out on a new 3R engine, one of two ordered for the City and South London Railway. Fig. 2 shows the engine coupled to a Froude water brake. It is designed for an emergency load of 585 B.H.P., its most economical load being 470 B.H.P., at 320 revolutions per minute. According to the guarantee, the governing variation between full load and no load is not to exceed 1½ per cent., and if the whole load is thrown off during a space of 1 second, the momentary variation is not to exceed 5 per cent. Of course, this is largely a question of weight of fly-wheel, and as the engine is at present sans flywheel and sans dynamo the governor trials have not yet been made.

A walk through the works impressed us with the large number of engines of various sizes in process of construction for electricity supply stations, including some large units for St. Pancras. Mr. Robinson informed us that it has been decided to extend the works at Rugby by the addition of a

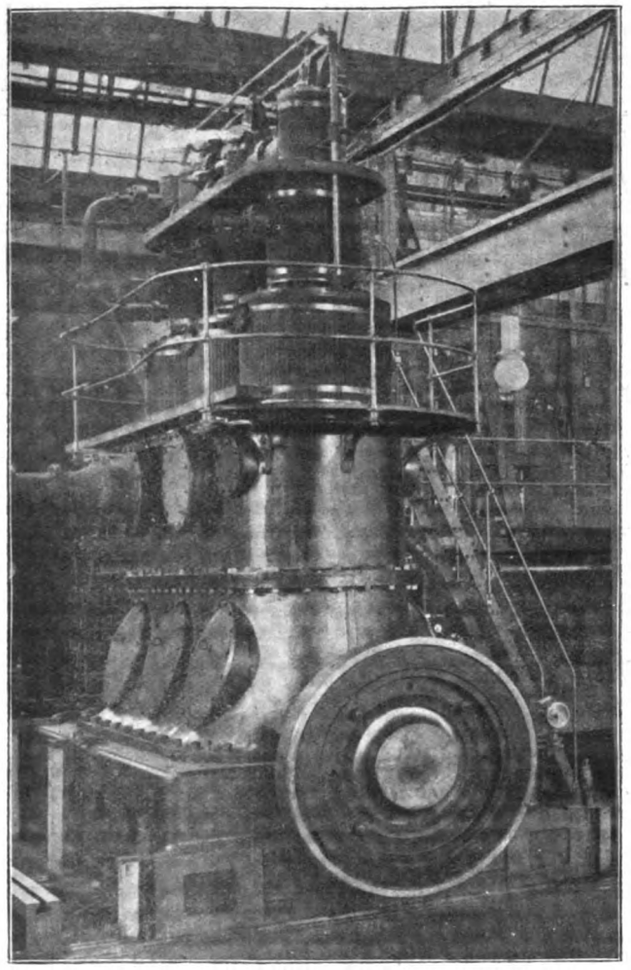

FIG. 1.—1,000 H.P. WILLANS ENGINE FOR THE LIVERPOOL CORPORATION TRAMWAYS.

shop lofty enough to fit engines of 2,500 H.P. and upwards without inconvenience, and that as slow speeds were usually demanded for these large sizes it was probable that double-acting engines would be built. We wish his firm every success in its new venture. Mr. Robinson is also as sanguine as ever with regard to the ultimate success of the double-water tube Niclausse boiler, the manufacture of which is shortly to be moved to new works in Cheshire.

Sand Fire Extinguishers.—It is stated in the *Electrical World*, of New York, that sand will be used to extinguish fire, if there should be one, in the New Telephone Co.'s exchange at Indianapolis. It is to be used because it is less injurious to the electrical apparatus than water or chemicals would be. The sand is stored in a large tank above the exchange room, and is sifted automatically to any or all parts of the building.

EXPERIMENTS ON ALTERNATE-CURRENT ARCS BY AID OF OSCILLOGRAPHS.

(Continued from page 860).

PART II.

SECTION 8.—SEARCH CARBONS IN ARC.

(Fig. 4 and Table IV.)

In the investigation of the distribution of the fall of potential in the arc, two search carbons (2mm. diameter) were inserted into the arc—one search carbon, designated *b*, being 0·5mm. distant from the top carbon, which was designated *a*; the other search carbon, called *c*, was similarly proximate to and distant from the bottom carbon (called *d*) by 0·5mm. Three potential difference wave forms were thus obtained and recorded simultaneously, viz., the waves between *a* and *b*, between *b* and *c* and between *c* and *d*.

Directly after obtaining the above wave forms we, in each experiment, recorded the curves of P.D. between the main carbons and the current through the arc, the search carbons remaining in position in the arc. The experiments were carried out for two different arc lengths, viz., 6mm. and 15mm., and for the same combinations of carbons as in our other experiments. We find in all cases, when we consider the instantaneous values of the distribution of P.D., that they are very similar to those obtained for the direct current arc, and that we may divide the fall of the potential into three parts: a drop at the surface of the + crater, a drop in the arc proper, and a drop at the − crater, the drop at the + crater being always much larger than at the −.

As each crater changes its sign every half period, the difference of potential between it and the search carbon near it is alternately large when the crater is + and small when it is −, which makes the wave forms of this difference of potential very much higher on one side of the zero line than on the other, as is seen in Fig. IV. Thus if a search carbon is connected to the main carbon through an outside circuit, the quantity of electricity which will flow round this circuit will be larger in the direction from the main carbon to the search carbon than in the opposite direction. If a galvanometer be introduced into this circuit its deflection will seem to indicate that the main carbon is always at a higher potential than the search carbon in the arc; and this result is obtained whichever main carbon the search carbon is connected to. Our curves thus explain the above observation of Dr. Sahulka and others, and considerably alter its bearing on the question of the back E.M.F. of the arc.*

The magnitude of the fall of potential in the arc vapour is, we find, nearly independent of the direction of the current, so that the wave forms of potential difference between our two search carbons are almost the same on both sides of the zero line. The instantaneous value of the P.D. between our search carbons is largest at the early part of the period giving a peak on the curve of P.D. between the search carbons, and this peak is very considerable with long arcs (experiments 45, 49, and 53—curve of P.D. between *b*, *c*). *We thus trace the large front peak which we found on the P.D. arc curve for long arcs to the resistance of the gaseous column between the carbons, after cooling during the extinction of the arc. The small back peak obtained with short solid arcs seems to arise at the + crater.*

If we add up the corresponding ordinates of the three curves of fall of P.D. obtained with the search carbons, we ought to obtain the curve of the P.D. between the terminals of the arc, which should be the same as that obtained experimentally; and, as long as the current in the arc is not too small, this agreement is as close as might be expected in view of the fact that some minutes elapsed between recording the search carbons' curves and the corresponding P.D. arc curve. When adding the ordinates of the curves for the cored arc we find that *the chief cause of the characteristic dent in the front side of the P.D. arc curve is the peak in the curve of the drop of the P.D. along the vapour column.* And, since this peak becomes higher with increase of arc length, the dent is moved up the side of the P.D. arc curve, as noticed when considering the effect of length.

All results obtained by means of search carbons in the arc are liable to error, due to the disturbance of the arc by their presence. In our case we noticed that the introduction of the search carbons into the arc caused a sharp ridge to form across the craters, the direction of the ridge being parallel to the nearest search carbon, this latter appearing to protect the crater from wasting away. Another change that the search carbons

Table IV.—*Search Carbons in Arc.*

Expt. No.	Carbons. Top.	Carbons. Bottom.	Arc length. mm.	P.D. arc. Volts.	Power. Watts	Power factor.	Notes.
42,43	Solid	Solid	6	74·5	901	0·825	A sharp ridge formed across craters where protected by search carbons.
44,45	,,	,,	15	93·0	1,155	0·83	
46,47	,,	Cored	6	54·7	786	0·97	Same note.
48,49	,,	,,	15	70·5	1,025	0·98	
50,51	Cored	,,	6	46·7	688	0·995	Same note.
52,53	,,	,,	15	60·5	874	0·975	

* See leading article in *The Electrician*, Vol. XL., 1897, p. 326; and Dr. Sahulka, *Zeitschrift für Electrotechnik*, 1898, p. 213.

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produced was to increase the P.D. required to maintain an arc of given length and current, this increase being 17 per cent. in the case of a 6mm. solid arc (compare experiments 26 and 42). The power factor was also affected, and, as far as our results go, the power factor is reduced with the solid arc and increased in the other cases by the introduction of the search carbons. One other difficulty which we noticed was that, if by any chance one of the search carbons touched the crater of the main carbon, the arc was extinguished, the crater touched appearing to travel along the search carbon until the arc became of considerable length and then went out. In spite of these difficulties, we think the results show conclusively—

1. *That at any instant the distribution of the difference of P.D. in the alternating arc is similar to that in the direct current arc.*

2. *That the growth of the front peak in the P.D. curve of the long solid arc and the movement of the dent in the P.D. curve of the cored arc are due to the increase of resistance of the gaseous column during such extinction as the arc is lengthened.*

The authors have carried out an immense number of experiments in examining the effect of resistance in series, and in their Paper give no less than 48 sets of curves illustrating this effect. Their interpretation of the more significant changes in the wave form is so clearly set out in the text, that we confine ourselves to reproducing only two of these curves, viz., those corresponding to experiments 54 and 55. These curves are, it will be noticed, for arcs of 1mm. length between solid carbons. In experiment 54 the resistance in series was 0·96 ohms, the potential difference of the alternator 51·5 volts, of the arc 42·1 volts, the power absorbed by the arc 360 watts, and the power factor 0·58, the arc hissing and unstable. In experiment 55 the alternator potential difference

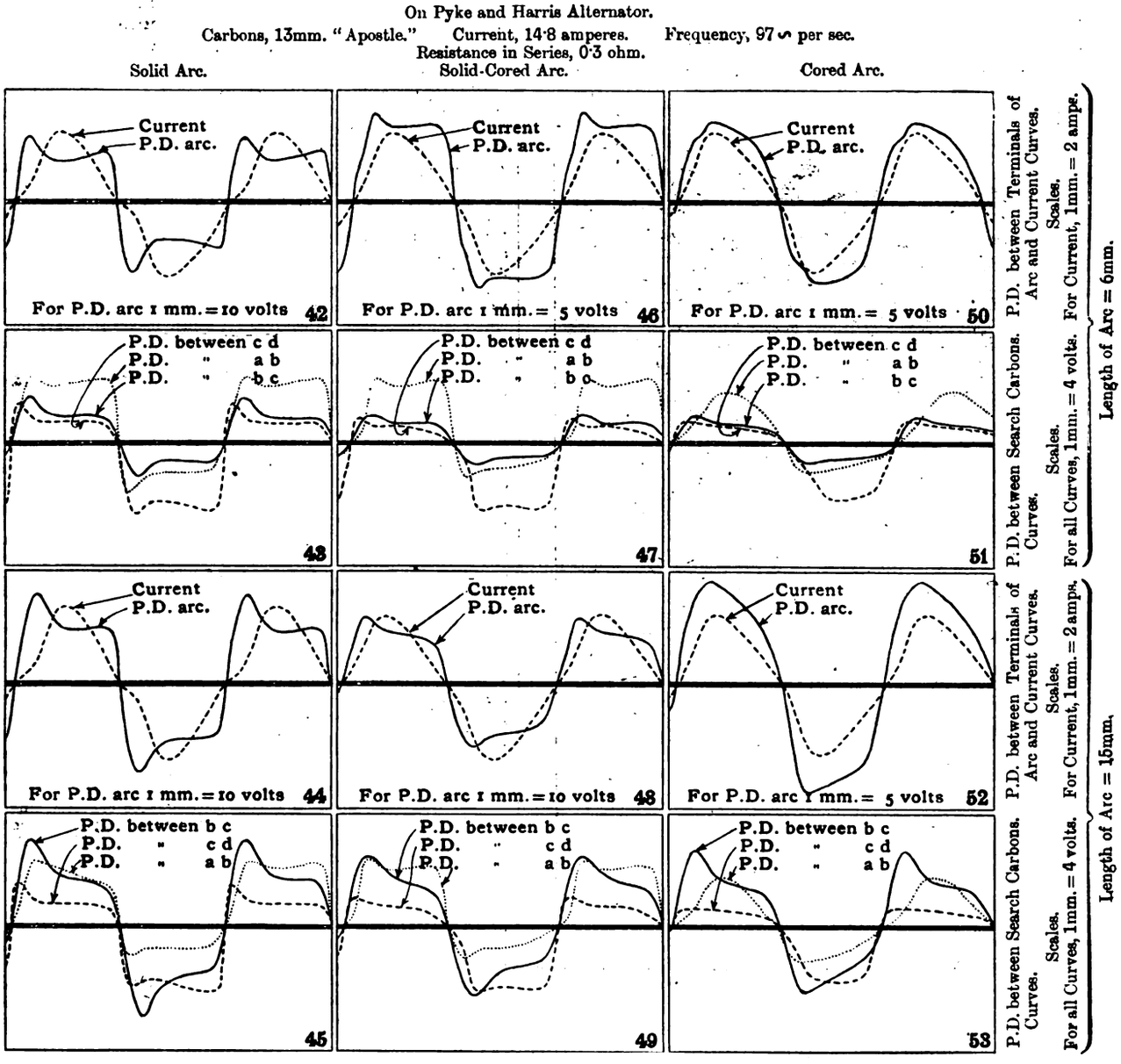

FIG. 4.—Search Carbons in Arc.

SECTION 4.—EFFECT OF RESISTANCE IN SERIES.

Mr. Frith, in his Paper before the Physical Society, said that the effect of the arc on the wave form could be destroyed by placing a large resistance in series with the arc, and he pointed out the great importance of this observation as affecting efficiency tests of alternate current arcs. The curves with resistance in series obtained by Mr. Frith differ, however, very much from any of those given by M. Blondel; and the latter has not published any series of strictly comparable results to show the effect of change of resistance in series. We have therefore carried out a complete investigation of the subject for several different arc-lengths.

In our experiments we kept the size and kind of carbons, the arc-length, the current, and the frequency constant, the resistance in series being varied by small steps. The current in all cases was kept constant by changing the dynamo excitation. The experiments were carried out on both alternators and with the usual combinations of carbons.

was 92 volts, the arc pressure 48·5, power 404 watts, and the power factor 0·63, with hissing going on. Both experiments were with the Ferranti machine.

The range of resistance used with the Ferranti machine was from 0·3 to 3·9 ohms; but it was found impossible to burn the solid and solid-cored arcs with 0·3 ohm. in series; the cored arc, however, could be maintained, though it was not very stable. With about one ohm in series all three arcs could be maintained, the solid arc being none too steady, however.

Increasing the resistance in series has, with the solid arc, increased the peaks on the P.D. arc wave and reduced the time during which the current remained small (experiments 54 and 55); with the solid-cored and cored arcs, however, the effect was not very noticeable.

Experiment 54 is of interest, as it was made with the arc having the lowest power factor for which we have recorded the periodic curves, the

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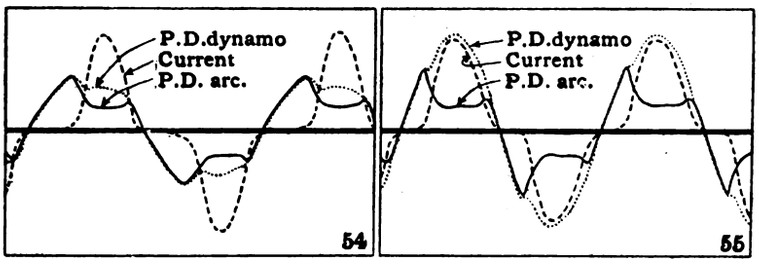
power factor being only 0·58; yet it will be noticed in the curves that there is no angle of lag, in the ordinary meaning of the term, as both the P.D. between the arc terminals and the current are zero at the same time. The idea that as the power factor is low there must be a considerable difference of phase between the P.D. and current seems still to exist in spite of all that M. Blondel has written on the subject, and in spite of the periodic curves he has published, none of which show any appreciable phase difference between P.D. and current. It is, perhaps, needless to add that, as yet, in all our results we have not come across a case where the curves are sensibly out of phase: and we believe that in those cases, where previous experimenters thought they obtained a considerable angle of lag between their periodic curves of P.D. arc and current, this erroneous result was introduced by their not recording the two curves simultaneously.

Returning to experiment 54, it is to be noticed that the curve of P.D. between the dynamo terminals is also distorted by the arc to a considerable extent, the distortion being greatly reduced by increasing the resistance in series (experiment 55). On the Pyke and Harris machine the range of resistance was from 0·3 to 10·2 ohms. In this case, owing to the inductive nature of the machine, it was possible to burn all the arcs with 0·3 ohms in series. As before, increase of resistance in series with the solid arc tends slightly to increase the peaks on the P.D. arc wave, the effect being most marked in the 1mm. arc. *The effect on the current wave was in all cases to make it more like the open-circuit wave form of the alternator used*, and this is well illustrated by the similarity of the current waves with 10 ohms in series with the arc to the open-circuit curve of the dynamo.

Turning next to the R.M.S. values of the P.D. between the terminals of the arc, in all cases they are reduced by increasing the resistance in series with the arc, except for the 1mm. solid arc, this reduction in P.D. being as large as 9 per cent. for the 3mm. solid arc.

The power factors with the Ferranti alternator all tend to increase with increase of resistance in series, while those with the Pyke and Harris machine decrease for the solid and solid-cored arcs, and are almost unaffected for the cored arcs. These changes in the power factors are chiefly due to the current waves becoming more like the open-circuit



Scales: For P.D. Dynamo, 1mm. = 10 volts. NOTE.—Scale of Time not the same as usual.
„ P.D. Arc, 1mm. = 10 volts.
„ Current, 1mm. = 2 amps.

FIG. 5.—Effect of Resistance in Series.

curves of the alternators as the resistance in series is increased, while the P.D. waves for arcs of medium length do not alter very much. Thus, while we have not been able to produce the considerable changes in the shape of the P.D. arc wave observed by Mr. Frith, *our results confirm his conclusion that the efficiency of the alternate current arc is affected by the amount of resistance in series with it.* For change of resistance in series, we find, considerably modifies the current wave, and Messrs. Rössler and Wedding and others showed that the efficiency is dependent on the shape of the current wave form. Mr. Frith's remark, that the arc has the power of automatically converting any wave form into the one best suited to its requirements, is not, however, borne out by our experiments (*see* experiments 54 and 55).

SECTION 5.—EFFECT OF FREQUENCY.

A very large range of frequencies being in use in the alternating supply systems of this and other countries, and there being exceedingly little available data as to the effect of change of frequency alone on the behaviour of the arc, we carried out a series of experiments over a range of frequencies from 29·2 to 200 ∽ per second, and this range embraces most of the frequencies that are in practical use. At the present time, in this country nearly all the public supply stations use frequencies between 50 and 100 ∽ per second; but there is a tendency towards lowering the frequency so as to be better able to operate alternate-current motors.

To make our experiments as far as possible comparable one with the other, we brought the current back to a fixed R.M.S. value by varying the dynamo excitation after each change of frequency, while the arc length and all the other conditions of the circuit remained unchanged. To obtain the range of frequency from 29·2 to 200 ∽ per sec., we were obliged to use both the alternators, the results for the range 29·2 to 127 ∽ per sec. were, however, obtained on one single machine and arc, thus strictly comparable one with the other, while the results for 100 and 200 ∽ per sec., though not obtained on the same alternator, lead us to the same general conclusions.

The chief effect of reducing the frequency is, in all cases, *not only greatly to increase the actual time during which the current remains small in each period, but also to increase the fraction of the period during which it is so.* Accompanying this there is, as we should expect, seeing that we have kept the R.M.S. value of the current constant, a considerable increase in the maximum value of the current with decrease of frequency, and this increase of the maximum value has caused the low frequency *solid* arc to hiss badly and become so unstable that we were unable to obtain results below a frequency of 57 ∽ *per sec.* The *solid-cored* arc was slightly unstable at 46 ∽ *per sec.* The *cored* arc, however, did not become unstable at 29·2 ∽ *per sec.*, the lowest frequency we tried; but the light of the arc was exceedingly unpleasant to the eyes at this low frequency. When the R.M.S. value of the current, the length of the arc, &c., are kept constant, lowering the frequency increases the R.M.S. value of the P.D. for the solid arc, but reduces it for the cored arc, the effect with the solid-cored arc being apparently *nil.*

The power factor in all cases which we have tried was reduced by lowering the frequency.

In one of his first Papers on the alternate current arc, M. Blondel stated that, as the current had a small value for a long time with low frequency arcs, he expected that the efficiency would be smaller with low frequencies than with high ones. Experiments,* however, made subsequently, convinced him that the opposite was the case. This conclusion was also arrived at by Professor Fleming and Mr. Petavel,† and is borne out by some experiments made by Messrs. Cameron and Hecht, at the Central Technical College, who measured the luminous efficiency of some of the arcs. For the latter found that with the solid arc a reduction of frequency from 127 ∽ per sec. to 57 ∽ per sec. increased illumination per watt by 50 per cent., and that for the cored arc a reduction of frequency from 127 ∽ per sec. to 46 ∽ per sec. increased the illumination per watt by 10 per cent. Thus, *as far as efficiency is concerned, a reduction of frequency is very advantageous;* there is, however, a practical limit to this reduction due to the instability of the arc with low frequencies.

SECTION 6.—ARCS ON TRANSFORMERS.

In this section the authors give the result of their investigations to determine whether the reactions on the wave forms still take place when the arc is run off a transformer, and if so, whether these reactions are reflected in the primary circuit of the transformer.

We find that the reaction of the arc on the wave forms of the circuit, when supplied with current by the secondary of a constant P.D. transformer, is similar to what we have found when the circuit is supplied by the alternator direct, and that the characteristic forms of the P.D. arc and current waves *are transmitted through this transformer to its primary circuit*, so that the P.D. and current curves for the two circuits are very similar. One point of difference which we noticed with the solid arc is that while in the secondary circuit the current curve keeps along the zero line for a time as usual, in the primary the curve approaches the zero at a small angle, this being due to self-induction.

As was to be expected, however, the authors find that with a *constant-current* transformer the distortion of the potential difference wave form *is not transmitted* to the primary circuit, in consequence of the much greater magnetic leakage in such a transformer, as compared with one designed for constant pressure on the secondary. With both classes of transformer the arc was found to react on the potential difference wave between its terminals and the current in the ordinary way.

SECTION 7.—ARCS BETWEEN DIFFERENT MAKES OF COMMERCIAL CARBONS.

After experimenting on the same alternator with the same excitation, first with a constant resistance, and afterwards with a constant self-induction in series with the arc, the authors find that—

The characteristic reactions of the arc on the wave forms are seen to occur in all cases, being modified, however, in amount by the nature of the carbon, and by the presence of impurities.

We conclude from these experiments that although the amount of the reaction of the arc on the wave forms varies to a certain extent, from one make of carbons to another, yet the main features are in all cases so similar that we can deduce what will be the effect of the change of any variable on the reaction of one make of carbons from the known effect on the reaction of another make. It is well known that any change in wave form changes the impedance of an inductive coil, and as the shape of the wave depends on the nature of the carbons, we might expect the impedance of an inductive coil in series with an arc to depend on the kind of carbons in the arc; and that this is the case is evident from the observed values of the impedance of the choking coil used in experiments 135 to 141 (*see* also experiments 5 to 8 *ante*). This change of impedance, though small, may affect the the design of the regulating coils for arc lamps.

* *The Electrical World* of New York, 1897, Vol. 29, pp. 232, 258.
† *Proceedings of the Physical Society*, 1895, Vol. 14, p. 247.

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SECTION 8.—ARCS BETWEEN ONE SOLID CARBON AND ONE CARBON CORED WITH A FOREIGN SUBSTANCE.

This section of the Paper contains many interesting results of experiments prosecuted in the hope of discovering some substance for the core which, while not impairing its luminous efficiency, would reduce its reaction on the wave forms. This primary object was unsuccessful, but, amongst other things, it was found, as may be gathered from the table on the "Effect of Soaking Carbons in Aqueous Solutions," that:—

It is possible considerably to reduce the P.D. necessary to maintain an arc, of given length and current, without affecting the appearance of the arc, by treating the carbons with a potassium salt, and it seems more than probable that the low P.D. and steady burning properties of the cored arc are largely due to the presence of potassium silicate in the core. A remaining trace of this salt probably accounts for the low P.D. required for the arc between a solid and a hollow carbon, which hollow carbon was made by drilling out the core of a cored carbon. When foreign substances, which are not in, or reduced to, the metallic state, are present in the arc, they produce a reduction of the P.D. between the carbons, for a given length and current, and generally reduce the reaction on the wave form and increase the power factor.

Effect of Soaking Carbons in Aqueous Solutions.

Carbons both solid 13mm. "Apostle." Arc Length, 3mm. Current, 14·8 amps., 100 ∽ per sec.

Exp. No.	Solution in which carbons were soaked.	P.D. arc. Volts.	Res. in series. Ohms.	Power. Watts.	Power factor.	Notes.
165	Unsoaked.	53·2	3·29	581	0·74	When soaked in tap water and dried gave same results.
166	4 % sodium carbonate	42·4	3·50	565	0·90	When first started had a strong sodium flame; burnt 45 min. before taking readings.
167	4 % potassium carbonate	42·4	3·50	558	0·89	Looked like an ordinary carbon arc; burnt 45 min. before taking readings.

(*To be concluded.*)

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"Science Abstracts," April, 1899. Part 4, Vol. II. (London: E. and F. N. Spon). Price 2s.

"Metius: the Hollander, Inventor and Discoverer." By H. R. Rogers. (Buffalo: City Press Printing House.)

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ELECTRICITY WORKS ACCOUNTS.

Kingston-upon-Thames Municipal Electric Supply Works.

It is disappointing to find that the accounts for the 1898 working of the Kingston-on-Thames undertaking hardly indicate a fulfilment of the promise contained in the 1897 accounts; at least, as regards accession of business and financial results. A comparison of the 1897 with the 1896 accounts showed a drop in the ultimate deficit of from £1,326 to £792, a 34·8 per cent. increase in the equivalent lamp connection and a rise of nearly 25 per cent. in the output. As may be noticed from our table this week a similar comparison of the last two completed years of working shows an increased deficit, viz., £1,112, an increase in the equivalent lamp connection of barely 29 per cent. and an increased output of only 19·6 per cent.

The management charges for 1898 show a diminution over those of 1897, but the same cannot be said of the generating costs in consequence of increases in the fuel and "repairs and maintenance at the station" items. The result is that the total costs per unit are but slightly lower than those of the previous year, which were higher than the average of stations of equal output. No doubt these high costs are due in great measure to the heavy fuel bill, which constitutes *the* burden of the concern. At 1·8d. per unit, this fuel charge is more than double the average obtained in municipal stations of similar output in 1897.

The working profit for the year was £1,221. After paying £1,231 into the sinking fund and £1,102 as interest the deficit is £1,112.

The following figures show the progress made since supply was commenced in 1898:—

Year.	No. of consumers.	Equiv. 8c.p. lamp connection.	Output units sold Total.	Units sold to consumers.	Max. load K.W.	Rev. Total.	Expenditure. Total.	Working profit.
1893–4	77	4,000	128,267	44,642	130	£1,985	£2,573	– £587
1895	99	4,800	134,084	67,446	136	2,442	2,704	– 262
1896	129	6,825	155,681	88,620	152	3,013	2,712	+ 301
1897	163	9,200	194,268	126,835	203	3,929	3,062	+ 868
1898	211	11,856	232,370	164,413	245	4,701	3,480	+1,221

Burton-upon-Trent Municipal Electric Supply Works.

It is satisfactory to find that the progress, though slow, of the Burton undertaking is being maintained. Since 1897 the expended capital has increased from £30,472 to £31,852, the increased expenditure being chiefly on plant.

Additional consumers to the number of 33 and lamps to the equivalent of 1,800 have been added during the year, while the output has risen from 79,492 units to 108,290, or 36 per cent.

The total revenue, at £2,590, averages 5·74d. per unit, and, like the costs, at 3·7d. per unit, are high, even for the small output. In spite of substantial rises in the management and distribution costs, the total costs have fallen from 4·14d. to 3·7d., generating costs having dropped from 3·55d. to 2·87d. The fuel costs at Burton are very low, due, no doubt, to the advantage (in this respect) of running the electricity and gas works in proximity, and under the same interest and management.

The working profit comes out at £921. As at Kingston, nothing, apparently, has been provided for depreciation. A payment of £992 towards repayment of loans, and £860 as interest, leaves a deficit of £931.

We include a table indicating the history and progress of the electricity supply undertaking at Burton since the commencement of operations:—

Year.	No. of consumers	Equivalent lamp connection.	Number of units sold.	Expenditure. Total.	Revenue. Total.	Working profit.
1894	53	4,130	19,291	£844	£529	– £315 (loss)
1895	68	5,472	40,094	1,343	1,051	– 292 (loss)
1896	80	6,132	58,189	1,232	1,521	+ 289 (gain)
1897	104	7,786	79,492	1,369	2,073	+ 704 (gain)
1898	137	9,586	108,290	1,669	2,590	+ 921 (gain)

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)	1899	Jan. 6	Kensi'gton & Knightsbr' (Co.)	'99	Mar. 3
Ayr (Municipal)	1898	Nov. 11	Kingston-upon-Hull (Mun.)	1898	Aug. 19
Bedford (Municipal)	,,	Mar. 4	Kingston-on-Thames (Mun.)	,,	Mar. 25
Belfast (Municipal)	,,	Sept. 23	Lancaster (Municipal)	,,	Oct. 21
Birmingham (Company)	,,	Dec. 16	Leeds (Company)	1899	Mar. 3
Blackpool (Municipal)	,,	Oct. 7	Leicester (Municipal)	,,	Jan. 20
Bournemouth (Company)	,,	June 3	Leyton (Municipal)	1898	Sept. 23
Bolton (Municipal)	,,	Dec. 9	Liverpool (Municipal)	,,	Aug. 12
Bradford (Municipal)	1899	April 14	Manchester (Municipal)	,,	July 29
Brighton (Municipal)	1898	May 6	Newcastle and District (Co)	,,	Dec. 2
Bristol (Municipal)	,,	July 29	Newcastle-upon-Tyne (Co.)	1899	April 14
Burnley (Municipal)	,,	Sept. 16	Northampton (Company)	1898	April 15
Burton-upon-Trent (Mun.)	,,	April 15	Norwich (Company)	,,	Dec. 2
Bury (Municipal)	,,	Nov. 25	Notting Hill (Company)	1899	Mar. 17
Cambridge (Company)	1899	Mar. 10	Nottingham (Municipal)	1898	Oct. 28
Cardiff (Municipal)	,,	Jan. 6	Oldham (Municipal)	,,	Nov. 18
Charing Cross (Company)	,,	Mar. 17	Oxford (Company)	,,	April 1
Chelsea (Company)	,,	Mar. 31	Portsmouth (Municipal)	,,	Nov. 4
Cheltenham (Municipal)	1898	Oct. 7	Preston (Company)	,,	Oct. 28
Chester (Municipal)	,,	Oct. 14	Reading (Company)	,,	Sept. 16
Clerkenwell (Company)	,,	Mar. 18	Richmond (Company)	,,	Mar. 4
Derby (Municipal)	,,	Dec. 9	Scarborough (Company)	,,	April 1
Dewsbury (Municipal)	,,	Nov. 25	St. James' & Pall Mall (Co.)	1899	Feb. 24
Dover (Company)	,,	Mar. 11	St. Pancras (Vestry)	1898	May 13
Dundee (Municipal)	,,	Nov. 4	Sheffield (Company)	,,	Dec. 16
Eastbourne (Company)	,,	July 22	Shoreditch (Vestry)	,,	May 27
Edinburgh (Municipal)	,,	Oct. 14	Southampton (Municipal)	,,	June 3
Exeter (Municipal)	,,	Aug. 5	Southport (Municipal)	,,	Dec. 23
Glasgow (Municipal)	,,	Aug. 12	Stafford (Municipal)	,,	Oct. 21
Guildford (Company)	,,	May 13	Sunderland (Municipal)	,,	Aug. 19
Halifax (Municipal)	,,	Nov. 18	Taunton (Municipal)	,,	Aug. 5
Hammersmith (Vestry)	,,	June 10	Tunbridge Wells (Mun.)	,,	July 22
Hampstead (Municipal)	,,	Sept. 9	Walsall (Municipal)	,,	Nov. 11
Hanley (Municipal)	,,	April 8	Wandsworth (Company)	,,	Mar. 18
Harrogate (Municipal)	,,	Dec. 30	Westminster (Company)	1899	Feb. 24
Harrow (Company)	,,	Sept. 9	Whitehaven (Municipal)	1898	Dec. 23
Hast'gs & St. Leonard's (Co.)	,,	April 29	Windsor (Company)	,,	Dec. 30
H'nse-to-H'nse Co. (K'ns'gt'n)	1899	Mar. 31	Wolverhampton (Municipal)	,,	July 15
Hove (Company)	,,	Mar. 10	Woolwich (Company)	1899	Jan. 13
Huddersfield (Municipal)	1898	Mar. 25	Worcester (Municipal)	,,	April 7
Islington (Vestry)	,,	June 24	Yarmouth (Municipal	1898	June 17

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	KINGSTON-UPON-THAMES.		BURTON-UPON-TRENT.	
Undertaking Worked by	Corporation of Kingston-upon-Thames.		Corporation of Burton-upon-Trent.	
Date of Commencement of Supply	November, 1893.		March, 1894.	
System of Supply	Alternate-current transformer sub-station, [also house transformers.		Alternate-current transformer sub-stations.	
Chief Engineer	J. E. Edgcome.		F. L. Ramsden.	
YEAR ENDED	DEC. 31, **1897.**	DEC. 31, **1898.**	DEC. 31, **1897.**	DEC. 31, **1898.**
QUANTITIES—				
Units generated	—	—	—	—
„ SOLD (TOTAL)	194,268	232,370	79,492	108,290
„ sold to consumers	126,835	164,413	79,492	108,290
„ sold for public lighting, &c.	67,433	67,957	nil	nil
„ used on works	—	—	—	—
UNITS SOLD PER 8 C.P. LAMP CAPACITY	21·6	14·9	9·7	14·4
Maximum supply demanded	203	245	134 kilowatts	169
Number of public lamps	36	36	nil	nil
Number of consumers	163	211	104	137
Connections to mains in 8-c.p. lamps	9,200	11,856	7,786	9,586
CAPACITY OF PLANT IN 8-C.P. LAMPS	9,000	15,600	8,190	7,500
CAPACITY OF PLANT IN KILOWATTS	300	500	270	240
CAPITAL—	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.	Total. / Per kilowatt capacity.
AUTHORISED (TOTAL)	£41,766 / £139	£43,426 / £86·8	£30,993 / £115	£30,993 / £129
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	41,766 / —	43,426 / 86·8	30,993 / 115	30,993 / 129
RECEIVED (TOTAL)	—* / 139	41,000 / 82	30,993 / 115	30,993 / 129
Share	— / —	— / —	— / —	— / —
Loan (including Debenture charges)	— / —	41,000 / 82	30,993 / 115	30,993 / 129
AUTHORISED BUT NOT YET RECEIVED (TOTAL)	nil / —	— / —	— / —	— / —
Share (unissued)	— / —	— / —	— / —	— / —
Share (uncalled)	— / —	— / —	— / —	— / —
Loan (including Debentures)	nil / —	— / —	— / —	— / —
REPAID (TOTAL)	—* / —	— / —	— / —	— / —
RESERVE OR SINKING FUND	} nil / —	— / —	{ — / —	— / —
DEPRECIATION FUND				
EXPENDED (TOTAL)	36,700 / 122	41,000 / 82	30,472 / 112	31,852 / 133
Lands and buildings	—* / —	—* / —	4,921 / 18·3	4,925 / 20·5
Plant	—* / —	—* / —	8,959 / 33·2	10,838 / 45·4
Mains	—* / —	—* / —	14,335 / 53·0	14,903 / 62·1
Miscellaneous	— / —	— / —	2,257 / 9·0	1,137 / 4·74
BALANCE OF CAPITAL ACCOUNT	5,066 / —	— / —	+521 / +2·0	−859[b] / −3·58
REVENUE—	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.	Total. / Per unit sold.
TOTAL	£3,929 / 4·850d.	£4,701 / 4·852d.	£2,073 / 6·27d.	£2,590 / 5·740d.
Revenue from supply	3,045 / 3·760d.	3,827 / 3·950d.	1,989 / 5·90d.	2,496 / 5·532d.
„ meters, &c.	104 / 0·129d.	133 / 0·137d.	71 / 0·23d.	94 / 0·208d.
„ public lighting	720 / 0·890d.	720 / 0·743d.	— / —	— / —
„ sale of lamps, &c.	} 60 / 0·074d.	21 / 0·022d.	{ 7 / —	— / —
„ miscellaneous sources			{ 5 / —	— / —
EXPENDITURE OUT OF REVENUE—				
TOTAL COSTS	£3,062 / 3·780d.	£3,480 / 3·594d.	£1,369 / 4·14d.	£1,669 / 3·700d.
WORKS COSTS	2,459 / 3·040d.	2,942 / 3·037d.	1,195 / 3·60d.	1,395 / 3·091d.
Generation of electricity	*2,205 / 2·720d.*	*2,714 / 2·803d.*	*1,180 / 3·55d.*	*1,297 / 2·875d.*
Fuel (including cartage, &c.)	1,314 / 1·620d.	1,751 / 1·806d.	177 / 0·53d.	184 / 0·408d.
Oil, waste, water, stores	155 / 0·192d.	175 / 0·181d.	56 / 0·17d.	75 / 0·166d.
Wages at station	625 / 0·772d.	508 / 0·524d.	992 / 2·69d.	919 / 2·038d.
Repairs and maintenance at station	111 / 0·137d.	280 / 0·289d.	55 / 0·16d.	119 / 0·264d.
Distribution of electricity			*16 / 0·05d.*	*98 / 0·217d.*
Wages, &c.			— / —	— / —
Repairs, renewals of mains, &c.	254 / 0·314d.	228 / 0·235d.	16 / 0·05d.	98 / 0·217d.
Public lighting			— / —	— / —
Attendance			— / —	— / —
Renewals			— / —	— / —
MANAGEMENT AND PROPERTY CHARGES	603 / 0·745d.	538 / 0·555d.	173 / 0·54d.	274 / 0·608d.
Royalties	— / —	— / —	— / —	— / —
Rent, rates, taxes	*100[a] / 0·124d.*	*134 / 0·138d.*	*71 / 0·23d.*	*77 / 0·171d.*
Management	*503 / 0·622d.*	*404 / 0·417d.*	*102 / 0·31d.*	*197 / 0·437d.*
Salaries	378 / 0·467d.	276 / 0·285d.	50 / 0·15d.	130 / 0·288d.
Stationery, &c.	37 / 0·046d.	33 / 0·034d.	— / —	— / —
Establishment charges	88[b] / 0·186d.	80 / 0·083d.	40 / 0·11d.	55 / 0·122d.
Law charges, &c.	— / —	15 / 0·015d.	12[a] / 0·04d.	12[a] / 0·027d.
FINANCIAL RESULTS—	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded	Total. / % to mean cap. exp'nded
WORKING PROFIT FOR YEAR	£867 / 2·87%	£1,221 / 3·14%	£704 / 2·4%	£921 / 2·96%
Sum carried to Depreciation Fund	— / —	— / —	nil / —	nil / —
Sum carried to Reserve or Sinking Fund	837 / 2·77%	1,231 / 3·17%	992 / 3·3%	992 / 3·18%
Net interest on loans (incl. Debenture charges)	824 / 2·70%	1,102 / 2·84%	875 / 3%	860 / 2·76%
BALANCE FROM LAST ACCOUNT	— / —	— / —	— / —	— / —
BALANCE AVAILABLE FOR DISTRIBUTION, &c.	— / —	— / —	— / —	— / —
Deficit	*792[c] / 2·60%*	*1,112 / 2·86%*	*1,164 / 4·1%*	*931 / 2·99%*
ORDINARY DIVIDEND PAID	— / —	— / —	— / —	— / —
PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE	77·8%	74%	66%	64·5%
Expenditure per kilowatt capacity	£10. 4s. 0d.	£6. 19s. 2d.	£5. 1s. 5d.	£6. 19s. 2d.
REVENUE PER KILOWATT CAPACITY	£13. 6s. 0d.	£9. 8s. 2d.	£7. 13s. 0d.	£10. 15s. 10d.
Expenditure per 8-c. lamp capacity	6s. 10d.	4s. 5½d.	3s. 1d.	4s. 5½d.
REVENUE PER 8-C.P. LAMP CAPACITY	8s. 9d.	6s. 0½d.	4s. 8d.	6s. 11d.
REVENUE PER 8-C.P. LAMP CONNECTED	8s. 6½d.	7s. 11d.	5s. 4d.	5s. 4½d.
Price charged for lighting, per unit	} 6d. to 1d.[d]	6d. to 4d.[d]	6d. to 3d.	6d. to 3d.[c]
Price charged for power, per unit				
Price charged for public lighting	£20.	£20.	—	—

KINGSTON-UPON-THAMES.—REMARKS—* Amount not stated in accounts supplied. *a* Inclusive of insurance. *b* Includes £40 for lamps, stores, etc. *c* Met out of the rates. *d* Maximum demand system (2 hours).

BURTON-UPON-TRENT.—REMARKS—*a* To insurance. *b* Over expended. *c* On "Wright"-system, 6d. for first one and a-half hours, 3d. after.

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The present number of "The Electrician" completes Volume XLII. With next week's number will be issued (Gratis) the Index to the Volume.

EARTH CURRENTS AND ELECTRIC TRACTION.

Even the most uncompromising advocates of electric traction, and the deriders of terrestrial magnetic research, must allow that Prof. Rücker made the most of his case for magnetic observatories in his discourse at the Royal Institution last Friday evening. Some of his audience came, we are sure, prepared to hear a violent diatribe against the use of earthed returns for electric traction currents, illustrated by experiments to show its effect on delicate magnetic instruments, and followed, probably, by a strong advocacy of insulated return conductors, or of polyphase or surface-knob traction systems. But Prof. Rücker followed a wiser course, and one which rendered his exposition much more acceptable than would have been a polemical lecture on the subject so near to his heart. He first endeavoured to arouse in his hearers an interest in the magnetic research that is so frequently scoffed at; and, having thoroughly succeeded in showing that, besides being an engrossing subject, it is also one involving important issues to science, he only then spoke of the disastrous effect stray earth currents had already had on the work of some magnetic observatories, and most of his hearers must have been in sympathy with him when he ultimately expressed the hope that the continuous observations carried on for 40 years at Kew might not be abruptly terminated as those at Washington and Toronto have been.

The first experiment Prof, Rücker performed was to show how magnetic iron ore, as well as the metal itself, lost its magnetic properties when heated. He balanced a piece of glowing basalt in a scale, a magnet being placed below it, and as soon as the basalt had cooled sufficiently the beam of the balance was pulled down. This led to a lucid exposition of Mr. Henry Wilde's hypothesis to account for the earth's magnetism, and a description of the model he had built to illustrate and in great measure to prove it. Those who have followed the work done in terrestrial magnetic research will remember that Wilde had at first endeavoured to imitate the magnetic action of the earth by a globe containing two magnetising coils of wire inclined at an angle, but had failed by this means to make it act properly upon a magnet on the surface until he conceived the idea of covering the seas with sheet iron. Then, however, he reproduced the effect to a remarkable degree of accuracy, for not only was the general polarity reproduced, but also the

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more important variations of the magnetic declination at different points of the earth's surface. The reason of this result Prof. RÜCKER explained as follows: Assuming that the earth's crust is of magnetic material, it can only be magnetised to a certain depth below the surface; for, as the depth and, therefore, the temperature increase, the iron ore loses its magnetic properties. But it is known that at great depths the temperature of the ocean is exceedingly low, and therefore the shell of the earth, being cooler beneath the seas, would have greater permeability and be permeable to greater distances from the surface. The hypothesis appears as plausible as it is ingenious, and we need hardly point out that, if it be correct, the continuous magnetic observations now being carried out may some day prove of inestimable importance to geologists and astronomers as well as to physicists.

It must be remembered that what Prof. RÜCKER and his supporters ask for is not by any means a suppression of electric traction in the neighbourhood of magnetic observatories, but merely that, where the proximity is unavoidable, precautions should be taken to obviate the leakage of large currents through the earth. It appears that the effect of the motors themselves is not so distressing. Opponents of any such restrictions being placed on electric traction schemes often aver that the case is similar to the historical fight between the traction and the telephone companies, and that it rests with the disturbed party to shield themselves from the disturbances. In the case of the telephone industry we are entirely in accordance with this view, as the shielding can be perfectly carried out, and has, in fact, resulted in telephony being made more efficient than before the invasion of the trolley car. Again, in mere physical laboratories, delicate instruments can certainly be shielded to a considerable extent from artificial magnetic storms without, and galvanometers of the d'Arsonval type, which are practically unaffected by such disturbances, are now constructed of such sensitiveness that they can take the place of suspended magnet galvanometers for nearly all purposes. But magnetic observatories come under an entirely different category, for they are threatened with having the actual quantities they wish to measure changed to abnormal values. The suppression of earth returns, if a continuous-current system is used, as will be done at Kew, or the employment of another system of traction within a certain radius of the observatory, can at most increase the capital expenditure, and perhaps also to some extent the working costs of the line; and if these sacrifices are made, as they often are, in deference to so-called "æsthetic" objections of municipal bodies, surely they can be made where much more important issues are at stake.

THE ZIPERNOWSKI-DÉRI-BLÁTHY TRANSFORMER DISTRIBUTION PATENTS.

An interesting patent will expire on Thursday next, and a still more interesting one completed its fourteen years' life on March 16th last. The pair constitute the famous Zipernowski-Déri-Bláthy transformer distribution patents, which it has been claimed cover the general principles governing practical transformer construction and alternate current distribution. Especially during the last year of its life has the patent No. 5,201 of 1885 become prominent, through the speculation which Mr. Martin Rucker, the some-time bicycle financier, has embarked in. A perusal of this patent (given in its latest amended form below) will show that, if the patent is not invalid owing to "prior common knowledge," it might be deemed to cover the modern method of distributing alternating currents by means of transformers connected in parallel on constant pressure mains. As a legal action is pending, we will offer no opinion on that subject at present.

Mr. Rucker, having acquired the patent, and it having been duly brought into a presentable shape by liberal disclaimers, sought about a year ago to obtain royalties from undertakers of alternating current supply. He commenced, perhaps unwisely for his purpose, with the London Electric Supply Co., whose knowledge of patent law in general, and transformer patents in particular, is particularly complete by its long experience in fighting the old Gaulard and Gibbs patent some years ago. This Company took the wise step of consulting with the other large alternating current companies, who agreed (with one notable exception) to support it in its defence; and subsequently, it being considered that some of the municipal electric lighting concerns in the provinces had also a large stake in the question, the Municipal Electrical Association was approached and agreed to join forces with the companies. A representative committee was formed, with Mr. Stewart Bain as chairman, and the matter was fully gone into. Prominent counsel were consulted (among them Mr. Fletcher Moulton, Q.C.), and a careful defence prepared. There was considerable delay between the serving of the writ and the action being put down for trial, leading some to think that it had been abandoned; but we believe the defendants have done all in their power to press it forward, with the result that a date for the hearing should shortly be fixed.

As has been mentioned, the patent underwent considerable amendation as recently as April, 1897. The provisional specification included five diagrams and was longer and covered much more ground than the complete specification in its present form; the complete specification originally contained four illustrations, but these have now been reduced to one. Originally there were three claims; but the first, relating to the construction of the generator and the regulation of its current, and the third, relating to "the groupment of the coils" on the transformers, were wisely disclaimed, leaving only one claim. It is a matter for surprise that there was not more opposition to the amendment of the patent. One company, we believe, threatened to oppose the amendment, but the opposition was subsequently withdrawn, a free license, we understand, being accepted as compensation. This company is, needless to say, not joining in the present combination. We have been told that one municipality represented on the committee, decided, on the recommendation of their town clerk, to offer Mr. Rucker a sum as composition for his claim upon them, but we can hardly credit the report, as in a case like this so much depends on the presentation of an unbroken front.

Needless to say, for the benefit of the industry, we wish the allied companies and local authorities every success. Perhaps this case may lead to a *rapprochement* over other issues.

The following is the text of the two patents. Of the first, space will only allow us to give the amended complete specification. This patent, it is seen, was granted to Messrs. Zipernowski and Déri. The second patent, granted to Zipernowski, Déri, and Bláthy, we give in full, in its original form. It was filed only as a complete specification, and was subsequently amended by the omission of the first claim, and the alteration of the numbers of the second and third claims to the first and second:—

[No. 3,379*, March 16, A.D. 1885.]

COMPLETE SPECIFICATION AMENDED.

Improvements in Distributing Electricity.

I, William Phillips Thompson, of 6, Lord-street, Liverpool, do hereby declare the nature of this invention (a communication from Carl Zipernowsky and Max Déri, of Budapest, Hungary), and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

For some time past induction coils, consisting of two coils or layers of insulated copper wires, with a common iron core similar to the Ruhmkorff apparatus, have been used for the transformation of alternating electric currents. By means of such transformation, electric energy can be cheaply conveyed over lines of considerable length, and be utilised in a number of local circuits for lighting and other purposes. The distribution of electrical energy by such means has, however, not succeeded in such a manner as to satisfy the requirements of every-day practice, because it was not possible to increase or diminish the number of points of consumption in operation, without affecting the working of the others in a marked degree, and it was, therefore, necessary to use mechanically acting regulating devices at the different points of consumption, to compensate for the variations caused by the changes in the quality of electrical energy used. In the

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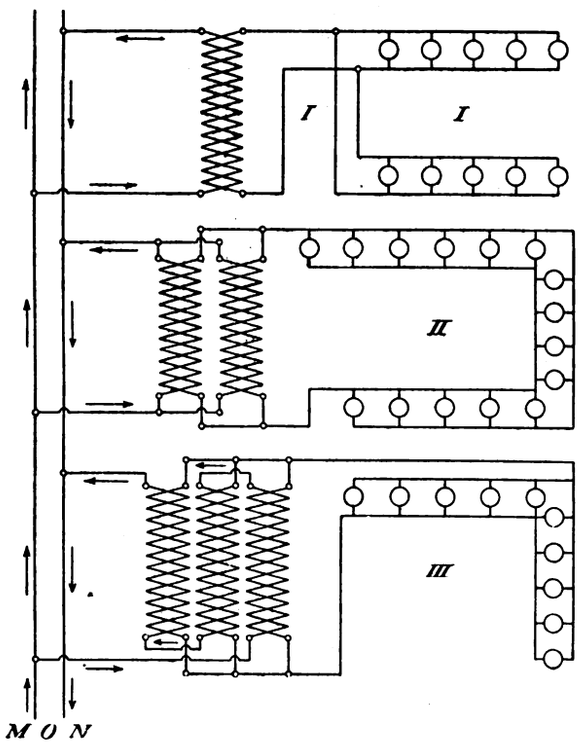
same manner the efficiency of the systems hitherto used was greatly dependent upon the number of points of consumption in activity.

Now the object of this invention is to make all individual points of consumption of electrical energy quite independent from one another, all necessary regulation being made by or at the generator of electricity. We group the induction coils or transformers so as to constitute secondary distribution stations or local centres. The primary coils of the several transformers of such a local centre may be arranged either in series or in multiple arc circuits. In the former case, the secondary or induced spires of all the transformers of the respective station form a single local circuit irrespective of whether these induced spires are connected up in quantity or in series. In the second case, however, *i.e.*, when the primary coils of the several transformers constituting a local centre are connected up in multiple arc, either each individual induced coil may form a separate secondary circuit, or any number or all of the induced coils of the transformers of a local centre may be connected to form a single local circuit. The apparatus for the actual utilisation of electricity, as incandescent and arc lamps, electromotors, &c., are in all cases connected up in multiple arc in the local secondary circuits.

But the distinctive feature of our system of distribution is, that each group of induction coils or transformers of the several stations of second order shall merely constitute branch circuits of the main line for the primary current, *i.e.*, the primary circuits of the several local centres, any one of these being taken as a whole, are connected in multiple arc. In this manner we have conductors distributing the primary (high tension) current in as many branch circuits as there are local centres, and any desirable number of secondary (low tension) circuits. Now the electromotive forces of the two coils of a transformer bear a constant ratio to one another—Therefore if the internal resistance of such an apparatus is very low, the secondary tension will remain almost unaltered, if we only have a constant difference of potential at the terminals of the primary coil. The



individual points of consumption in the several local circuits are independent of one another by reason of their distribution as branch circuits derived from the secondary line (*i.e.*, connection in multiple arc), provided only that the internal resistance of the transformers be relatively low, and the primary tension at the station invariable. If the independence of individual groups of lamps must be still more perfect, it will be advisable to feed such a group by an independent line, as any desired number of secondary circuits may be derived each separately from one transformer. It follows from the foregoing that our system of distributing electrical energy by means of alternating currents and induction coils or transformers is based upon having a constant difference of potential in the primary conductors as well as in the secondary ones. In a distribution of current, according to our system, there will be a variable intensity of current in the main line as well as in every branch circuit of it, in contradistinction to the systems of distribution by inductional transformers hitherto known or proposed, all of these being based upon constant intensity of the primary current—in our system the intensity of the primary current varies in the same way as the number of points of consumption in activity. This is caused by the counter-electromotive force of the transformers, somewhat increasing when the intensity of the secondary current diminishes, and *vice-versâ*. The consumption of energy for each local station varies in the same manner as the current in the corresponding local circuit, and, consequently, the total consumption of power varies in accordance to the total supply of current in the secondary circuits.

The drawing is a diagram showing the manner in which we supply local centres from the main line. At O is the central station. Between the main lines M and N the tension is invariable. Three local centres or secondary stations are shown. Station I. consists of a single transformer; at Station II. there are two transformers, with their primary as well as their secondary coils connected up in multiple arc; at Station III. there are three transformers, with their primary coils in series, the secondary ones in multiple arc. As it will be seen, all the branch circuits leading to the several local centres are derived as parallel circuits from the main line —*i.e.*, connected up in multiple arc. We desire it distinctly to be understood that the form of the induction apparatus or transformers used may be of any kind whatever, without departing from the principle of our invention.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed as communicated to me by my foreign correspondent I declare what I claim is:—

In the application of induction coils or transformers for alternating electric currents, the arrangement of several stations of second order as branch circuits of the main line, *i.e.*, connecting up the local centres with the main line in multiple arc, to which main line is supplied an alternating electric current of a tension as constant as possible, substantially as described and shown in the drawing.

Dated this 12th day of December, 1885.

W. P. Thompson, per his Agents, W. P. Thompson and Boult.

[A.D. 1885, April 27, No. 5,201.]

COMPLETE SPECIFICATION.

[Communicated from abroad by Carl Zipernowski, Max Déri, and Otto Titus Bláthy, all of Budapest, in the Empire of Austria, Engineers.]

Improvements in Induction Apparatus for Transforming Electric Currents.

I, Charles Denton Abel, of No. 28, Southampton-buildings, Chancery-lane, in the county of Middlesex, consulting engineer and patent agent, do hereby declare the nature of my invention for "Improvements in induction apparatus for transforming electric currents"; and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

It has been found that induction apparatus hitherto known, namely, Ruhmkorff's apparatus, as well as the newest apparatus of Gaulard and Gibbs are unsuitably constructed. Especially when electric currents of great strength are intended to be transformed by means of such induction coils, it should be the endeavour to obtain as favourable a useful effect as possible, and to produce with the smallest quantity of copper the greatest possible effect, inasmuch as the smaller the applied weight of copper may be, the lower will be the degree of heating, and consequently, also, the loss of strength to be expected.

It has been found that the constructors of the apparatus hitherto in use have in particular made an error in this way that they paid greater attention to the copper wires than to the iron cores, whereas it is believed that the distribution of the iron is the most important factor. All induction apparatus hitherto in use were made in the form of a bobbin with two or more coils, as shown in Fig. 1 of the accompanying drawings. A much better result has already been obtained by my correspondents, by making a ring of insulated iron wires, in a similar manner to the iron armature of a Gramme ring. This ring is surrounded with copper wires as shown in Fig. 2 in such a way that the electric current flows through all the convolutions of the primary wrapping in the same direction, and, therefore, no magnetic poles will be generated in the iron core;—one part of the wire convolutions takes up the inducing current, whilst the other part gives off the induced currents. The induction effect is thus the same in each convolution of the coils, quite in opposition to the induction bobbins hitherto in use, where the effect in the middle wires was a great deal stronger than on the outer parts of the bobbins.

The effect is considerably more favourable in the inverted arrangement, as shown in Fig. 3; two or more bobbins are made of insulated copper-wire and are formed into a ring. Round this ring magnetically insulated iron wire is wound as tightly as possible. From the ring of copper wire two or more ends are taken for conducting the induced current. The mode of connection of the iron wires is quite different.

Figs. 4 and 5 and also Fig. 6 show modifications of such an induction apparatus in which the convolutions of copper wire are enveloped round about with iron wires. In lieu of iron wires, iron plates may also be employed; these plates need not be spirally connected together; they are piled up one over the other like the elements of a dry Voltaic pile with insulating sheets between them. Into the hole stamped out in the middle, and passing through the whole plate column, are introduced the insulated copper wires and suitably connected for induction. In Fig. 5, two plate-columns are represented, and in Fig. 6, four. The number of these columns or bobbins of iron wire may, of course, be increased at will. But the direction of the current in two wires, the columns whereof touch one another, is always inverse.

Fig. 7 shows another construction of these induction apparatus. Iron plates of any optional shape are here employed, a great number of which are piled one over the other, but so that each two plates are separated by an insulating sheet. This plate column is peforated at several places, preferably in such manner that the perforations are identical in all the plates or sheets. In these holes the copper wires are passed to and fro, as shown in the figure—that is to say, in such a way that the current in two parallel contiguous branches of the wire must flow in opposite directions; or the wires may be passed in continuous convolutions. The induction effect of such a plate column upon the wires has then in each branch of the wire the same value, and the several effects thus united give a very high result.

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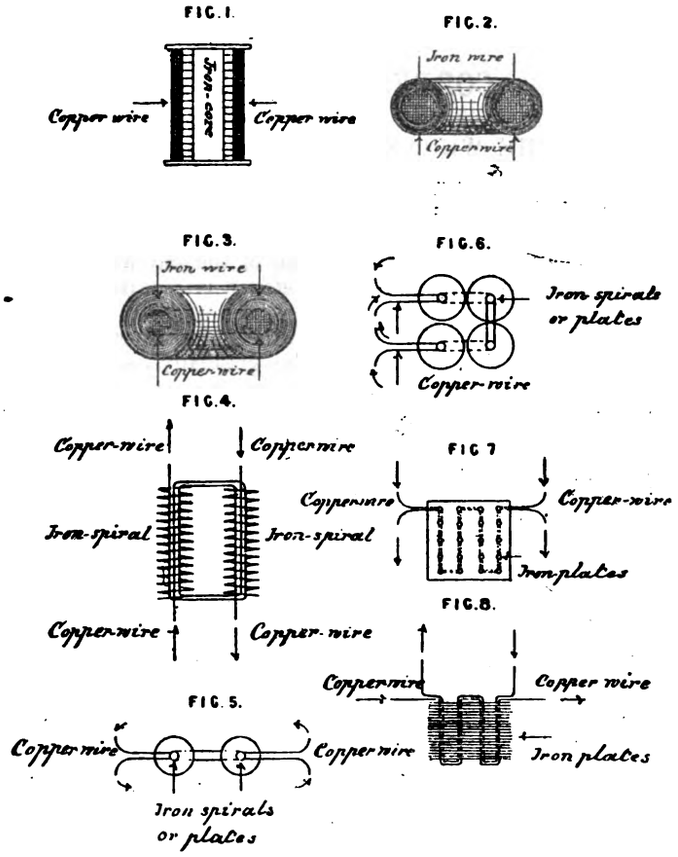
In lieu of employing insulating sheets the plates themselves may be covered with an insulating mass, such as varnish, lac, etc., and then be piled one over the other. It will be evident that the above described method of construction is capable of being modified in a great variety of ways, both as regards the number of coils, the number and shape of the plates and of the conductors which may be either copper wires, bars or tubes.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed I declare that what I claim is:—

* 1. The construction and use of induction apparatus as herein described with reference to Fig. 2 of the drawings wherein the iron core is formed as an annulus of circular or other shape.

2. The construction and use of induction apparatus as herein described and shown in Figs. 3, 4, 5, and 6 of the drawings wherein the core consists of the inducting and induced copper wires, which are entirely surrounded with magnetically insulated iron wires or magnetically insulated iron plates, the shape being either circular or polygonal, or composed of several columns, as shown in Fig. 6.

3. The construction and use of induction apparatus as herein described and shown in Fig. 7 consisting of magnetically insulated iron plates, which are



Reduced Facsimile of Drawing in Specification.

perforated at several places, with insulated copper wires passing through the perforations disposed either in windings passing to-and-fro or in continuous convolutions.

ABEL and IMRAY, Agents for the Applicant,
28, Southampton-buildings, London, W.C.

Dated this 27th day of April, 1885.

* This first claim was "disclaimed" Oct. 29, 1886.

THE HISSING OF THE ELECTRIC ARC.

The following is an abstract of the conclusion of the discussion which took place at the Institution of Electrical Engineers on April 13th, in connection with Mrs. Ayrton's Paper on this subject:—

Prof. J. A. FLEMING said there were many points in connection with the arc that apparently could only be properly investigated with the guidance of some theory of what was going on in the arc. When one looked at a continuous-current arc the first thing noticed was its want of symmetry, viz., the positive carbon was at a very great temperature, then there was the cooler carbon vapour and then the much cooler negative terminal. Seeing that the phenomenon of the arc consisted in the conduction of the current through a column of vapour, if they asked by what process that was effected, he thought they would be brought to the conclusion to which most investigators who had studied the propagation of currents through gases had been brought. It appeared to be very similar to the electrolysis of liquids. One theory was that it was electrolysis going on in a gaseous column. Starting with that as a provisional hypothesis, he said that in the electrolysis of liquids the chief phenomenon was the fact that the molecules of the liquid were broken up into ions, which were moved in opposite directions, and according to the majority of researches, these ions moved with very different velocities. Accepting this as a provisional hypothesis—that in the arc electrolysis of the carbon vapour was going on by the separation of the two carbon ions, which were being taken in opposite directions rapidly—he suggested that the velocity of the negative ion was much greater than that of the positive ion. The result would be that there would accumulate upon the pole of the positive crater negative ions which would cover up that crater with what he might call a "cushion" of negative carbon ions which would practically have the effect of a resistance. With regard to the behaviour of the arc when air had access, this, as shown by Mrs. Ayrton, produced the phenomenon of hissing. The result then of the access of air or oxygen to the arc was to destroy by combination these negative ions near the crater of the carbon, and that would immediately produce an equivalent diminution in the resistance of the arc. This process would be an intermittent process, because the effect of the diminution of the resistance would be to produce a momentary greater current, and that again would produce a further deposit of the ions. This pointed to the fact that a hissing arc must be an intermittent arc. Since the reading of the Paper, he had examined a hissing arc in a revolving mirror, and had found that a hissing arc *was* an intermittent arc. This had already been noticed by Messrs. Frith and Rogers, and the process going in the normal arc, according to his (Prof. Fleming's) view, would be something of this kind—that the electrolysis taking place in the arc provided the means for the passage of the current, and the rush of these negative ions to the crater was the cause of the excavation of the crater. The arc practically fed itself by this process, which was an easy way of explaining the manner in which the arc had to be started and the necessity, so to speak, of having to begin the process over again when the arc was blown out. In addition, he thought this theory would explain in some way the formation of the mushroom on the negative carbon at the very moment hissing began. It also would explain why it was that the hissing started apparently when oxygen or air had access and not when nitrogen was there; because to have any hissing there must be intermittence, and there must be something to remove this "cushion" of carbon ions. The hissing caused by hydrogen might be explained in this way also, but of course the carbon ions would not be removed by any neutral gas, and he ventured to make the suggestion that any other gas would do that, or any vapour, which had the property of combining with carbon at a high temperature. Perhaps Mrs. Ayrton might say she had tried it, but that it had failed; but he would then suggest that it might be well to use chlorine, iodine or any similar gas. Mrs. Ayrton had not, in her Paper, entered into the discussion of such points as the negative resistance and counter electromotive force which belonged to the region of hypothesis. With regard to the question of counter E.M.F. he had long held the opinion that there was no such thing as counter E.M.F.

Captain W. DE W. ABNEY thought that anyone who had worked with the electric arc could not but agree that the conclusions and deductions made by Mrs. Ayrton were perfectly right. The phenomenon of the hissing of the electric arc had long been of interest—and very sad interest—to him, because it had interfered many times with experiments he had in hand, and it was by rule of thumb that he had come to the conclusion that a certain voltage was requisite, and so on. Long before Mr. Trotter brought forward his interpretation of the arc, he (the speaker) had been considerably bothered by the hissing, in his experiments. He threw an image of the carbon points on the slit of a spectroscope, having passed it through the prisms and fixed it on a focussing screen. He then removed the focussing screen and once more recombined the spectrum, and formed an image of the prism upon a distant screen and by that means got any colours he wished to investigate. In a great number of cases it had happened that the patch of light so formed had given him the impression that it was oscillated, but he had found afterwards that there was a distinct rotation of something in the arc light. To investigate this still further, the slit of the spectroscope was diminished to a pin-hole, and this exemplified the whole phenomenon on the screen, for by using a pin-hole he got an image of the carbon points on the prism. He hesitated to say whether the rotation was as much as 450 times a second or minute, whatever the case might be, but he could say that, immediately before the hissing, there was seen the phenomenon which Mrs. Ayrton had described so well in her Paper. It was not so quick, however, and this fact led him to the conclusion that perhaps it might be due to oscillation in the arc as Prof. Fleming had pointed out. He had not investigated this, but at the same time the phenomenon of hissing was certainly accompanied most frequently with a rotation, but not always. He thought Mrs. Ayrton would be rewarded if she made the following experiment, viz., throw a monochromatic image of the electric light on a screen and watch it. This was done in a very easy way by throwing an image of the carbon points by means of a lens through a slit. Instead of having a slit without a lens, put a lens quite close to the slit and throw a sharp image upon the prism. Then take away the lens and she would get an image in white light of the carbon points on the screen. Then if she put a slit in the focus of the spectrum and passed it through, she would get an image of the carbon points in every colour, and it was very interesting to find the spot where the flame came on the screen when the hissing began. There was a certain phenomenon which began when the hissing began, viz., the flame surrounding the carbon points was quite different to the violet spectrum which was ordinarily seen between the poles. This was of a yellow colour and was probably a higher compound

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of carbon and oxygen. It also appeared immediately before the hissing, but not very readily.

Prof. W. E. AYRTON said that at the beginning of the discussion Prof. Thompson criticised a statement that he had made on a previous occasion. His statement was that if they were dealing with normal arcs and kept the potential difference between the carbons constant, then when the carbons were drawn apart slowly so as to lengthen the arc, they increased and not diminished the current, as might, *a priori*, have been expected. To this statement Prof. Thompson had taken exception, and had said that what should have been stated was this, that with normal arcs if they lengthened them and wished to keep the potential difference between the carbons constant it was necessary to alter the outside conditions so as to increase the current. This appeared to him to be a distinction without a difference. Supposing they had two arcs of different length with the same carbons, and they wished the potential difference to be the same, say 55 volts. With a 4mm. arc they would have some 7 amperes, and with a 5mm. arc 11 amperes. There were millions of outside conditions which enabled them to have these 55 volts, and there were millions of other outside conditions which would enable them to have the same potential difference with a longer arc. If they had the two together they must select outside conditions, which would enable them to have 55 volts in both cases; exactly the same thing applied to a wire resistance. Another criticism of Prof. Thompson's was with reference to what Capt. Abney had referred to, viz., the slow rotation of the bands, which may be seen on the crater before the arc hisses. Prof. Thompson said that Mr. Trotter had pointed this out previously. The curious part about it was that in Mr. Trotter's Paper before the Royal Society, and in the account given by Mr. Trotter in *The Electrician* (of which he was then editor), there was no reference whatever to this slow rotation.

Prof. S. P. THOMPSON here interposed to the effect that what he said was that Mr. Trotter had shown it to him and that it was referred to in his (Prof. Thompson's) Cantor lectures.

Prof. W. E. AYRTON then intimated that he was glad to hear this, but that it was curious, if this phenomenon was commonly known of, that an area of the crater should have been suggested (he believed even by Dr. Thompson himself) as a standard of light.

Prof. S. P. THOMPSON replied to the effect that that was quite true, but that he had abandoned his idea when Mr. Trotter showed him the phenomenon of rotation.

Prof. W. E. AYRTON then continued saying that Mr. Trotter had been kind enough to ask him to go to his house and see the rapid rotation, which could only be seen in the rotating sectors, and he had no recollection whatever of Mr. Trotter having drawn his attention to the slow movement of the dark bands which could be seen without any sectors at all. He did not think that Prof. Thompson quite grasped last time what Mrs. Ayrton meant about that region of instability between the silent and the hissing states. This was really quite distinct from what Prof. Thompson had referred to, and from what he (Prof. Ayrton) had referred to, viz., whether the length of the arc was altered. What Mrs. Ayrton was putting forward in her Paper was what happens when the length of the arc was not altered.

Mrs. AYRTON thanked all those who had criticised her Paper for the very kindly manner in which they had done it, and everyone for the extremely warm way in which they had welcomed her Paper. Prof. Thompson had asked her what she meant by the hissing arc; did she mean a green arc, or an arc in which the P.D. had fallen, or an arc that was making a noise? An arc made a great many noises. It hissed in all sorts of ways and under all conditions. There was the long arc with small current which made a noise like a kettle just beginning to boil, and there were arcs under other conditions of which she did not even know, and which made all sorts of noises. But there was only one hissing arc as she knew it, viz., the arc in which the potential difference fell. The interesting part of the subject to her was the diminution of the potential difference between the terminals of the carbons. That seemed to her the most interesting of all the phenomena attached to it, and it was upon this that she stood or fell. The green colour she believed to be intimately connected with the fall of potential, but she could not say how. Mr. Mordey had asked if the hissing arc gave out less light. She believed it did, but it was difficult to say. Did he mean less light for the power supplied? M. Blondel in 1893, in a Paper written in *The Electrician*, said that the hissing arc always gave 10 per cent. or 20 per cent. less light than the normal arc. But how much light did the normal arc give? If they have different currents they had different light. It was true that the arc appeared duller when it began to hiss, but she had found that the power supplied to a hissing arc was less than the power supplied when the arc was silent; and therefore it was very difficult to say whether, for the amount of power supplied, the amount of light given out was less when the arc was hissing than when silent. As regards arcs being unsteady when hissing, that was only the case when the arc was only just at the hissing point. Everyone who had studied them must know that it was possible to get an extremely steady light from a hissing arc. As to the dark band of the alternate current arc, referred to by Mr. Mordey, she had no notion of this, as she had never worked with alternate current arcs. She had had various letters sent her about her Paper, and one of these letters had suggested that the ends of carbons shown by her at the reading of the Paper were of a very different character to those he was accustomed to with the ordinary enclosed arc. She thought she had made it clear that she was using an ordinary enclosed arc enclosed in a crucible arranged in such a way that the air could be let in in different quantities or entirely excluded. Her arc, however, was never completely enclosed because there was always sufficient clearance between the positive carbon and the crucible to allow a certain amount of the vapour inside to escape, but not sufficient to allow air to get in. M. Blondel had written to her and mentioned that he had noticed the green shade in the arc in 1893. They all knew M. Blondel's work, and they must respect his opinions because he had done more good work on the arc than any other single individual. In this letter he had reminded her that she had not mentioned the opacity of the vapour of the hissing arc. This, she said, was certainly more opaque than the open arc, but not so opaque as the enclosed arc. M. Blondel had also suggested that this opacity was caused by the carbon being disruptive. In a part of this letter from M. Blondel, which Mrs. Ayrton read, he stated that his opinion was that hissing was caused by particles being torn off the positive carbon and dropping on the negative carbon. This Mrs. Ayrton did not think to be the case, as she did not believe the potential difference was sufficient to allow of this tearing off. At the same time she was not prepared to say how the oxygen did act. She was sorry to say she had not properly followed Prof. Fleming's remarks. Why were the negative ions supposed to go more quickly than the positive ones? The mushroom, she mentioned, only took place with a short hissing arc. With regard to the rotation of the arc, she was sure nobody could have studied it from the point of view of light without having seen this rotation.

The PRESIDENT, in proposing a vote of thanks to Mrs. Ayrton, thought they were all the more indebted to her for communicating this most valuable Paper, as she was not a member of the Institution. The fact that they did not now number any lady members amongst them would not debar ladies from becoming members, and he looked forward to Mrs. Ayrton becoming one.

CORRESPONDENCE.

THE WEHNELT INTERRUPTER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Noticing considerable discussion of the Wehnelt interrupter, and its properties and actions, I think I may add a few words as to the probable cause of the actions, with an explanation of why it is that inductance is required in the circuit in order that the interrupter works.

On closing the circuit through the interrupter with an inductance in series, the current value gradually rises until at some point the electrolytic action on the surface of the platinum anode gives rise to bubbles of gas, which diminish to some extent the surface of the platinum in contact with the liquid. On account of the inductance in circuit there arises out of this condition a critical state which causes the instant stripping of the liquid from the platinum—an explosive interruption, so to speak. The inductance in circuit tends to keep the current flow constant, *i.e.*, it prevents the current falling off as the surface of liquid in contact with the platinum falls off.

There results from this, on the beginning of the uncovering of the platinum by the liquid, a state of unstable equilibrium, whereby the current tending to flow at one value is crowded, so to speak, into a section of liquid which from the moment it begins to diminish around the platinum must immediately continue up to complete interruption. This sudden interruption cannot occur without greatly increased voltage across the terminals of the interrupter, and necessarily between the platinum anode and the liquid which is being separated. This forces a discharge through the last portions of the liquid in contact with the platinum, and results also in a vigorous driving off of the liquid, together with the possible dissociation of a portion of the liquid. The platinum surface also becomes pitted and worn by continued use, owing to the violence of the discharges attended with spark. The platinum anode would naturally be surrounded by oxygen gas and, perhaps, in addition thereto, water vapour and dissociated water. On the entire cessation of current the water vapour condenses, and the products of dissociation probably recombine suddenly, casting out the excess of oxygen and renewing the condition as at first.

This theory of the action is rendered all the more probable by the fact that the ohmic resistance at the contact of the platinum and the liquid must necessarily be high, on account of the restricted section; and that, on the beginning of separation by gas bubbles, this resistance must instantly rise, the current, owing to the inductance in circuit, tending to remain of the same value as before, causing a critically increased drop of potential over the platinum liquid contact, and, in consequence, a critically increased energy delivered thereat. This view of the actions was arrived at when working with the interrupter, and in studying its properties.

—Yours, &c.,

ELIHU THOMSON.

Lynn, Mass., April 4, 1899.

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A CORRECTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have noticed a slight mistake in my letter with reference to the Wehnelt interrupter, which you published in your issue of the 7th inst. In comparing the glow produced on a fluorescent screen by an X-ray tube excited by an 18in. coil with the new interrupter, I stated that the glow was as brilliant as that produced when the tube was excited by means of a 160-plate Wimshurst machine, instead of by a "16-plate machine," as you printed. I draw attention to this, because I believe that this 160-plate machine is the largest that has yet been made, and gives extraordinarily fine X-ray effects.—Yours, &c., E. W. MARCHANT.

Blythswood Laboratory, Renfrew, N.B., April 19, 1899.

THE THEORY OF THE MARCONI TELEGRAPH.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Although several theories on the laws which govern the function of the vertical wires and the earth or capacity connection in Mr. Marconi's system have been advanced none would seem to have met with general acceptance. I am therefore induced to submit through your columns some observations which may tend to elucidate the part played by these adjuncts in wireless telegraphy. To take, firstly, the question of the vertical wires. Might we not reason that these wires, when charged, act *inductively* upon one another through stress in the intervening ether, just as the one plate or coating of a Leyden jar when charged induces a charge in the other coating owing to stress in the glass insulating medium which separates them? In short, may we not suppose that the vertical wire attached to the upper sphere of the transmitter is charged to the potential of the spark each time the key circuit is closed, and this induces effects in the distant vertical wire and coherer? If we can justly regard the action as being inductive pure and simple we need seek no further for an explanation of the important effect of these vertical wires in increasing the signalling limits.

At first sight it appears extraordinary that any such inductive action should take place over distances amounting to many miles. We must, however, bear in mind the frequency and high potential of the spark, and also the extreme delicacy of the coherer. It seems only reasonable to suppose that, as currents of high frequency overcome resistance, so *inductive distance* is increased by the same effect.

The inductive hypothesis explains intelligibly, I think, the fact that better results are obtained with vertical conductors than with horizontal conductors, because the vertical conductor gives greater elevation; and the earth and points of intervening capacity then absorb less of the inductive energy, radiated in the form of rapidly succeeding waves from wire to wire, than is the case when the conductors are horizontal or in any other position. This absorption effect would seem to explain why greater distances have been spanned at sea than on land, the surface of the sea offering no points of elevated capacity to intercept the inductive rays.

There remains for consideration the function performed in this system by the earth connection used for the transmitter and coherer respectively. I would submit that this function is to discharge the vertical wires after each signal, the one through the secondary wire of the induction coil and the other through the circuit of the distant relay, which, when the coherer is passive, offers a path to earth after each impulse.

In the discussion on Mr. Marconi's Paper it transpired that the earth on the coherer may in certain cases be severed without interrupting communication or even affecting the reception of signals. In these cases it would appear that the *surface leakage* of wire and pole, together with the capacity and leakage of the relay system itself, are in themselves equivalent to an earth, bearing in mind the very low capacity of the elevated conductors and the necessarily very small impulses which they attract. Apparently it is owing to its higher potential or inductive energy that the transmitter requires a better earth than suffices for the receiver.

Information on these points will doubtless be forthcoming from authorities on the subject. In the meantime these observations are with diffidence offered to your readers.—Yours, &c., H. W. SULLIVAN.

19, Great Winchester-street, E.C., April 10, 1899.

[The publication of the above has been delayed until this issue, at Mr. Sullivan's request.—ED. *E.*]

ELECTRICAL MOTOR CARRIAGES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There seem to be so many obstacles to the ultimate firm establishment, and apparently inseparable from the early life of a new industry, such as the adverse state of the law, the over-sanguine inventor, and lastly the professional company promoter, that those who are most interested in the matter, and one who has largely contributed to the years of labour necessary in making the electrical vehicles a practical success, take all these things as a matter of course. But when a gentleman of the standing of Sir David Salomons states (assuming that he has been correctly reported in the *Royal Magazine* of this month) that the electrically propelled carriage is an impossibility, it is to be pardoned if the remark is not allowed to pass unchallenged. And one is almost inclined to think that it was made without due consideration, as was the case when the same gentleman, in estimating the cost of propulsion by electricity a year or so ago, based his calculations on the cost of electric current at 4d. per unit, whereas at that very time it was to be obtained in London at 1d. per unit!

That one does not see many self-propelled carriages on the streets here is not evidence that they are unpractical. Our natural caution in adopting new ideas and our love of horses are enough to account for this; although, as a lover of horses myself, one of the last uses I would put a horse to would be the hauling of a tram car or an omnibus, and I think that many of the horses one sees in cabs are fit subjects for anyone's compassion, and the sooner their use is rendered unnecessary by the introduction of electricity the better.

In spite of the long start which the automobile movement has had on the Continent, and in view of the fact that it is only during the last two years or so that one was allowed to run a motor vehicle on the street here at all, it is a very significant fact that the principal systems of electrical vehicles which have been adopted in Paris are of English origin.

The argument, which Sir David is reported to have used when discussing the "inutility" (*sic*) of electrical motors, "it is as if one should go for a fast drive and expect the horses to gallop along with a load of passengers as well as a dozen sacks of coal," is not to the point, and one is tempted to remark that the horses would go very fast indeed if they had no load at all to carry. But why Sir David should try to prove the matter by wishing to carry accumulators (represented by the sacks of coal) in a horse-drawn vehicle, I fail to understand, for when we carry a set of accumulators in our electrical vehicle we do not want to carry a horse, but do without them.

In conclusion, I can only say that, regarding the weight of an electrical carriage, it is now quite possible to produce one capable of carrying two persons for a 40 mile journey, the total weight of the carriage being under 12 cwt., at a cost for electric current of two shillings (2s.) and an annual expense for renewal of accumulators of £20.

Thanking you for your courtesy in inserting this letter and apologising for taking up so much of your valuable space.—Yours, &c., C. OPPERMANN.

The Automobile Club, S.W., April 17, 1899.

Wiring Rules.—The number of the *Journal* of the Institution of Electrical Engineers, just issued, contains the conclusion of the discussion on Wiring Rules, as well as the proceedings at ordinary meetings up to the conclusion of the discussion on Prof. Wilson's Paper. No less than eight members have communicated their share of the Wiring Rules discussion in writing, Mr. Pigg has communicated his reply, and Mr. Wordingham has added about a page to his remarks.

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PARLIAMENTARY INTELLIGENCE.

NORTH-WEST LONDON RAILWAY BILL.

Last week the Select Committee of the House of Commons, of which Mr. Jeffreys is Chairman, the other members being Mr. Souttar, Mr. Bathurst and Mr. Shaw, commenced the consideration of the North-West London Railway Bill, under which authority is sought for the construction of underground electric railways, connecting the Marble Arch with Cricklewood. Mr. Balfour Browne, Q.C., Mr. Joseph Shaw and Mr. Hutchinson appeared for the promoters; the only opponents, the London County Council, were represented by Mr. Freeman, Q.C.

Mr. BALFOUR BROWNE said the line would be four miles long, and it was supported by all the local authorities through whose districts it passed. A railway was under construction along the Bayswater-road, past the Marble Arch to the City, and it was proposed to connect the two railways at the Marble Arch. The stations on the new line would be at the Marble Arch, at Edgware-road (near the Metropolitan Railway Station, with which it was to be connected), at Hall-road, Maida Vale, at Kilburn, at Brondesbury, another a little further to the North, and then the terminus at Cricklewood. The line would also be connected with the Baker-street and Waterloo line now under consideration. The large extent of the traffic on the proposed route was indicated by the fact that there were some 6,000 omnibuses plying daily. The time occupied on the journey from Cricklewood to the Marble Arch by omnibus was about 40 minutes, but by the railway it would be only half that time. The capital asked was £1,500,000, with borrowing powers of £500,000; and the line, which was to consist of double tunnels, it was estimated would cost £10,65,183. Each train would carry 350 persons, and each lift at the stations would accommodate about 250 persons. The opposition of the County Council was designed to place on the Company a clause under which they would have to carry workmen at an unremunerative rate and at an hour of the day which the company held was unsuitable for workmen's trains, and which would allow a large number of clerks and others well able to pay ordinary fares to travel by the cheap trains. The Company desired to provide workmen's trains, but only at a proper time and at a remunerative rate. If the clause of the County Council were adopted it would mean that they would be unable to raise their capital.

Mr. BRAITHWAITE, of Messrs. Foster and Braithwaite, stockbrokers, of Austinfriars, and Mr. C. C. Macrae, vice-Chairman and Managing Director of the Railway Share Trust and the Railway Debenture Trust, and a Director of the London, Brighton and South Coast Railway, gave evidence showing that if the clause of the County Council were put upon them they would be hampered in raising the capital.

Sir HENRY OAKLEY, formerly general manager of the Great Northern Railway Co., and Chairman of the Central London Railway Co., gave evidence showing the large traffic on the route of the line, and said that the locality of Cricklewood was very ripe for development, and would develop largely if increased facilities were given. Assuming the working expenses to amount to 50 per cent., the line would yield a minimum, he estimated, of 3 per cent. He thought, however, the expenses ought to be less than that, because with an electric railway there was not the same increase of expense, train by train, as with an ordinary steam locomotive. They might fairly and reasonably estimate the expenses at about 40 per cent; but whether the expenses were 40 or 50 per cent., having regard to the enormous traffic at present existing, and the prospects of development, he had no doubt the line would be a dividend earning one. He deprecated the passing of special legislation in the case of each railway with regard to workmen's trains. There was an Act under which the question of accommodation of workmen was referred to the Board of Trade or the Railway Commissioners, and he thought that course should be adopted in the present as in all cases, and not that the matter should be dealt with and settled specially, in each individual case.

Sir BENJAMIN BAKER, joint-engineer with Sir Douglas Fox for the proposed line, said the estimates, &c., were all based on his experience in connection with other similar lines in London. The estimates worked out to about £450,000 per mile, showing that the line would be very expensive.

A long discussion arose round the demands of the London County Council for lower workmen's fares than those proposed in the Bill, but the Committee came to the unanimous decision to allow the return fare of 2½d., the single fare 1½d., the intermediate 1½d., and the hour of arrival from 8 o'clock.

The Bill was then ordered to be reported to the House.

BAKER-STREET AND WATERLOO RAILWAY BILL.

On Tuesday a Select Committee of the House of Commons, presided over by Mr. Jeffreys, commenced consideration of the Baker-street and Waterloo Railway Bill. The counsel engaged for the Bill were Mr. Pember Q.C., Mr. Ernest Page, Q.C., Mr. W. J. Noble, and Mr. Joseph Shaw. There were a considerable number of petitions in opposition, including those of the Metropolitan Railway Co., the Charing Cross, Euston and Hampstead Railway Co., the Grand Junction Canal Co., the Gordon Hotels Co., and the London County Council.

Mr. PAGE said under the Bill power was sought to make extensions of a railway authorised in 1893, and to provide for an extension of the time granted for the completion of that line. By a later Act power was given, in consequence of the known intention of the Great Central Railway Co. to make their London terminus at Marylebone, for the Baker-street and Waterloo Co. to extend their line to Harewood-square for the purpose of communicating with the Great Central terminus. The extensions now proposed were from Harewood-square to Paddington station and from Portland-road to Euston. It was proposed that there should be two subways, one at Paddington and another at Trafalgar-square from the underground station there, reaching the surface at the corner by the Grand Hotel. The London and Globe Financial Co., of which the Marquis of Dufferin was chairman, were promoting the line, and as that Company had already spent £300,000 on it there was little doubt that the line—whether the public subscribed to it or not—would be constructed. The length would be about 2⅛ miles, and the estimated cost was £856,000. The capital powers sought were for £1,400,000, the balance being required for the subways, rolling stock, and the erection and equipment of a generating station in South London, where sufficient electricity to work the whole of the line would be generated. The petitions of the Metropolitan and Charing Cross, Euston and Hampstead Railway Companies alleged that the line would compete with them. The Grand Junction Canal Company's opposition was based on the suggestion that danger would result to their canal by the passing of the line for some length under it. The County Council opposed the Bill with a view to imposing on the Company some special liability with regard to cheap trains for workmen. Counsel pointed out that in this matter the Company was in a very different position from the great trunk lines, and contended that the general law was sufficient to meet the case.

Much evidence was given in favour of the proposals to extend the line to connect with Euston and Paddington by Mr. Harrison, General Manager of the London and North-Western Railway Co., Mr. Wilkinson, General Manager of the Great Western Railway Co., and Mr. William Pollitt, General Manager of the Great Central Railway Co. and Mr. Owen, General Manager of the London and South-Western Railway Co. These witnesses were unanimous in their opinion that the projected line would be of enormous advantage to persons travelling to London over their systems, and desiring to go to Waterloo or to the great shopping centres of Regent-street and Oxford-street; and to the extent that the line was used the traffic through the streets would be relieved. Mr. Owen stated that the traffic to and from Waterloo was increasing at an almost phenomenal rate, the passengers booked to and from the station having grown from 18 millions in 1888 to 28 millions in 1898. Of these a very large proportion went to the City and the remainder to the West. He had always considered the lack of communication between the great termini of London as one of the great faults of our railway system, and any proposal to link up two or three of the termini at present without communication, he would heartily support. His experience of the Waterloo and City Railway enabled him to say that the public very much appreciated the mode of conveyance contemplated by the Bill, the number of passengers carried on that line in the last 4½ months having been 1½ millions, which would have been much larger if the Company had had more rolling stock. In reply to the Chairman, he said the ventilation on the Waterloo and City line was absolutely perfect. It was simply caused by the trains in their movements drawing after them a large current of air.

Sir BENJAMIN BAKER (one of the engineers to the line) was examined at length regarding the proposals of the Bill. He said the site of the generating station was originally placed in Paddington, but, owing to the opposition with which the scheme was met, another site south of the Thames was fixed upon. There would be a covered-in underground depôt at Paddington, where carriages would be stored, light repairs executed, &c. The machinery necessary for the repairs would be driven by electricity. Probably the traffic from Charing Cross to Paddington would be heavier than that from Paddington to Waterloo. They proposed to run trains each six minutes from Euston and Paddington, which would give them a three minutes' service to Waterloo. Though an Act was obtained in 1893, no works had been done till about a year ago. The £300,000 spent had been expended principally in the purchase of land. The tunnels and carriages would be the same size as on the Central London Railway, and six inches larger than those on the City and South London line. The tunnels would be constructed in the clay, at an average depth of 60ft. from the surface. His estimates were not excessive, and he had given them as the result of his experience. In his opinion the only way of meeting the congestion of traffic in the crowded thoroughfares was by means of these expensive electric railways. There could be no comparison between the slight disturbance occasioned by them to the inconvenience caused by strings of omnibuses.

The CHAIRMAN: Can you make it quite clear to the Committee how much per mile the railway is going to cost?—The estimated cost of the Baker-street and Waterloo Railway is £575,000 per mile. The cost of the Central London line is estimated at £585,000; the Great Northern and City at £652,000; the North-West London, £435,000; and the Great Northern and Strand, £502,000.

The CHAIRMAN: According to these figures, your estimate is about an average. Does the £575,000 include all contingencies?—Yes, all contingencies, including the electric lifts at the stations (which were not in the original estimates), professional charges and working capital.

Continuing, witness said they proposed to ventilate the line by the shafts at the stations, which experience has proved was sufficient; but, if necessary, they could employ electric fans.

The CHAIRMAN: But if there were a stoppage in the tunnel? We are told that the train in motion causes the ventilation.—I went very carefully into that, for there was some alarm in consequence of the stoppage on the City and Waterloo Railway. It was said that the passengers broke the windows of the carriages. As a matter of fact, they were not in danger of suffocation, but got very hot in consequence of being penned up in the carriages with the windows closed. From calculations made, it is found that if a train were full of passengers in the tunnel, and both ends of the tunnel were blocked up, the passengers might die of starvation, but they would feel no inconvenience from the air.

Mr. W. R. GALBRAITH, civil engineer, joint engineer of the Waterloo and City Railway, and of the Baker-street and Waterloo Railway, confirmed generally the evidence of Sir Benjamin Baker with reference to the

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Waterloo station. The railway was laid out in 1893 so as to secure an interchange of traffic between it and the Waterloo and City line. The South-Western Company contemplated making another line to Clapham Junction, so they could not secure the land originally fixed upon. They were compelled, therefore, to go to Paddington to secure a site for their sidings and shops.

Yesterday Lord Loch and Mr. Galbraith were re-examined, and the case for the promoters was closed, and the proceedings were adjourned.

GREAT NORTHERN AND STRAND RAILWAY BILL.

This Bill came before a Select Committee of the House of Commons on Thursday last. The members of the Committee were :—Mr. A. H. Brown (chairman), Mr. Leuty, Lord H. Bentinck, and Sir T. J. Gibson-Carmichael.

Mr. Balfour Browne, Q.C., Mr. Fitzgerald, Q.C., and Lord R. Cecil appeared for the promoters ; Mr. Freeman, Q.C., represented the London Council Council, and counsel also appeared for the numerous opponents of the measure.

Mr. FREEMAN, Q.C., said that as the proposed railway was to be underground throughout, and as it was intended that it should run under the new street proposed to be constructed from Holborn to the Strand under the London Improvements Bill, which stood to be next considered by the Committee, he thought the best course would be to take the railway measure independently, but to reserve the decision upon it until the next measure had been disposed of.

Mr. BALFOUR BROWNE said the Railway Bill would in no way be prejudicial to the new street. The present scheme was one of the most important in its bearing on London traffic that had been promoted for a long time. It was proposed to construct an underground railway from Wood Green to St. Clement's Danes, in the Strand. The line would consist of four separate railways, one of which would leave the Great Northern at Wood Green and run to Finsbury Park, and would be about 2½ miles in length. A second railway would begin at Finsbury Park and extend to King's Cross, and would be underground throughout, and be worked by electricity. It would also run almost entirely under the Great Northern line. These lines would not form a portion of the Great Northern Railway, but would be affiliated with it. Although, as the Great Northern were not opposing, the Company would not have to pay for the land in getting to King's Cross, yet they would incur great expense in constructing the tunnels of sufficient strength to bear the traffic of the Great Northern Railway. From King's Cross it was proposed to run the line under private property at a great depth, and to pay for the necessary easements, a procedure which had been favourably reported upon by a Committee in 1892. From the Central London Railway in Holborn the proposed railway would proceed *via* the new street to be built by the County Council, upon the making of which they were to some extent dependent in order to reach the Strand. The railways altogether would be 6 miles 27 chains in length, and their estimated cost was £2,297,903. It was proposed to fix the Company's capital at £2,400,000, with a borrowing power of £800,000, making altogether £3,200,000. The expenditure per mile, as estimated, would be a low one, viz., £381,000.

Sir H. OAKLEY, formerly Manager of the Great Northern Railway, said he was of opinion that the traffic on the railway would be from 12,000,000 to 13,000,000 passengers per annum. As to the objection of the County Council, the subsoil of a street was of no value to anybody. It would be in the interest of the public to give the promoters the facilities they asked for ; indeed, he should have thought that the County Council would have been glad to see the railway run under their new street.

Mr. CHAS. STEEL, General Manager of the Great Northern Railway, said that his Company were favourable to the Bill. He estimated that the proposed railway would relieve the Wood Green traffic to the extent of between 6,000,000 and 7,000,000 passengers a year. It would save them 30 or 40 trains per day, and enable them to give a better service to outlying districts. If the new street to the Strand were not made the southern portion of the proposed railway would fall with it.

Mr. FREEMAN addressed the Committee for the London County Council. He did not deny that the railway would be a public advantage, but contended that his clients should retain possession of the subsoil of their proposed new street, which they were buying with hard cash. He asked the Committee not to decide the Strand part of the scheme until the London Improvements Bill had been considered.

The Committee ultimately passed the preamble of the Bill. Clauses will be considered to-day (Friday).

Sixty Thousand Words an Hour Telegraphy.—The *Daily Chronicle's* Vienna Correspondent has announced that a Vienna engineer named Pollak has invented "a simple apparatus" capable of transmitting telegraph messages at the rate of 60,000 words an hour. He states that the United Electrical Joint Stock Co. have bought the invention, and that their trials have, up to the present, met with great success; also that experiments will be attempted between Vienna and Budapest next week, and that the company will shortly open up negotiations with all European and American post offices for the sale of the patent. A *simple* apparatus which can transmit and receive at the rate of 1,000 words a minute would indeed be a boon, but we prefer to reserve our opinion as to the possibility of such a feat being accomplished on an ordinary telegraph wire until further particulars of the invention are to hand.

LEGAL INTELLIGENCE.

Castner-Kellner Alkali Co. (Limited) v. Commercial Development Corporation (Limited).

In our last issue we gave the summing up of the Master of the Rolls in this appeal action. It will be remembered that Lord Justice Rigby concurred with the Master of the Rolls in giving judgment for the defendants. Lord Justice Vaughan Williams differed from his colleagues. The judgments of Lord Justice Rigby in favour of defendants and Lord Justice Vaughan Williams in favour of the plaintiffs are given below :—

Lord Justice RIGBY said he proposed, in his judgment, to deal exclusively with the question of the validity of the patent sued upon—Kellner's of 1894. If as, in his opinion, was the case that patent could be shown to be invalid it would be an academic question, whether, on the supposition of its being valid, there would be an infringement, and he did not propose to enter into the question at all. The grounds alleged for holding the patent invalid were disconformity and want of subject matter. He should deal mainly with the first of these, which depended upon the comparison of the provisional and complete specifications according to the true construction of each. This construction was entirely for the Court. Experts, however eminent, had nothing whatever to do with it, though their evidence might be valuable in explaining the meaning of technical terms, the state of the invention and the date of the patent and the working of the apparatus described. The main point for consideration would be the meaning of the words "stationary mercury cathode" which, paraphrased, meant a stationary cathode composed of mercury, otherwise a stationary mercurial cathode or a cathode composed of stationary mercury. He had come to the conclusion that the first was the true meaning differing in this respect from Mr. Justice Bigham, who adopted the second. The difference was crucial, because the second meaning was the only one which rendered it possible, however difficult, to take the further steps which Mr. Justice Bigham had taken for interpretiug in a manner different from its ordinary meaning, what his Lordship took to be "stationary" in reference to surrounding unmoving objects, and he attributed to it a very different and exceptional meaning of "stationary" with reference to the containing vessel. In his judgment it was not only startling, but quite inadmissible, to say that the ultimate development of an invention, which must rely for its validity upon an inventive departure from a pre-existing state of things, would be to bring them back to precisely that pre-existing state of things, as was done by the claim in Figs. 7 and 8 of Kellner, when the bottom of the chamber was rotated. His conclusion was that the actual modification of apparatus exactly described and claimed in Figs. 7 and 8 ; at any rate, when the bottom containing chamber was made to revolve under the cells rigidly connected with one another was not a legitimate development of the invention, the nature of which it was shown by the provisional specification, and that the patent was, therefore, void for disconformity. That was the main ground of his decision as to the invalidity of the patent. Going to the question of subject-matter, even if it could be shown that the objection of disconformity failed, there would remain that of want of subject-matter. Comparing Figs. 7 and 8 of Kellner's with Fig. 1 of Castner's patent, they found in that modification of 7 and 8, viz., the motion with which the cells remained still and the bottom alone was made to rotate, an exact correspondence between Castner and Kellner up to the point where the question arose how to move the mercury cathode. Castner effected this by a stirrer consisting of helical blades mounted on a rotating shaft passing down the apparatus. All that Kellner did was to substitute for this rotating stirrer a rotation of the bottom of the vessel containing mercury. There was no clear evidence of any advantage over Castner in this arrangement. Further, the modification introduced by Figs. 7 and 8, by moving the bottom of the vessel, so far from being shown to be an important improvement in practice from former apparatus, had never been used at all, and there was no evidence of experience, or even experiment, that it would practically work at all as a commercial success. In his judgment the Kellner patent was void from want of subject-matter, so far as concerned the particular modification of apparatus which had been dealt with and the claim (No. 3) founded thereon ; and, therefore, the whole patent was void on this ground also.

Lord Justice VAUGHAN WILLIAMS said he differed from the other members of the Court, and as he did not think the Kellner patent was bad for disconformity he should necessarily have to go into the whole question, both of the merits of the Kellner patent and of the alleged infringement of the Kellner patent by the Rhodin patent. In order to deal with the case it was necessary to make some comparison of the plaintiffs' patent and prior letters patent, and in particular a prior patent taken out by Castner. The main features of the Castner patent seemed to have been :—(1) A single chamber divided into two sections—one for salt and water, and one for pure water—by a partition not extending quite to the bottom of the vessel, and sealed by the mercury at the bottom of the vessel. (2) A continuous electric current passing through both chambers. (3) The adjustment of the proportion of amperes passing through the chambers respectively by a division of the continuous current. (4) The change in the location of the mercury relatively to the two chambers by the flow of the mercury round and round the containing vessel, produced by the propulsion of paddles attached to a central revolving shaft. (5) The maintenance of an average minimum of 0·2 per cent. of sodium throughout the mercury by the churning produced by the propelling paddles. The idea of Kellner seemed to have been this : He had a large dish with mercury at the bottom. On the top of this mercury he had movable cells with the lower edge just dipping into the mercury so as to seal the bottom of the cell and prevent any liquid which might be placed inside the cell running out at the

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bottom. These cells he filled with salt and water. The whole of the vessel outside these cells he filled with pure water, so that the whole of the mercury which was not covered by the salt and water contained in the movable cells was covered with pure water; he electrolised the salt and water by a current passed through the salt and water to the cathode formed by the mercury. This current was not continuous, and did not as in the case of Castner's patent pass on through the pure water. He then by shifting the bells containing the salt and water electrolyte about on the surface of the mercury caused patches of the mercury to be alternately covered by the salt and water electrolyte and the pure water respectively, thus charging with sodium the patch of mercury covered by the salt and water electrolyte, and discharging of sodium the same patch of mercury when subjected to the pure water by the shifting on of the cell containing the salt and water to the adjoining patch, which prior to the shifting had been covered with salt and water. In order that the shifting of the cells should not by reason of the dipping of the lower edge or lips of the cell into the mercury, carry with it the patch of mercury which was under the cell at the time of the shifting of the cell, Kellner made in the lower edge of the cell a series of notches, or openings or serrations. The mercury in Kellner's apparatus had no fluid motion, or, at least, was intended to have none relatively to the vessel containing it. The Kellner apparatus had no continuous electric fluid, not even an adjusted continuous current passing through the pure water cell. In Kellner's provisional specification the motion of the cell containing the salt and water electrolyte was a to-and-fro motion. In the complete specification he made several additions, which his counsel called "developments of the invention, identified by the provisional specification," but which the opposing counsel contended were "departures from the provisional specification amounting to disconfirmity." These were the substitution for the to-and-fro movement of a rotary movement of the cells on the top for the mercury, and also the substitution as an alternative method of the rotation of the dish containing the mercury instead of the movement whether to-and-fro or rotatory of the cells, or the top of the mercury. The other addition made in the complete specification was the addition of a short-circuited current in the pure water cell, "starting from the mercury amalgam acting as an anode." This the defendants relied upon as another instance of disconformity, and also relied on it on the question of utility, alleging that the apparatus would not act without it, whereas the plaintiffs said that the "short-circuited current" was only to be used in case it was desired that the alkaline metal should be rapidly removed from the amalgam formed. The principal feature of the Kellner invention seemed to be (1) The substitution of non-circulating mercury for flowing mercury; (2) The subjection of the surface patches of the still mercury alternately to salt and water electrolyte and pure water respectively; (3) The maintenance, as far as possible, of the mercury in a still condition, free from agitation. The idea of the Rhodin patent seemed to have been to adopt the Kellner idea so far as it related to the movement of the salt electrolyte in a rigid vessel over the top of a stationary cathode, but to modify it so as to enable the use of a stronger electric current than that which could be used with the Kellner invention. Dealing with the defences set up in the action, his Lordship said that he thought the view taken by Mr. Justice Bigham, as to the meaning of the words in the Kellner's provisional specification "stationary mercury cathode," was right. It was clear that prior to the Kelvin patent inventors had always tried to get over the difficulty arising from necessity of quickly taking away the mercury when charged with the sodium deposited by electrolysis by causing the mercury thus charged to flow in the vessel containing it. The earlier inventions caused the mercury to flow when charged into a separate vessel or chamber when it was discharged of the sodium by contact of the amalgam with pure water, sometimes assisted by an electrical current passing through the second as well as the first chamber, and sometimes with the current passing only through the salt and water in the first chamber. Castner made the mercury flow in a single vessel underneath two rigid chambers, part and parcel of the same vessel. He read the word "stationary" as qualifying the word "mercury," and the words "stationary mercury" qualifying the word "cathode." The various defences set up by the defendants were these: (1) Denial of infringement; (2) Denial of the validity of the patent on the grounds (*a*) of want of novelty, by reason of the anticipations set forth in the particulars; (*b*) want of subject matter; (*c*) want of utility; (*d*) want of invention; (*e*) disconformity. With regard to the defences of disconformity and denial of infringement, which his Lordship considered together, it was said that the complete specification departed from the provisional, first because Figs. 7 and 8 introduced the rotary instead of the to-and-fro movement. It seemed to his Lordship that there was nothing in this, because if the invention of Kellner consisted of moving about a rigid body over stationary mercury in the sense in which he read those words, it seemed to him to be a legitimate development to say that in addition to movement by the to-and-fro method, the movement of the chamber over the stationary mercury might be attained by the rotary movement of the chamber over the stationary mercury, or by the rotation of the mercury dish over the chambers. In either case there was no flowing of the mercury relatively to the dish containing it. He thought that Mr. Justice Bigham was right, and that there was no disconformity, even in the case of the rotation of the bottom dish, because the mercury, even in this case, was stationary relatively to the dish containing it. As to the suggested disconformity, by reason of the claim in respect of the third electrode in the combining chamber, his Lordship thought there was nothing in it, because it was limited by the words at the beginning of claim 4, "In apparatus of the kind specified in preceding claims." His Lordship further thought that, assuming, as he did, that claim 3 was not bad for disconformity—assuming, that is, that there was no distinction between the rotary movement and the to and-fro movement, the infringement by the defendants of the Kellner patent was clearly established, even apart from important admissio of the leading counsel for the defendants, an admission which, for his own part, his Lordship thought he was right in making. Indeed, if it were not for the denial of Rhodin, he should have thought it tolerably clear that Rhodin's patent was framed by someone with Kellner and Castner's patents before him, seeking to extract the best portions of both. The total combination in the Rhodin apparatus seemed to his Lordship very different from the total combination in the Kellner apparatus. The result was arrived at by the application, in part at all events, of very different principles, but if Kellner's patent claimed, as his Lordship thought it, the use of stationary mercury relatively to the vessel containing it, and divided chambers, one of which was rotary, he thought that there was a clear infringement, and not the less so because Rhodin might have improved upon Kellner's apparatus by applying it to a novel and more effective apparatus. Dealing with the defence of anticipation, his Lordship said that the only anticipation seriously urged was the Castner process. It was said that the Kellner patent was anticipated by the Castner, because the movement of the chambers above the mercury was a mere mechanical equivalent for the flow of the mercury under the chambers. He (his Lordship) thought, not having regard to the object in view, Castner wanted to produce churning of the mercury; Kellner wished to avoid it. Castner's process did produce churning; Kellner's to a large extent avoided it and was intended so to do. Then it was said that Castner's double chamber was an anticipation of Kellner's double chamber. His Lordship thought that Castner's double chamber was fixed, and a part of a single structure. Kellner's was detached and movable, being, in fact, one of two rigid structures. Then, as to the defences of want of invention, want of utility and want of subject-matter, which, more or less hanged together, in his Lordship's opinion, all failed. He thought there was sufficient ingenuity to constitute an invention entitled to a patent, and that the invention was not only ingenious, but useful. It offered a method of producing caustic soda with a low electric current by dealing with surface patches of sufficiently still mercury, and that he considered was a distinctly new method. He came to the conclusion that the plaintiffs' apparatus was proved by the evidence to have sufficient utility, as affording, theoretically, a novel alternative mode of producing caustic soda by an electrolytic mercurial process. For those reasons he thought the judgment of Mr. Justice Bigham right.

The appeal was then allowed as previously announced.

Mr. TERRELL, Q.C., for the defendants, asked that the particulars of objections should be certified, for otherwise there would be a difficulty with the taxing master in allowing them.

Their Lordships decided that the matter should be mentioned to them again at a later date.

National Company for the Distribution of Electricity by Secondary Generators (Limited) v. John Dixon Gibbs and Henriette Onesime Ruelle.

This case came before Mr. Justice Cozens-Hardy, in the Chancery Division, on the 17th and 18th inst., and was an action brought by plaintiffs for specific performance of two agreements of May 25, 1883, and Oct. 31, 1883. The second defendant is the wife of Sylvain Jean Baptiste Ruelle and the administratrix of Lucien Gaulard.

It appeared that by the agreement of May 25, made between Lucien Gaulard and the defendant Gibbs, the vendors, and the plaintiff Company, it was agreed that the vendors should sell to the plaintiffs the exclusive privilege of using and vending certain inventions in connection with the manufacture and construction of secondary generators for the distribution of electricity, and other apparatus connected with electric lighting, for which the vendors had obtained letters patent in the United Kingdom, France, Belgium, Italy, Austria, Spain, New Zealand, India, Canada, Victoria, New South Wales, Queensland, South Australia, and Tasmania, and also all the said letters and patents and privileges, and the benefit of certain inventions and improvements for the sum of £220,000, to be paid as to £200,000 in 20,000 shares of £10 each of the plaintiff Company fully paid up, and £20,000 in cash. It was further agreed that the vendors should, at the expense of the plaintiff Company, establish a title to the inventions and letters patent and privileges, and should transfer the same to and cause the same to be legally vested in the plaintiff Company, and that the assignments to the plaintiff Company should contain a covenant by the vendors that all the letters patent were valid, and all such other covenants as might be required by the plaintiffs for giving effect to the sale. By the agreement of Oct. 31, 1883, made between the vendors and the plantiff Company, the former agreement was altered and varied so that the vendors should be paid by the plaintiff Company in lieu of the £20,000 in cash, a moiety of the moneys to be realised by the plaintiff Company from licences or concessions or agreements of any kind to use or work the inventions in question until such moiety should amount to £10,000, and the further sum of £10,000 residue of the sum of £20,000 cash, in 1,000 Preferred shares of £10 each, fully paid up. The plaintiffs alleged that they had allotted to the vendors the shares in question, and had paid to the defendant Gibbs £984 in cash, and to Gaulard £1,788 in cash, in pursuance of the agreements, but that the letters patent and privileges had not, in fact, been transferred to or assigned to the plaintiff Company, nor were the letters patent and privileges, in fact, valid. The plaintiffs also said that various persons had taken proceedings in France, the United States, Germany and Austria impeaching the validity of the letters patent and privileges granted in those countries, and as a result of those proceedings, the letters patent in respect of the United Kingdom had declared to be void, the Brevets d'Invention, in respect of France, Germany and Austria, had been declared to be invalid or restricted to such an extent that the remaining claims were of little or no value

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The plaintiff Company had paid a large sum in respect of costs which they asked that the defendants might be ordered to repay, and also for so much of the purchase money paid to the defendants by them (the plaintiffs) as was properly attributable to the patents which had been declared to be wholly invalid, and of a due proportion of so much of the purchase money as was properly attributable to the patents which had been declared to be partially invalid.

Mr. Fletcher Moulton, Q.C., and Mr. Gore Brown appeared for the plaintiff Company; and Mr. Eve, Q.C., and Mr. Rowden for the defendants.

Mr. FLETCHER MOULTON said that Gibbs and Gaulard were people who were very well known in the early days of electric lighting. The plaintiffs estimated that by what had taken place the value of the patent was reduced by £50,000 in the United Kingdom. The learned counsel said that by the Gibbs and Gaulard invention it became possible to distribute electricity over very much larger areas than it was possible to do by the direct current, and which enormously diminished the expense of electric light installations. That was the fundamental patent for the distribution of electricity by secondary generators. If that patent was valid all persons setting up installations by secondary generators would have had to take licences from the plaintiffs. At the present moment one half of the installations over England were by this system, which reduced the cost of installations by something like 25 per cent. His Lordship would see that the value of the fundamental patent controlling the whole of that was enormous. If he (counsel) said that that patent was worth £1,000,000 he should not be exaggerating.

His LORDSHIP: What is the defence?

Mr. EVE said the defence was that there had been a release by the joint contractor, and that the action could not be maintained. The defendants also said that the thing was *res judicata*. His Lordship would find that as long ago as 1884 the parties chose to appeal to the French jurisdiction, and the case was subsequently dealt with by the French Courts, and he thought he should show his Lordship that all the points raised in the present action were decided in the French action. The last defence set up was that the plaintiffs had not carried out their part of the agreement. The defendants also counter-claimed of the amount found due to them in the French proceedings.

His LORDSHIP: Is there any point about the joint covenant?

Mr. EVE said there was, and he thought it would be convenient to deal with that point before the witnesses were called.

Mr. MOULTON said he did not think that defence was pleaded.

His LORDSHIP said that if the point arose on the documents there was no reason to plead it. He thought that the point went to the whole root of the action, and that he ought to hear counsel upon it at once.

A long legal argument then followed as to whether when letters patent were granted to two persons and one died the grant passed to the survivor. Mr. Fletcher Moulton submitted that the grant of letters patent to two persons was such a grant that if one died his executor took all his rights under the patent.

His LORDSHIP said he would consider his judgment on this point, and the further hearing would be adjourned till after this judgment was given.

Powell v. the Eastern Telegraph Co. (Limited).

In the High Court, before Mr. Justice Wills and a Special Jury, Mr. William Frederick Powell sought to recover damages from the Eastern Telegraph Co. for alleged wrongful dismissal and arrears of salary due.

It appeared that plaintiff entered into the defendant Cmpany's service in 1879 as an operator, and was stationed at Porthcurnow, Cornwall. In April, 1891, he entered into a written contract for five years' service, at home or abroad, and was entitled to three months' notice if defendants wished to terminate the engagement. A book of rules was subsequently issued by the Company, and a copy was sent to plaintiff. By one of these rules it was stipulated that after five years' uninterrupted service abroad an employé was entitled to four months' furlough at home on full pay. In 1893 plaintiff went on service to Gibraltar, and later was drafted to Alexandria, where he stayed till 1898. His health failed at Alexandria, and he suffered from dyspepsia and insomnia, and, having completed his five years' service, he applied for furlough, in accordance with the rule, and this was granted. He came to England in May, 1898, and his leave expired in September. His (plaintiff's) health did not improve during the interval, and he consulted Dr. Peyton, of Newport, where his father resided, and Dr. Peyton advised him that he was not in a state of health enabling him to go abroad. Plaintiff notified the defendant Company of this advice, and asked to be transferred temporarily to an English station, but the Company desired that their own doctor should examine him, and this was done, and in September he received a letter intimating that his leave had expired, and as the Company's doctor had reported him fit for duty, he was to proceed forthwith to Gibraltar. He replied by sending his own doctor's certificate to the effect that he was not in a state to leave England. The Company replied that they could only accept their own doctor's certificate, and ultimately plaintiff declined to enter into a fresh agreement for a further five years' service, and in October he was dismissed.

In cross-examination plaintiff said he did not tell his doctor that he had been offered a post at Gibraltar. He did not inform him to what country he was expected to go. His state of health was the real reason for his declining to go abroad. When he was stationed at Gibraltar previously his health had been good.

Dr. ARTHUR CÆSAR, acting medical officer to the Eastern Telegraph Co., said he saw the plaintiff twice in September, when he complained of dyspepsia and insomnia. Witness was of opinion, however, that he was in good health, and quite fit for duty. He had, however, made no note of the case, and had not sent a report to the Company.

Further evidence showed that the original rules, as supplied to plaintiff in 1891, had been amended, and it was now provided that privilege leave was only granted on condition that the employé returned for a further period of service, and the Company reserved the right to recover the amount of salary paid to an employé while on leave should he fail to return to the service. It had been found necessary to make this new rule, as clerks had frequently taken their four months' furlough on full pay and then declined to return for service abroad. A copy of the rule was posted up in the office at Porthcurnow while plaintiff was there, and it was suggested that he knew the rule. As he declined to contract for a further period of service, the defendants contended they were justified in dismissing him.

The jury found that the order given to plaintiff to go to Gibraltar was an unreasonable one, and that he did not know of the new rule which required employés on coming home on furlough to enter into fresh agreement for service with the Company.

On these findings judgment was given for plaintiff for £112, the amount claimed, and costs.

Ashwell and Nesbit (Limited) v. Stanton.

In the Divisional Court on Friday, before Mr. Justice Wills and Mr. Justice Ridley, Mr. Manisty moved, on behalf of the defendant, Mrs. Stanton, to set aside the findings and judgment of Mr. Pollock, the official referee, in an action tried before him at Leeds, by which he gave judgment for plaintiffs on their claim for £500, and on the defendant's counter-claim. The action was brought by plaintiffs, who are electric light engineers and contractors, at Leicester and Nottingham, to recover £500 in respect of work done under two contracts. The defence was that the work had not been completed in accordance with the terms of the contract, and that it was defective; further, there was a counter-claim that the work was done on the terms of an express assurance given by the plaintiffs that the work should be completed on Nov. 4, 1897, so as to enable the defendant to open certain business premises in Leeds on that date, and that, relying on the faith of that assurance, she incurred large expense in advertising the opening of the premises and engaging assistants; and the work was not completed by that date. The consideration for the promise that the work should be completed on Nov. 4 was that she incurred great expense on the faith of the promise, and if a person incurred expense on the faith of an assurance that gave him cause of action. The referee held that there had been consideration for the promise, but he said the terms of the promise had been complied with, and there had been no breach. His (counsel's) point was that there was a clear breach, having regard to the proper construction of the promise. As a fact, the premises were not ready till December, and the electric lighting was not in order until December 10th. He read the findings of the official referee, from which it appeared that it was not the fittings provided by the plaintiffs which were not completed at the date promised, but a gas engine that had not arrived, and the referee found that it was not the fault of the plaintiffs that the work was not completed. Defendant had, however, contracted with plaintiffs to supply the whole installation complete, and, therefore, he contended that the official referee was wrong in his finding. There was no written contract, but there was a verbal agreement that the whole of the works should be completed and in running order by November 4, and that guarantee was not carried out.

After hearing evidence in opposition to the motion their Lordships held that the referee was wrong and that the plaintiffs gave an unqualified assurance, but final judgment was reserved to enable another point to be considered.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

NEW BOOKS AND EDITIONS.

The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—

NOW READY.

"LABORATORY NOTES AND FORMS."—With the above title we have ready the New Edition of a set of 40 Elementary and Advanced Exercises for use in Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators and Students. The object of this series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

NOW READY.—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnic and other science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper and with less space for tabulated records, are issued at half the price of the original set.

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free; abroad 11s.

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"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new work by Messrs. H. K. C. Fisher and J. C. H. Darby, with the above title, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated. *Second Edition now ready.*

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson, M.I.E.E., &c., fully illustrated; price 12s. 6d.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"ELECTRIC MOTIVE POWER," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s. *New edition ready May 1, 1899.*

"WIRELESS TELEGRAPHY: SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES."—By Dr. O. J. Lodge, with many original illustrations. *Enlarged Edition*, 2s. 6d. net, 2s. 9d. post free.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside *Vol. I.*, 12s. 6d. *Vol. II. ready May 1, 1899.*

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready. Price 7s. 6d.; abroad, 8s.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated price 1s. 6d.; post free, 1s. 9d.

"THE BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH, 1896-97." A valuable, up-to-date compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of genera as well as special information bearing upon the whole subject of electrica discharge research. Price 5s., post free; abroad, 5s. 3d.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free; abroad, 5s. 6d. Prospectus on application.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. A fine large paper edition with wide margins for notes can also be supplied. Price 12s. 6d.; post free, 13s.; abroad, 13s. 6d. *New Edition in the press.*

"THE ALTERNATE CURRENT TRANSFORMER," Vol. I.—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. *New Edition.* Price 12s. 6d., post free. Vol. II., price 12s. 6d. post free, is also ready.

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. Price 7s. 6d., post free.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 8d. each, post free.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s. post free; abroad, 6s. 6d. Digest post free.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d.; abroad, 8s. Prospectus on application.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free; abroad 13s. 6d. Prospectus post free.

"ARMATURE WINDINGS OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s., post free.

"The Electrician" Electrical Trades' Directory and Handbook for 1899.—The "Big Blue Book" for 1899 is NOW READY. The Directory Division has been corrected up to Feb. 8, 1899, and all the latest new names, changes of address, &c., will be found included. The Handbook Division has been much extended, many valuable tables having been added. The volume contains, also, the large Sheet Tables of Electricity Supply Stations and Electric Railways and Tramways, finally corrected to Feb. 9, 1899. The price of the Directory and Handbook remains the same—10s., post free 10s, 9d.; abroad, post free, 12s. (United States 13s. 6d.).

TENDERS INVITED.

As advertised elsewhere, the *Epsom* District Council invite tenders for the supply and erection of: (*a*) Lancashire boilers and fittings, economiser, feed pumps, &c.; (*b*) pipework, &c., in engine and boiler house; (*c*) steam dynamos and motor boosters; (*d*) storage batteries; (*e*) main switchboard and connections; (*f*) overhead travelling crane; (*g*) underground mains and conduits; (*h*) arc lamps and posts; (*i*) street glow lamps and accessories; and (*k*) station lighting. Specifications, &c., may be obtained from the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C., on and after the 10th inst. Tenders to the clerk (Mr. E. G. Wilson), High-street, Epsom, by noon of May 8.

The *Belfast* Electric committee also invite tenders for laying conduits and building junction boxes and for laying cables. An advertisement contains further particulars. Specifications, &c., may be obtained from the city electrical engineer (Mr. Victor A. H. McCowen), and tenders must be lodged at the office of the town clerk (Sir Samuel Black) by noon of Thursday, 27th inst.

The Vestry of *St. Pancras* (London) invite tenders for supplying and fixing additional plant, comprising dynamos, engines, &c., at the Regent's Park electricity works. Further particulars are given in an advertisement, and tenders must be sent to the vestry clerk (Mr. C. H. F. Barrett), Vestry Hall, Pancras-road, N.W., by noon of Tuesday, May 16.

The *Darlington* Corporation invite tenders for the supply and erection of:—(1) Lancashire boilers, with mechanical stokers; (2) engines, dynamos, pumps, pipes, &c., Green's economiser and tools; (3) storage battery; (4) switchboard and boosters; (5) arc lamps; (6) feeders, mains and arc light leads, including roadwork. Further particulars are given in an advertisement. Plans and specifications can be obtained at the office of the borough surveyor. Plans can also be seen at, but not obtained from, the office of the consulting engineer (Prof. Alex. B. W. Kennedy), 17, Victoria-street, London, S.W., and tenders must be lodged with the town clerk (Mr. Hy. G. Steavenson), Town Hall, Darlington, by May 8.

The Vestry of the parish of *St. Mary, Battersea* (London), require tenders for the supply and erection of (1) feeders, distributing mains, and arc light leads (including laying and jointing); (2) watertube boilers; (3) steam dynamos and engines. Tenders to to clerk (Mr. W. Marcus Wilkins), Municipal-buildings, Lavender-hill, London, S.W., by noon, June 7. An advertisement gives further particulars.

The *Hampstead* (London) Vestry require two 500-kilowatt steam alternators, five Ferranti or similar type switchboard panels, boilers, feed-water heaters, feed pumps, a 40-kilowatt exciter, water softening plant, air pump and condenser, economiser, overhead travelling crane, &c. Tenders to the clerk by noon of May 18.

The Town Council of *Reigate*, Surrey, require tenders for (1) two water-tube boilers, economiser, brickwork, and flues, (2) steam exhaust and other pipes, steam pumps, &c., (3) two 100 kilowatt and one 20 kilowatt steam alternator, 8-ton overhead travelling crane, and sub-station equipment, (4) switchboard and instruments, (5) mains, lamp-posts, lamps and fittings. Tenders to town clerk, 84, Station-road, Redhill, by noon May 1.

The *Salford* Electric Light committee invite tenders for the supply of 3,220 yards of 0·2 high tension concentric lead-covered cable, compound insulation. Tenders to the office of the town clerk by 9 a.m. 28th inst.

The *Darlington* Corporation require tenders for the erection of electricity station buildings. Tenders to town clerk by May 8.

The *Southampton* Corporation invite tenders for the reconstruction of about 1¾ miles of tramway. Tenders to acting town clerk by May 2.

The *Wallasey* District Council invite tenders for the supply of electric stores, including meters, insulated concentric cables, main switches and cut-outs. Tenders to clerk, Egremont, Cheshire, by 9 a.m. of 24th inst.

The *Ealing* Council invite tenders for two Lancashire boilers with superheaters and accessories. Tenders to clerk by May 1.

The *Morley* (Yorks) Corporation invite tenders for wiring the public baths. Tenders to town clerk by 4 p.m. 26th inst.

The Visitors' committee of the *Isle of Wight* County Asylum, Newport, invite tenders for a combined engine and dynamo giving an output of 400 amperes at 110 volts. Tenders by 29th inst.

The *Edinburgh* Corporation invite tenders for twelve months' supply of:—(1) steam coal, (2) arc lamp carbons, (3) cast iron pipes, pavement box frames, &c. Tenders to town clerk by 24th inst.

The *Poplar* (London) District Board of Works invite tenders for engine and pump room equipment and all electrical plant except battery; boiler house equipment; battery and battery stands; and public street lighting. Tenders by 10 a.m. April 25.

The *Hull* School Board invite estimates for the installation of the electric light at the central higher-grade school and school of science. Tenders to clerk by 25th inst.

The *West Ham* Council invite tenders for two 1,500 I.H.P. engines, two 800 kilowatt alternators and exciters, Tenders to town clerk by 4 p.m. April 25.

The *St. Marylebone* (London) Guardians invite tenders for the wiring of the new front blocks of their workhouse in Northumberland-street, W. Tenders to clerk by May 8.

The *French* Post and Telegraph authorities invite tenders, until 4th May, for the supply of 666 metres of paper insulated electric cable. Tenders to Le Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle 103, Paris.

Tenders are being invited, until May 18, by the municipal authorities of *Ferrol*, for the concession for the electric lighting o

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the town for 15 years. Particulars from and tenders to el Secretario del Ayuntamiento de Ferrol, Spain.

The Municipal Authorities of *Tarifa* invite tenders until May 16 for the concession for the electric lighting of the town for 20 years. Tenders to el Secretario del Ayuntamiento de Tarifa, Spain.

TENDERS RECEIVED AND ACCEPTED.

Correction.—By a clerical error in our note last week of the acceptance of tenders by the Gloucester City Council it was stated that the British Insulated Wire Co. had been allotted the contract for public lamps. We learn that the tenders for this section of the work are still under consideration.

The following tenders have been received by the Barking District Council for the supply and erection of one 80 kilowatt steam dynamo (vertical high speed engine and two-pole dynamo) with pipe work and accessories :—

Sunderland Forge Co. (*accepted*)	£945	Musgrave and Co. (Thomson-Houston dynamo)	£1,374
Crompton and Co. (Willans engine)	1,790	E. Scott and Mountain	1,255
Willans and Robinson (Crompton dynamo)	1,657	D. Bruce Peebles and Co. (Willans engine)	1,247
Geo. Wailes and Co.	1,612	D. Bruce Peebles and Co. (Alley & McLellan engine)	975
Electric Construction Co.	1,546	Brush Co.	1,226
McClure and Whitfield	1,490	Mavor and Coulson	1,002
Brush Co. (100 kilowatt set)	1,424	Ditto (larger engine)	1,168
Musgrave and Co. (Mather and Platt dynamo)	1,396	General Electric Co.	1,053
		Foote and Milne	1,002
		Ditto (larger engine)	1,030

The Glasgow Corporation have accepted the offer of Messrs. M'Dowall, Steven and Co., for the supply of the lamp pillars to be erected on Glasgow Bridge to carry the trolley wires and arc lamps for the electric lighting of the bridge.

The Southampton Corporation have accepted the tender of the Leeds Steel Works Co., for 1,200 tons of rails and fishplates at £7. 5s. per ton.

The Islington (London) Vestry have accepted the tender of Mr. Oscar Scholzig for the supply of electric light carbons during the ensuing year.

The Shoreditch (London) Vestry have accepted the tender of Messrs. S. Minns and Co. for the supply of boiler fluid for the Lighting committee and that of Messrs. Middleton Bros. for engineer's stores.

APPOINTMENTS VACANT AND FILLED.

The Belfast Electric committee require an assistant electrical engineer. Further particulars are given in an advertisement, and applications must be lodged with the city electrical engineer (Mr. Victor A. H. McCowen), Central Station, East Bridge-street, Belfast, by Tuesday, 25th inst.

The Gas committee of the Keighley Corporation require an electrical engineer to prepare specifications, &c., of an electric lighting scheme. Applications (addressed chairman of committee) to town clerk by May 1.

The Sheffield Corporation require a mains superintendent. Applications to manager and engineer by 27th inst.

The Central London Railway Co. require a traffic superintendent and an accountant. Applications to secretary, 16, Great George-street, S.W., by 29th inst.

Mr. Charles H. Furness has been elected borough electrical engineer by the Devonport Council, the apointment to date from June 1, Mr. Furness in the meantime to gratuitously render such assistance as will not interfere with the discharge of his existing obligations to Messrs. Veale and Co. Out of the applications received the following were reserved for special consideration :—Messrs. A. Arthur Mahood (Hanley), James T. Baron (London), Charles Furness (Plymouth), W. Howard Tasker (London), E. G. Okell (Plymouth), Wm. T. Proctor (Nuneaton), W. R. Wright (Burnley), and J. B. Mitchell (Southend).

Mr. W. C. P. Tapper, who has been for nearly five years one of the chief assistants of Mr. Arthur Wright, at the Brighton Electricity Works, and who has for some time past acted as chief engineer for Mr. Wright in his London work, has been appointed resident electrical engineer to the Whitechapel District Board of Works, to carry out the electric lighting of that district under Mr. Wright's supervision.

Mr. H. Haskayne, assistant superintending engineer for the South Wales district of the Post Office, has been appointed superintending engineer for the North-Western district, in succession to Mr. J. Doherty, retired.

BUSINESS NOTICES.

Messrs. A. W. Jackson and F. J. Coleby (trading as Jackson and Coleby), electrical engineers, 7, Thayer-street, Manchester-square, London, W., have dissolved partnership. Debts by Mr. Coleby, who continues in his own name.

Messrs. F. Hodgson and A. H. Hodgson (trading as Frederick Hodgson and Co.), electrical engineers, 56, Gresham-street, London, E.C, have dissolved partnership.

Messrs. Sax, Slatter and Co. (Limited) ask that all future communications be addressed to Foresters' Hall, Clerkenwell, London, E.C.

The London office of Messrs. W. H. Allen, Son and Co. is now 27, Old Queen-street, Westminster, S.W.

BANKRUPTCIES, LIQUIDATIONS, &c.

In the London Bankruptcy Court, before Mr. Registrar Brougham, Edward Baldwin Pym, electrical engineer, formerly of Scarborough, and now of Burnham, was publicly examined on Friday last, on accounts showing liabilities £3,744, assets nil. Debtor said he had been entitled, under the will of his uncle, to a life interest in £10,000, but that had been terminated by the bankruptcy proceedings. He only owed about £130 in respect of his electrical business. His business at Scarborough was not successful, and he had been concerned in various bill transactions. Examination concluded.

A meeting of the Coventry Electric Tramways (Limited) (in voluntary liquidation) will be held at 17, Hertford-street, Coventry, on May 17, to receive an account of the winding up.

J. E. Stott (trading as James E. Stott and Co.), electrician, 10, Wood-street, Byram-arcade, and 9, Westfield-road, Huddersfield, has been adjudicated bankrupt. First meeting of creditors 24th inst., at 19, John William-street, Huddersfield ; public examination 28th inst., at County Court, Huddersfield.

James Stephen Blackwell (partner in Charles and Blackwell, trading as the Central Electrical and Engineering Co.), 74 and 111, Church Gate, Leicester, and 22, Kennington-road, London, has been adjudicated bankrupt.

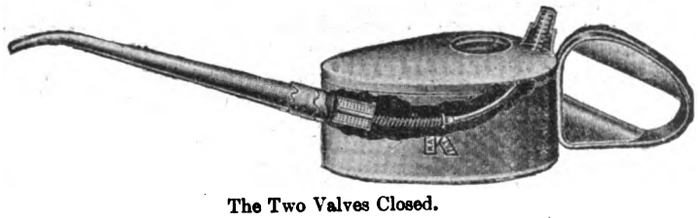
Claims against the London Motor Car Works Co. (Limited) must be in by May 5 to Mr. S. Wheeler, 33, Carey-street, London, W.C.

Sale by Auction.—This day (Friday) Messrs. Wreford and Brown will sell at their auction rooms, 44A, Wilton-road, London, S.W., at 6:30 p.m. precisely, a quantity of shop-soiled and new electric light fittings. See advertisement.

Plant for Sale.—Messrs. Laurence, Scott and Co., Limited, Gothic Works, Norwich, have lathes and a drilling machine for disposal. See advertisement.

Improved Oil Cans.—More than 30 years ago Mr. Joseph Kaye, senior partner in the firm of Joseph Kaye and Sons (Limited), of Leeds and London, first obtained letters patent for

The Two Valves Open.



The Two Valves Closed.

improvements in oil cans. Since this time 20 patents have been granted to him for such improvements. The illustrations we give below show the perfection to which Mr. Kaye's oil can has arrived. Messrs. Kaye were the first makers to produce a seamless oil can fitted with a patent slide feed-hole, and they still claim four valid patents in this connection. One of these is the valve thumb button. This improvement consists in the thumb button being loose (not soldered as hitherto) at the top of the valve spindle. When the pressure of the thumb is released, the spiral spring, within the bell-shaped sleeve A, pushes the button back to its seating—the latter forming a valve and sealing the top of the can. This prevents waste of oil and the possibility of the thumb button being broken off. These useful cans are in use all over the world in thousands, and need no further recommendation. These latest improvements will serve to increase their popularity.

The "Journal."—Part 139 of the *Journal* of the Institution of Electrical Engineers is now ready. Its contents are set out in an advertisement elsewhere.

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"Strand" Watches.—An interesting announcement is made in an advertisement on another page, by Messrs. S. Smith and Son (Limited), the well-known watch and chronometer makers, of 9, Strand, London, with regard to the safeguard offered by the firm to watch buyers by a perfected system of identification, by which the buyer can assure himself that he has the actual watch selected. This enterprising firm also announce that they have adopted a system of payment by monthly instalments for the well-known "Strand" watch, a large number of which are in use by electricians in all parts of the world. A not unimportant point to be observed is that Messrs. S. Smith and Son are actual manufacturers of the goods offered.

Fuel Economisers.—We learn that the "Green" fuel economiser has been selected by the East End Electric Railway Co., New York, in keen competition with other makes of this class of apparatus for use at the extensive power station about to be built by the company. The contract, which we believe to be the largest on record, amounts to about 10,000 tubes. These economisers are manufactured by Messrs. E. Green and Co., of Manchester.

The Duddell Oscillograph.—The Cambridge Scientific Instrument Co., of Carlisle-road, Cambridge, inform us that they are the sole makers of the oscillograph shown by Messrs. Duddell and Marchant at the Institution of Electrical Engineers last week.

Patent Amendment.—As advertised elsewhere Charles Howard, 67, Lerchenfelderstrasse, and Dr. Robert Mayer, 18, Taborstrasse, Vienna, have applied for leave to amend the specification of letters patent No. 23,623 (1897) for "An improved process of manufacturing electric incandescent lamps." Objections must be lodged by May 12.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from April 12 to April 18, with the ports of destination:—

Aden, £150 (including £50 telegraph material). *Argentina*—Buenos Ayres, £1,079 (including £84 telegraph material). *Australasia*—Launceston, £15; Melbourne, £4,516 (including £4,421 telegraph cable); Sydney, £800. *Belgium*—Antwerp, £27. *Brazil*—Rio Grande, £30. *Ceylon*—Colombo, £54. *China*—Shanghai, £152; Tientsin, £25. *Columbia (Republic of)*—Santos, £244 (including £104 telegraph material); *Denmark*—Copenhagen, £110. *Egypt*—Alexandria, £129. *Germany*—Hamburg, £115. *Holland*—Amsterdam, £54; Rotterdam, £35 (telegraph material. *Hong-Kong*, £45. *India*—Calcutta £434; Madras, £197. *Italy*—Genoa, £70; Spezia, £245. *Japan*—Yokohama, £178. *Madeira*—£29. *Mauritius*—£25. *Russia*—St. Petersburg, £10 (telegraph material). *Siam*—Bangkok, £125. *South Africa*—Cape Town, £1,379; Durban, £343 (including £220 telegraph material); East London, £33; Port Elizabeth, £329. *Straits Settlements*—Singapore, £10. Total £10,987, against £30,363 for 12 days last year (April 8 to 19).

MUNICIPAL, FOREIGN AND GENERAL NOTES.

Ambleside.—The question as to whether the Council should establish municipal electricity works or take current from the Windermere and District Electric Light and Power Co. was debated at the last meeting. Mr. C. Hopkinson, the Council's consulting engineer, said he calculated that a municipal scheme would cost about £3,800 and he was in favour of establishing an independent installation. Further consideration has been adjourned for a fortnight.

Bangor.—The Lighting committee on Wednesday reported that they had obtained signed agreements and verbal promises to take electric current from the Corporation to the amounts of 30,360 units and 16,800 respectively (7,160 units more than the amount stipulated for in the resolution passed at the last meeting), and the Council was, therefore, recommended to accept the agreements and promises in lieu of the guarantee by councillors, and to proceed forthwith to erect electricity supply works; also that the report of the engineer (Mr. F. H. Medhurst) be adopted, and that tenders for the work (amounting to £1,3052. 6s. 7d.) be accepted. The committee's recommendations were adopted in their entirety.

Barmouth.—The Board of Trade have intimated to the Council that they have refused Mr. D. Davies' application for a provisional order, but in the event of the Council applying for an order they would not agree to the insertion of any clause giving power to transfer the order to a company.

Beccles.—In a recent report to the Council, Mr. F. H. Medhurst states that there is every prospect of an electricity supply scheme being successful in this town. He estimates the cost of a scheme to provide for public and private lighting at about £12,500.

Belfast.—A sub-committee has been appointed to consider certain proposals made to the Council in connection with the purchase of the Belfast Street Tramways Co. The town clerk (Sir Samuel Black) has prepared a report, and estimates the cost of conversion of the lines into electric lines at £350,000.

Bermondsey (London).—The appeal of the London Electric Supply Corporation against the refusal of the Vestry to sanction the laying of mains on both sides of the streets has been decided by the Board of Trade. With the exception of Bermondsey New-road the mains are to be placed on one side of the street only, where trunk mains already exist, the company are, as far as possible, to lay the new mains under or over the trunk mains, and should the company at any future time require to lay a main on the other side of any street notice must be given to the Vestry.

Bradford.—The borough electrical engineer (Mr. A. H. Gibbings) has been instructed to report upon the revision of the charges to large consumers of electric current for motive power. A sub-committee recommends the acceptance of a tender for new batteries at £3,000.

Cardiff.—Messrs. S. F. Walker and Co. have intimated to the Corporation that they are willing to take electric current for motive power, provided a supply is given at 2d. per unit. A guaranteed minimum consumption of 4,500 units per annum is made. The present charge for current for motive power is 2½d. a unit, and the borough electrical engineer (Mr. N. Appelbee) has been asked to report upon the advisability of reducing this scale.

Cheltenham.—The Corn Exchange is now lighted electrically. Incandescent lamps of an aggregate of 1,200 c.p. are employed and current is taken from the town mains.

Chile.—An Act has recently been passed by the Chilian Congress, empowering the President of the Republic to expend 50,000 dollars on the survey of a line of telegraphs from Punta Arenas to Puerto Montt.

Cuba.—The duty imposed by the United States upon dynamo electric machines, inductors and detached parts is 20 per cent. *adval.*

Devonport.—The Council have adopted a motion in favour of lighting all the main roads in the outer wards electrically forthwith.

Dock Lighting.—The Mersey Dock and Harbour Board have decided to erect arc lamps at the new Canada Graving Dock, at an estimated cost of £700.

Dublin.—Application was made to the Dublin Grand Jury on Monday, on behalf of Mr. J. M'Auley and Mr. W. Mc'Dermott, for approval of a scheme for the construction of an electric tramway between the terminus of the Dublin and Lucan Tramway and Leixlip. The Grand Jury approved the scheme subject to certain conditions.

Dunblane.—Edmundson's Electricity Corporation have submitted proposals for establishing electricity works for Dunblane and Bridge of Allan, and a joint committee of the two Boards of Commissioners are considering the scheme. Gas in Dunblane is 5s. 5d. per 1,000.

Electric Traction in London.—It will be remembered that the London County Council is seeking powers to dispense with standing orders to introduce a Bill to enable the Council to use the trolley, conduit, or surface contact system on the Council's tramways, and to utilise the roads without the consent of the local authorities. Beyond the issue of the usual notices in the *London Gazette*, the Council has not thought fit to acquaint the local authorities of its intention to supersede them as the road authority in this respect. These facts have been brought before the Lambeth Vestry in connection with the Council's application to the Board of Trade for a license to adopt mechanical traction on the Westminster Bridge–Tooting route, and the Vestry have decided to oppose the petition, but the Vestry will consider the application if the form of traction to be used is specified.

Fire.—When the cause of a fire is not easily discoverable it has become the custom to put the blame on "defective electric light wires," and the recent serious fire at Hyde Park Court was no exception to the rule. As will be seen from the following letter from Mr. A. H. Howard, A.M.I.C.E, M.I.E.E., consulting engineer to Hyde Park Court, there was apparently no justification whatever for the assertion:—

"A statement has been widely circulated by the press that the fire at Knightsbridge was caused by a defect in the electric light wires. There is no foundation for this assertion beyond the fact that the fire was first seen in a place where there are several electric light wires. An exhaustive inquiry was held yesterday [Wednesday] by representatives of the insurance companies interested and of the Salvage Corps together with the Directors and officers of the Hyde Park Court Co. Eighteen witnesses were examined, and the unanimous opinion was that the fire first broke out in the turret, which is above everything else in the building, and that it had no connection with the electric light wires. A proof of this lies in the fact that the chief part of the damage was done in the turret and the floor into which the turret opens immediately below, while the fireproof doors and walls effectually prevented the fire from penetrating beyond the part where it originated, viz., the turret and top floor facing Knightsbridge. Electricity has most unjustly become a scapegoat to carry the blame for fires whose origin is obscure, and I trust you will insert this letter to show that in this case it is in no way to blame."

"Free" Wiring.—The Tunbridge Wells Corporation and the Salisbury and the Northampton Electric Lighting Companies have entered into arrangements with the National Electric Free Wiring Co.

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Germany and Japan.—In the recently concluded tariff convention between Germany and Japan the duty on telegraph or galvanised wire of iron or mild steel is fixed at 0·256 yen per 100 catties. All other telegraph wire pays an *ad val.* duty of 5 per cent.

Glasgow.—An inquiry was held here on Wednesday by Sheriff Berry, at the instance of the Lord Advocate on behalf of the Postmaster-General, in which his lordship is asked to intervene between the Post Office authorities and the Corporation as to laying telephone lines under the city streets. Mr. K. Craigie, for the Corporation, said the Postmaster-General urged that he was entitled to the authority to lay the wires whether the Corporation acquiesced or not, and he was not to agree to the condition that the Corporation would only grant that consent provided it was not to be made applicable to the purposes of any private company. The Corporation's position was that it was not judicious to give a company a right to use their streets, because such right would deprive them of the control of the streets. This application was a fraud on the Corporation. Refused permission by the municipality, the telephone company incited the Postmaster-General to apply in his own name. Mr. Fleming, advocate for the Postmaster-General, said that it was the intention of the Government to give permission to lay a junction wire between Douglas-street and the Central Exchange of the company. Mr. Thomas Shaw, Q.C., M.P., contended that there was the same veto against operations by the Postmaster-General as was provided by the Act of 1892 against private companies. Mr. Henry Johnstone, Q.C., said what his lordship had to determine was whether a municipality was entitled to dictate to the Postmaster-General what use he would make of pipes laid down under the streets under his statutory powers. The telephone was part of the telegraph system, and the Postmaster-General had power to grant licences and apply for wayleaves from municipalities. Sheriff Berry announced that he would shortly give his judgment.

Greenock.—Mr. John Young has prepared his report on the municipalisation and electrical equipment of the tramways with great expedition. There is no doubt in Mr. Young's mind that the Police Board could successfully work the tramways within its own boundary, independently of the sections within Port-Glasgow and Gourock. Exclusive of rolling stock, he estimates that to renew the tramways throughout, double the existing single lines, and electrically equip them would cost about £96,400. With the prospect of serving three burghs, representing a resident population of about 85,000, in addition to the large influx of summer visitors, Mr. Young would recommend a 7½ minute service in the thickly-populated part of the route in Port-Glasgow and Greenock, and a 15 minute service on the Gourock end, with augmentations at busy times. The total capital expenditure is put at £159,680, the average revenue for the first three years (at 11d. per mile) at £25,086. 10s., working expenses at £13,689, and after deducting interest, sinking fund and depreciation, there would be a credit balance of £229. 18s. For the following three years the credit balance would be £2,238. 8s., and afterwards £4,633. 8s., on a regularly increasing traffic. The proposal of the Board to grant a lease, with option of purchase, at 14 or 21 years, would be much more costly, as the valuation would be based on the profit-earning capacity of the undertaking, and, accordingly, Mr. Young advises the Board to municipalise the whole system within and without the burgh. Proposals of the Port Glasgow Tramways Co. and Mr. W. M. Murphy are under the consideration of the Board.

Hornsey.—The question of putting the Council's electric light provisional order into force has been referred to a special committee. The chairman said he should oppose the scheme at every stage. Several offers to take over the order have been received, but have been declined.

Hull.—A further loan of £15,500 for electricity supply purposes has been sanctioned by the Local Government Board.

Ibero-American Benevolent Society.—The ninth annual banquet in aid of the funds of this deserving charity will take place at the Hotel Cecil, London, on Friday, May 5, at 7 for 7:30 p.m. The executive committee include the chief Spanish and Spanish-American residents in London, and the stewards include Mr. Ch. Gerhardi, manager of the Direct Spanish Telegraph Co., Winchester House, Old Broad-street, London, E.C., to whom donations may be remitted, and from whom tickets for the dinner can be obtained.

Infirmary Lighting.—The Stockport Infirmary is to be lighted electrically.

Ingleton.—The local electric light company are pushing on with their electric lighting scheme, and it is expected that current will be available by the end of the summer. Water power is to be utilised, the turbines being supplied by Messrs. Gilbert Gilkes and Co., of Kendal. Of the £2,500 capital of the company, £2,000 has been subscribed locally. Gas is 6s. 8d. per thousand in this district.

Ilford.—The Council have adopted Mr. W. C. C. Hawtayne's scheme for the erection of electricity works, and tenders will shortly be invited.

Islington (London).—The Electric Lighting committee are to report upon the question of extending the electric light mains to Hornsey-road (to parish boundary), Stroud Green-road, Crouch Hill, Blackstock-road, Gillespie-road, Drayton Park, St. Paul's-road, Newington Green-road (to parish boundary on Newington Green), Mildmay-road, Mildmay Park, and Ball's Pond-road, and to submit estimates of cost. It is quite time these outlying portions of the parish were afforded an opportunity of adopting the electric light. Supply commenced in January, 1896.

Leyton.—According to a recent report by the electrical engineer (Mr. F. Harman Lewis) the capacity of the electricity supply station, when the extensions in progress have been completed, would be equivalent to 19,000 8 c.p. lamps, and as 13,000 lamps had been already connected, it was advisable to order additional plant at once, the cost of which was estimated at £24,086. He had obtained quotations from the makers of the most suitable kinds of engines, to be delivered and erected by 1st prox. next. Messrs. Willans and Robinson offered two 300 B.H.P. engines at £1,184 each, being £3·87 per brake horse-power. Each engine would supply 5,700 8 c.p. lamps. Messrs. G. E. Belliss and Co. offered two 350 B.H.P. engines at £1,429 each, being £4·08 per brake horse-power. Each engine would supply 6,500 8 c.p. lamps. In order to obtain any of the engines by the date named they must be ordered by the end of the month, and Messrs. Willans and Robinson, whose tender he recommended for acceptance, would take the order on the understanding that approval of the Local Government Board was subsequently obtained. This plant would be a portion of that for the general scheme of extension by steam, which he recommended should be of such size as to contain four 5,700 8 c.p. lamp engines. This would allow three for working purposes, and the capacity would be 17,000 lamps actual, at the consumers' terminals. Taking 60 per cent. as the ratio of the lamps actually supplied at maximum load to those connected to the mains, it would give the capacity of 28,300 lamps connected. The cost of the scheme would be approximately £24,086, and included four boilers, four engines, four dynamos, steam and exhaust pipes, pumps, tanks, &c., overhead crane, switchboard and connections, water softener, condenser, economiser or feed heater, buildings and foundations, mains, service lines, meters, terminal boxes, lamps, columns, &c. Having regard to the urgency of placing the order for two of the engines, the Electric Lighting committee have acted upon the recommendation of Mr. Lewis and placed the order, subject to the Council's confirmation. In addition to the £24,068, the purchase price of the land necessary for extensions would have to be provided for, and the committee recommended that application be made for sanction to a loan of £30,000 to carry out the extensions. The Council have adopted the report of the committee.

Light Railways.—The Board of Trade, on Friday, heard objections to the confirmation of the order granted by the Light Railway Commissioners for the construction of a light (electric) railway between Dundee and Broughty Ferry. The objectors were the Caledonian and the North British Railway Companies. Mr. Littler, Q.C., who appeared in the case, said he did not know why the promoters, who hailed from Leeds, should come marauding into Scotland to plunder the railway companies. The distance between Dundee and Broughty Ferry was about 3½ miles. The proposed light railway would not serve any new traffic, and it was a speculative scheme. Mr. Balfour Browne contended that under Sec. 9 of the Light Railways Act this order should not be confirmed. An application on behalf of the promoters for an adjournment till 29th inst. was agreed to.

The Hornsey Council have decided to apply for sanction to construct a light (electric) railway along the Archway-road to connect with the London County Council's system at the foot of Highgate Hill.

Light Railways along Main Thoroughfares.—In the House of Commons, on Tuesday, Sir J. W. Maclure asked the President of the Board of Trade whether his attention had been called to the issue of orders for the construction of light railways along main thoroughfares in populous districts; and whether he would consider the propriety of suspending any further orders until the opinion of the law officers of the Crown as to the legality of the action of the Board and of the Light Railway Commissioners could be ascertained. In reply, Mr. Ritchie said the Board of Trade were advised at the outset upon the legality of the course that had been adopted—a course which had now become well-settled practice.

Maidstone.—Electric lighting matters do not make much progress in this town. Reports from the Electric Lighting committee and the consulting engineers (Messrs. Kincaid, Waller and Manville) were considered at a recent meeting of the Council, but no decision was arrived at. The Maidstone provisional order was obtained in 1892.

Manchester.—According to the estimates of the Electricity committee for the current year an income of £82,500 is anticipated. After meeting all expenditure it is expected there will be a surplus balance of £8,115, and by adding £2,000 from last year, there will be

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a total disposable balance for the year of £10,115, of which £10,000 will be paid to the city fund. In the year just closed there was an actual profit of £16,754, out of which £12,000 was paid to the city fund, the remainder being held over. The estimated expenditure on capital account for the year is £203,400, the principal items being Dickinson-street station £26,900, Bloom-street station £18,200, Stuart-street station £40,000, cable stores £10,000, and mains £86,200. For street lighting there is an estimate of £2,000. receivable from the city fund.

In the estimates of the Tramways committee an item of £3,000 figures for sample electric tramcars.

Mile End (London).—£30 has been voted by the Vestry to enable inquiries to be made as to the advisability of establishing electricity supply.

Mill Lighting.—The electric light is to be introduced into the Lucknow (India) Paper Mills. "Safety, economy and efficiency are the grounds upon which this decision has been arrived at." At present kerosene oil lighting is employed.

Municipal Trading.—The Plymouth Mercantile Association approves the proposed parliamentary inquiry to define the limits of municipal trading.

Newcastle-on-Tyne.—The Tramways committee recommend the Council to appoint a permanent electrical engineer at a salary not to exceed £500 per annum in order to supervise the construction of electric tramways under the consulting engineer, Mr. C. Hopkinson.

Oswestry.—Mr. W. C. C. Hawtayne has been retained by the Council to report on the advisability of purchasing the undertaking of the Oswestry Electric Light and Power Co.

Paddington (London).—No objection is to be made by the Vestry to the proposal of the Metropolitan Electric Supply Co. to lay electric light mains in Shirland and Croxley-roads and Saltoun-crescent. The company also propose to lay mains in a number of streets in the northern part of the parish.

Paignton (Devon).—The Council have appointed a committee to report upon a scheme submitted by a company for the electric lighting of the district.

Perth (W.A.).—Rapid progress is being made with the work of constructing the electric tramways in this town, and it is anticipated that the first section will be completed by July 1.

Private Bill Legislation.—The Charing Cross, Euston and Hampstead Railway Co. has been ordered for third reading in the House of Commons.

The Central London Railway Bill was read a third time in the House of Commons on Tuesday.

Opposition has been withdrawn to the Kensington and Notting Hill Electric Lighting Bill, and it will now go forward as an unopposed measure.

The House of Lords has passed the preamble of the Glasgow Corporation Tramways Bill, under which the Corporation seek powers to extend their tramways into a number of areas outside the municipal boundary. The Corporation have come to an agreement with the Paisley Corporation to acquire the tramways in Paisley three years hence, and the Glasgow Corporation will work the lines as well as the tramways running through Renfrew and connecting Glasgow with the Paisley system.

Ramsbottom (Lancs.).—The newly-elected chairman of the Council (Mr. J. Garnett) suggests that an electrical expert should be engaged to prepare an estimate of the probable cost of lighting the town electrically. He thinks an electric lighting scheme would prove remunerative.

Richmond (Yorks.).—The Council has recently discussed a report, prepared by Mr. A. A. Campbell Swinton, on the proposal to establish electricity works. Mr. Swinton points out that it is questionable whether sufficient support could be obtained for such an undertaking, and the Council has decided to postpone further consideration of the matter.

Ripley.—The advisability of erecting electric supply works is to be considered and reported upon by a special committee of the Council.

St. Pancras (London).—The Vestry have sanctioned an expenditure of £5,500 for a cable to connect up the Regent's Park and King's-road stations so that the latter may obtain current from the former in case of need.

Seville.—The entire tramway system of this city is being converted to electric traction. Heavier rails are being laid, and the lines are being largely extended. The plant and material are mainly German, the tramway company being a German concern.

Shoreditch (London).—The Vestry have decided, at the suggestion of Mr. C. Newton Russell, chief electrical engineer, to establish two new arc light circuits, each to comprise 20 lamps, at an estimated expenditure of £2,350. The Lighting Committee have been requested to further consider a proposal to obtain the arc lamp columns, lamps and switches from former contractors.

Soudan Telegraphs.—In the report on Egypt, by Lord Cromer, just issued from the Foreign Office, the following particulars respecting Soudan telegraphs are given :—

"The Soudan telegraph system south of Khartoum will be extended up the east bank of the Blue Nile to Abu Haraz. Thence a branch line will be carried to Gedarif, which will be connected with Kassala. A second line will run from Abu Haraz to Sennaar, the Blue Nile being crossed by means of a cable. From Sennaar the line will run to Abba Island on the White Nile, and thence up the river to Fashoda and the Sobat. These extensions will require about 1,000 miles of wire. The greater portion of the wire has been already sent to the Soudan. Work is proceeding on the Kassala-Gedarif section. An arrangement has been made as to the rates to be charged on through telegrams passing over the Soudanese and Egyptian lines in the event of telegraphic communication being established with South Africa."

Teddington.—The Council have unanimously decided to apply for a provisional order.

Telegraphs in East Africa.—The Belgo-German South Cameroons Co. has been amalgamated with the British Mozambique Co. in order to build a railway and erect a telegraph from Beira to the British possessions on the Zambesi. The company has a capital of 25,000,000f., with headquarters in Lisbon, and branches in London, Paris and Brussels.

Theft of Cable.—At the County of London Sessions on Saturday Mr. Loveland sentenced John Williams, James Smith and William Clark to 8, 4 and 12 months' imprisonment respectively for stealing a large quantity of electric light cable, value £170, from the Crystal Palace District Electric Supply Co.

The Government Telephone Proposals.—The Cardiff Chamber of Commerce decided on Wednesday to memorialise the Government against the Telephone Bill and in favour of a system with one central authority.

The Hyde Park Court Fire.—In connection with the fire which occurred at Hyde Park Court, London, this week (referred to in another column), Commander Wells, chief superintendent of the Metropolitan Fire Brigade, stated at an inquiry into the cause of this conflagration that had the "call" reached headquarters more promptly a large proportion of the property destroyed might have been saved. In this connection it is stated that few metropolitan buildings and not one metropolitan theatre possesses a "fire alarm," and that the ignorance of the general staff as to where one if wanted could be found is general. The *Daily Telegraph* points out that this is an important point for theatre managers to consider in order that this omission may be remedied.

Warrington.—The Council have instructed the town clerk to submit a tender for the wiring of the workhouse and to offer to supply electric current for lighting the building at 5d. per unit. The consulting engineer (Mr. A. H. Preece) has been authorised to proceed with the working drawings of the electricity supply works.

Woking.—The Council and ratepayers are to have the assistance of Major Cardew in dealing with the vexed question of electric lighting. The proposal to purchase the undertaking of the Woking Electric Supply Co. was recently rejected by the casting vote of the Chairman, and a meeting of ratepayers was held last week to consider the position. Major Cardew, who is a resident in the district, attended, and said he thought the present company had been somewhat harshly treated in regard to the light they supplied. He thought that for a small country station, and such a district as Woking, there was little to find fault with it. He held an inquiry the other day in a very much bigger place than Woking, where there had been a total cessation of supply during the greater part of October, owing to a large station being run with only one engine. If the Woking undertaking were purchased, there was a great deal of money for which no possible return could be expected, and there was a good deal of money required to put the whole thing into an up-to-date condition. They must negotiate, if they negotiated at all, with the idea of purchasing the whole of the mains and the station. Then they would have to face the Local Government Board, and he thought they would probably find a good deal of opposition, and apart from local opposition there would be the question for the Local Government Board to decide of whether they could allow the rates of Woking to be burdened in any way for works in another parish. Big Corporations like Manchester had got powers to supply neighbouring districts, but they could hardly compare Woking with Manchester. It was not as if they had a self-contained thing, or were applying for an order themselves, and starting from the beginning. He thought it would be undesirable to begin what, in his opinion, would be a fruitless negotiation. He considered the district was one in which the electric light ought, properly managed, to be a very great success, because they had a neighbourhood in which a good class of building was continually going on. As soon as people had confidence in the light, houses would be wired as a regular thing. A resolution in favour of opening fresh negotiations was carried, Major Cardew acting as scrutineer.

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PATENT RECORD.

The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. CHAPMAN and Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs and Trade Marks may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application an asterisk is affixed.*

March 10, 1899.

5,250. C. W. HILL. Oldham. Automatic electric brake.
5,255. R. F. HALL. Birmingham. Improvements in electrical switches.*
5,262. R. F. HALL. Birmingham. Improvements in electrical tumbler and other switches.
5,279. J. A. L. DEARLOVE. London. Improvements in electric cables.
5,296. G. S. FORT and A. FORT. London. A method of distinguishing electric and other switches in the dark.
5,322. J. H. LAMPREY. London. Improvements in or in connection with apparatus for the production of ozone by electricity.

March 11, 1899.

5,341. A. WATSON. Birmingham. Improvements in tumbler switches for electrical purposes.
5,356. H. BENNETT. Keighley. Improvements appertaining to electric arc lamps.
5,374. J. J. STANGER. London. Improvements in and relating to electro-therapeutic bath and the like.*
5,392. H. A. EARLE. London. Improvements in controlling switches for electric motors.
5,398. E. BEDE. London. Improvements connected with electric traction.*

March 13, 1899.

5,416. J. J. WALKLATE. Birmingham. Improvements in spring break switches for electric currents.
5,464. P. SCHARF. London. Means for rendering electrically conductive incandescence bodies which conduct only when their temperature is raised and apparatus therefor.
5,468. A. ZIMMERMANN. London. Improvements in the electro-deposition of metals. (Dr. Courant, Germany).

March 14, 1899.

5,486. G. C. ALLINGHAM and W. FENNELL. London. Improvements in electric incandescence lamps.
5,514. G. W. MORGAN. Aberdeen. Improved electric light apparatus for taking photographic portraits.
5,518. T. B. KINRAIDE. London. Improvements in electric spark gap apparatus.*
5,519. T. B. KINRAIDE. London. Improvements in electric break apparatus.*
5,543. B. S. COHEN and P. H. COLE. London. A multiplex selective system of "wireless telegraphy."

SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1898.

6,633. COOKE and IRELAND. Apparatus for indicating the charge in a secondary battery.
7,199. TATE. Wall socket and plug for electrical fittings.
7,283. HARRISON. Miners' lamps and apparatus for electrically lighting the same.
7,333. MÉRIAN. Construction of plates for electrical accumulators or storage batteries.
7,470. WISE (Solvay and Co.). Effecting electrolysis.
7,471. WISE (Solvay and Co.). Electrolysis.
8,054. MOORES and FARRELL. Means for fixing or fitting incandescent electric lamps into lanterns.
8,140. WRIGHT. Switches for electric circuits. (Date applied for under International Convention, September 18, 1897.)
8,142. LAMME. Systems of electrical distribution. (Date applied for under International Convention, Sept. 18th, 1897.)
8,348. HEAP. Electrical measuring and indicating instruments.
8,391. DAVIS. High-tension transformers and induction coils for Röntgen ray work and for other purposes.
9,002. BROCK and THE UNITED ALKALI Co. (LIMITED). Apparatus for the manufacture of potassium, chlorate, or sodium chlorate by electrolysis.
10,428. MARTIN. Electro-therapeutic exercising apparatus.
10,710. WEISS. Dry battery.
11,858. KING. Manufacture of elements or plates for secondary batteries or electric accumulators.
12,313. KING Secondary batteries or electric accumulators.
13,569. BARKER. Jointing electric cables.
14,548. BOWLES. Electrical contact makers.
15,801. LEIMER. Electric accumulators.
15,802. LEIMER. Electric accumulators.
18,552. CAPEWELL. Motor-trucks for electric and other railways or tramways, and driving gear therefor.
19,824. COTTERELL. Means or apparatus for facilitating calculations relating to secondary electrical batteries.

COMPANIES' MEETINGS AND REPORTS.

The Consolidated Telephone Construction and Manufacturing Co. (Limited).

The adjourned extraordinary meeting of this Company was held yesterday (Thursday) to continue the business adjourned from August 18 last and to consider a report made by the committee then appointed. Mr. C. L. W. FITZGERALD presided.

The CHAIRMAN referred to the question of proxies and to the issue of the report, and said that no doubt a member of the committee would make some remarks.

Mr. W. R. LAWSON (a member of the committee) stated that on behalf of the committee proxies had been sent in favour of their report representing 63,000 shareholders, while the proxies obtained by the Chairman represented only 40,000. They would remember that at the meeting last August the Directors suddenly and unexpectedly brought forward a proposal that the Company should be wound up voluntarily. The shareholders declined to act on this suggestion, and appointed a committee which had held many meetings, and, with the assistance of two of the Directors, had obtained a considerable amount of information as to the working of the Company during the past few years. At a very early stage it began to be evident that if the Company were to survive at all, the management would have to be very considerably changed. After several failures the committee got into communication with a gentleman of technical knowledge, Mr. Hubert Jackson, whom they all agreed in regarding as highly suitable for serving the Company. It had seemed to the committee that there was not only a great want of expert management in the Company, but also considerable room for more business management. The committee, therefore, proposed that two of the Directors, who had endeavoured to keep the existing management right, and were not always agreed with the Chairman, should remain, and that room should be made for two new Directors. That was the whole business before the meeting now. He concluded by moving a resolution, "That the committee's report be adopted, and that the voluntary winding up proposed by the Directors was unnecessary."

Mr. F. C. STOOP seconded the motion.

The CHAIRMAN said he was accused of mismanaging the business. His colleagues took the management out of his hands in 1892. That being the case why did not the whole Board resign, and why should he be personally attacked? He had done his best for 15 years for the shareholders, and had sacrificed he did not know how many thousands of pounds in connection with the Company. He honestly believed that the Board had done their utmost to serve the interests of the shareholders. The committee's report and letter reached the shareholders on April 7; there was a Board meeting on the 10th, and his reply was in the hands of the shareholders on the 15th. Through Mr. Grewing and Sir Alexander Armstrong, the committee pressed him so hard to fix the date of a meeting, before their report came out, that at last he did so, and on March 24th the present meeting was fixed. The committee's report, however, was ready on March 15th. Why was its issue delayed? While the committee had been squabbling the Directors had been making money, and that without any recommendations of the committee being carried into effect. It seemed to him that what he had proposed in the course of his reply would be the much better course to take. He might state that he had strongly objected to their electrician leaving them. It had been said that it was he who nominated Mr. Menzies as general manager, but that was not the case, as shown by the resolution of the Board, which was in his circular. He asked the shareholders whether it was not strange that the Company was in such good order if there had been the lax management which had been suggested by the committee. All that the Company wanted was orders. Apart from the question of the Directors, the Committee's report amounted to this:—Appoint an electrician, appoint a works manager, get a traveller. His (the Chairman's) proposal was exactly to the same effect. He believed that a new era had dawned in the telephone world. The Post Office were going to compete with the National Company, and that was a fact which altered everything. It did not matter to him if the shareholders chose to dispense with his services, although he was willing to serve them if they desired it.

After a few remarks from Mr. DRUCKER,

Mr. A. H. BAKER said the committee stated that when the meeting was called for August 18 the proposal of the Directors was to wind up the Company, but he (the speaker) emphatically denied this. Acting under a promise given to Mr. Stoop, with the pressure of Mr. Grewing, that meeting was called. The competition was then so keen and so great on the part of foreigners, who were not trammelled by trades unions, that the Company were practically making no money, and the Directors honourably and straightforwardly, as trustees for the shareholders, brought the question of liquidation before the latter; but he was at a loss to understand how Mr. Stoop and Mr. Lawson could state that the Directors suggested the liquidation of the Company. The prime mover for winding up the Company was Mr. Stoop, whom the Directors had fought, and whom they would continue to fight if they remained on the Board. Since August 18 the Postmaster-General had given his consent to competitive telephones in municipalities. The whole state of matters had thus been altered. There would now be an enormous demand for telephones, although he could not say whether the demand would be at prices profitable for the company. The reason why the Directors brought the shareholders together last August had now passed away. He was strongly against the liquidation of the Company, owing to the change that had taken place, and he looked forward to there being some return for the shareholders. The committee stated that the Company had not a standard telephone, but

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who were their customers? The Post Office and the large railway companies, and when they tendered for work which they required done for them, the Company manufactured the article they required.

Mr. WOOLLEY supported generally the action and recommendations of the committee.

Mr. BAKER said a resolution for the liquidation of the Company had never been before them.

Col. WEST moved an amendment: "That the report of the committee be received and their suggestions carried out in the mode proposed by the Chairman in the first five paragraphs on p. 4 of his circular" (which was before the meeting).

This was seconded and further discussion followed. Eventually the Chairman put the amendment, in favour of which 10 voted for and 11 against. He afterwards put the original motion, for which 11 voted for and 6 against.

The proceedings then terminated.

Eastern Extension, Australasia and China Telegraph Co. (Limited).

The report of the directors of this company, for the half-year to Dec. 31 last, states that the gross receipts have amounted during the half-year to £290,431 1s. 9d., against £275,142 7s. 2d. for the corresponding period of 1897. The working and other expenses, including £26,045 1s. 7d. for cost of repairs to cables and expenses of ships, absorb £100,085 18s. 5d. against £102,844 13s. 10d. for the corresponding period of 1897, leaving a balance of £190,345 3s. 4d. From this is deducted £4,698 19s. for income tax, £31,921 5s. for interest on debentures, debenture stock, and contribution to sinking fund, &c., leaving as net profit £153,724. 19s. 4d., which, with £10,723. 1s. 9d. brought forward, gives an available balance of £164,448. 1s. 1d. One quarterly interim dividend of 1½ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount on 27th inst., making, with interim dividends, a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1898. The balance of £51,948. 1s. 1d. has been transferred to general reserve.

The policy of gradually renewing weak portions of the company's system has been steadily pursued. The cost of the renewals, amounting to £56,805. 12s. 1d., has been charged against general reserve.

Having been advised that, according to International Law, the United States are bound to take over the obligations which Spain entered into with the company in regard to telegraphic communication in the Philippines, the necessary representations have been made through diplomatic channels to the Government of the United States on the subject.

The development of the insurrection in the Philippines having made it impossible to maintain efficient telegraphic communication, the company were for a short time compelled to close all their stations in the islands of Panay, Negros and Cebu, and withdraw the staff to Manila. Since the close of the year the Panay-Negros cable has been re-opened for public traffic, and, by arrangement with the Government of the United States, the company's Manila-Capiz cable has been extended to Ilo-Ilo direct, thus making the latter communication independent of the unsatisfactory land-lines between Capiz and Ilo-Ilo.

Cuba Submarine Telegraph Co. (Limited).

The report of the directors for the half-year ended Dec. 31 states that the receipts were £27,483. 17s. 11d., and the expenditure £7,585. 1s. 9d., leaving £19,898. 16s. 2d., which, added to the balance of £3,713. 11s. 6d. from last account, leaves £23,612. 7s. 8d. to credit of revenue. The traffic receipts show a considerable increase, compared with the corresponding period of last year, owing to the exceptionally heavy Government traffic consequent on the Spanish-American war. £10,000 has been added to reserve, which now stands at £120,000. The dividend on the Preference shares will absorb £3,000, and leave £10,612. 7s. 8d., out of which the directors recommend a dividend at the rate of 6 per cent. per annum, and a bonus of 2s. per share on the Ordinary shares, both free of tax, the balance (£4,212. 7s. 8d.) being carried forward.

At the date of the last report, the cables broken during the war had been repaired, with the exception of the Cienfuegas-Casilda cable and the 1891 cable between Cienfuegas and Batabano. The repairs to these have been completed during the current half-year, and the cost of the whole will form the subject of a claim against the United States Government, which will be put forward as soon as the accounts have been prepared.

Oriental Telephone and Electric Co. (Limited).

The directors' report for the year ended Dec. 31 states that revenue shows a credit balance of £10,955. 3s. 9d. transferred to profit and loss. Including £964. 8s. 3d. brought forward, and after deducting £2,858. 8s. the amount of interim dividend paid in November last, there remains £9,061. 4s. for disposal. The directors propose to pay a final dividend of 8d. per share, free of tax, making 5 per cent. for the year, to transfer £2,000 to reserve, and carry forward £1,344. 8s.

With regard to the Indian subsidiary companies, the Bombay Company has again paid 6 per cent. for the year, whilst the Bengal Company has paid 5 per cent., against 7 per cent for the previous year, carrying forward Rs.20,000 as a precautionary measure against possible temporary outlay. The Telephone Company of Egypt has declared its usual dividend of 6 per cent. on its Preferred shares. This Company has recently entered into an agreement with the Government of Egypt to continue the Government Telephone service for a period of 25 years from Jan. 1 last. Its business in general progresses favourably. The China and Japan Telephone Co. has paid its Debenture interest, but its accounts for the past year have not yet been audited. They point, however, to a larger surplus than in previous years.

With a view to improving the telephone service at Shanghai, which would have involved a large expenditure of money, the directors approached the Council of the Shanghai Settlements some years ago to obtain, if possible, a prolonged term of concession so as to justify the outlay. The Council has now decided to grant a 30 years' concession, but has invited tenders by public advertisement. The directors of the China and Japan Co. have sent in a tender, but the result so far is not known.

The electric lighting branch of the Company's business shows a small surplus, which has been carried meantime to a suspense account to provide for expenses in connection with a change of management now being proceeded with in Calcutta.

Submarine Cables Trust.

The report of the trustees for the financial year to April 15 states that the revenue, including balance of £20. 3s. brought forward, amounted to £21,476. 2s. 3d. Expenses amounted to £1,108. 10s. 6d., and payments on account of coupons £20,286 (together £21,394. 10s. 6d.), leaving £81. 11s. 9d. to be carried forward.

The Brazilian Submarine Telegraph Co. (Limited), having entered into an arrangement with the Western and Brazilian Telegraph Co. (Limited), offered some of their shares in exchange for those of the latter company, held by the trust on the basis of five Ordinary shares of £10 each in the Brazilian Company for every six Ordinary shares of £15 each in the Western and Brazilian Company, and the trustees decided to assent to the proposed exchange, which has since been carried into effect. Certificate holders will be asked to confirm the resolution and sanction such exchange.

EDWARDS' PUMP SYNDICATE (LIMITED).—At the meeting on Tuesday Mr. C. W. Milne said they were on the eve of a tremendous development in electrical engineering, and it was satisfactory that no pump in the market that they knew of was better than theirs for running at high speeds. Conversations with electrical engineers had convinced them that when the time came their pump would meet with great favour. In some of the largest corporation electrical installations their pump had been specified for.

GREAT NORTHERN TELEGRAPH CO. (LIMITED).—The gross receipts for the year 1898 of this Company amounted to £402,795. 16s. 3d. After deducting £23,474. 14s. 9d., loss on exchange, and including a balance forward of £61,057. 17s. 10d., the total revenue account for the year was £463,850. 14s. 1d. Working expenses, &c., amounted to £85,130. 17s. 5d., leaving £378,722. 10s. 8d. An interim dividend of 10s. per share was paid absorbing £75,000, and a final dividend is now proposed of 15s. per share absorbing £112,500. £116,666. 13s. 4d. is added to reserve and renewal fund, £3,888. 17s. 9d. to the staff pension fund, and £61,417. 5s. 7d. is carried forward.

NATIONAL ELECTRIC FREE WIRING CO. (LIMITED).—At a confirmatory meeting of the shareholders held at the offices on Wednesday the resolution set out in our issue of March 31 altering the name of the company to the "National Electric Wiring Co. (Limited)" was approved.

WOODLANDS ELECTRIC CO. (LIMITED).—The first annual meeting of this company was held on Monday, when dividends were declared at the rate of 6 per cent. upon the Preference and 1½ per cent. upon the Ordinary shares.

NEW COMPANIES, STATUTORY RETURNS, &c.

ADAMS-RANDALL TELEPHONE PATENTS (LIMITED).—This company was registered on April 11, with a capital of £60,000, in £1 shares (of which 10,000 are £6 per cent. Cumulative Preference), to enter into an agreement with Mr. Charles Adams-Randall, to acquire, develop, work and deal with certain patents, and to carry on the business of a telephone, telegraph and electric light, heat and power supply company. The first subscribers (with one share each) are:—J. C. Hulbert, W. H. Parker, E. J. Broadbent, W. Lloyd, J. C. Colledge, J. S. Hall, and T. G. Holloway.

COMPASS TRADING CO. (LIMITED).—This company was registered on April 14 with a capital of £5,000, in £1 shares, to acquire the business of an engineer, general and financial agent and contractor, carried on by Mr. Edward Mann, and to carry on the business of general engineers, contractors, telegraph, telephone, electric light and engine makers, manufacturers of electrical apparatus, &c. The first subscribers (each with 100 shares) are:—C. A. Rollason, W. H. Fletcher, A. W. Paul, E. T. Pimm, E. J. Hale, G. R. Rollason and William F. Fearn. The first directors are:—Edward Mann, W. H. Fletcher, and one to be nominated by the subscribers.

HEATON AND SMITH (LIMITED).—This company was registered on April 14th with a capital of £25,000, in £10 shares, to acquire and carry on the business of electrical engineers and manufacturers of electrical apparatus carried on under the style of Heaton, Smith and Co. The first subscribers (with one share each) are:—F. W. Heaton (electrical engineer), H. Smith (electrical engineer), J. Eades, R. Heaton, T. L. Marsden, J. A. Shaw, and R. Watkinson. The first directors are the first three subscribers.

LANCASHIRE DYNAMO AND MOTOR CO. (LIMITED).—This company was registered on April 11, with a capital of £100,000, in £100 shares, to carry on the business of mechanical, electrical and hydraulic engineers, manufacturers of machinery, tool and boiler makers, metal founders and workers, and to manufacture, buy, sell, let and deal in apparatus and appliances of all kinds used in connection with the generation, distribution, supply, accumulation and employment of elec-

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tricity. The first subscribers (with one share each) are:—N. Kilvert, H. V. Kilvert, A. Tongue, W. Cherry, E. Pilkington, W. W. Pilkington, and A. P. Wood. The first directors are:—N. Kilvert, H. V. Kilvert, W. Cherry, and A. Tongue.

VAUGHAN AND SON (LIMITED).—This company was registered on April 15 with a capital of £50,000, in £1 shares, to carry on the business of mechanical and electrical engineers, machinists, tool makers, and manufacturers of and dealers in all kinds of cranes and hoisting apparatus actuated by electricity, steam, or other power, dynamos, electric motors, all kinds of electrical apparatus, engines, boilers, &c. The first subscribers (each with one share) are: William H. Vaughan (engineer), John T. Vaughan (engineer), T. Foster (engineer), J. Markham, Mrs. E. Markham, Mrs. G. T. Sadler, Miss H. Vaughan. The first directors are:—William H. and John T. Vaughan and T. Foster.

BIRMINGHAM ELECTRIC SUPPLY CO. (LIMITED).—According to the annual return to March 22, the whole nominal capital of £200,000, in £5 shares, has been taken up and paid for in full.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LIMITED).—The annual return to Aug. 8, 1898, was filed on Feb. 14, when 20,007 shares were taken up out of a capital of £250,000, in £10 shares. 20,000 are considered as fully paid, and 5s. per share has been called and paid on the remaining seven shares.

BRITISH COLUMBIA TELEPHONES (LIMITED).—The statutory return to Feb. 7 has been filed. The capital is £100,000, in £10 shares (of which 3,000 are Preference). 2,000 Preference and 3,000 Ordinary shares have been taken up, and the full amount has been called on the former, while £7. 10s. per share has been called on the latter.

NORWICH ELECTRICITY CO. (LIMITED).—The annual return to March 16 has been filed. The whole nominal capital of £50,000, in £10 shares, has been taken up and paid for in full. The capital has since been increased to £100,000 in £10 shares.

CITY NOTES.

MEMORANDA.—Bank rate 3 per cent. (since Feb. 2, 1899). Price of silver 27⅜d. per oz. (April 20). Consols (2¾ per cent.) 110½—110¾ for money, 110$\frac{11}{16}$—110$\frac{13}{16}$ for account; 2½ per cent. 103⅜—103⅝ (April 20), Stock Exchange Settling Days: Consols, May 4; Stocks and Shares Continuation Days, April 25 and May 10; Ticket Days, April 26 and May 11; Pay Days, April 27 and May 12; Mining Share Carry over Days, April 24 and May 9.

ANGLO-ARGENTINE TRAMWAYS CO. (LIMITED).—A meeting will be held to-day (Friday) to approve an agreement for the conversion of the existing horse tramways into overhead trolley lines.

SOCIETE ANONYME L'ACCUMULATEUR SEC.—An ordinary general meeting of this company will be held at Brussels on May 4.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has appointed Wednesday, the 26th inst., a special settling day for £233,334 First Mortgage Four per Cent. irredeemable Debenture stock of *Doulton and Co. (Limited)*. The Committee has been asked to allow this stock and 233,334 Five per Cent. Cumulative £1 fully paid Preference shares (Nos. 516,667 to 750,000) in the same company to be quoted in the official list. The Committee has also been asked to appoint a special settling day in 29,935 £5 vendor's Ordinary shares (fully paid), and a further issue of 40 £5 fully paid Ordinary shares in the *British Insulated Wire Co. (Limited)*, and to appoint a settling day in and to grant a quotation to 50,000 £1 Ordinary and 60,000 Six per Cent. £1 Cumulative Preference shares in *Davis and Timmins (Limited)*.

WEST INDIA AND PANAMA TELEGRAPH CO. (LIMITED).—The estimated traffic receipts of the Company for the half month ended April 15 are £2,141, compared with £2,541 in the corresponding period of 1898.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec.	No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec.
	1899	£	£		£	£
*Birmingham Tramways.	Apr. 15	3,865	− 275	14	57,173	+ 4,284
Blackpool Corporation...	...	...	...	...	...	...
Blackpool and Fleetwood	" 15	222	...	15	3,346	...
Bradford Corporation ...	...	..	...	...	...	...
*Bristol Trams & Carriage	" 14	2,543	− 730	15	38,709	+ 2,003
City & South London Ry.	" 16	1,050	+ 105	16	17,301	+ 530
Dover Corporation	" 15	151	− 29	2	415	...
Dublin United (Southern)	" 14	656	− 44	15	9,723	+ 3,470
*Glasgow Corporation ...	" 15	8,282	+ 216	...	...	...
Liverpool Corporation						
Dingle Route	" 8	575	...	21	10,935	...
Prince's Park Route...	" 8	401	...	12	3,840	...
Liverpool Overhead Rly.	" 16	1,404	− 332	16	21,394	− 637
*Sheffield Tramways.....	" 16	1,159	+ 74	15	18,067	+ 3,876
*South Staffs. Trams......	" 14	614	− 242	15	9,203	+ 265

* Partly electrical.
The corresponding week last year included Easter Monday.

ELECTRICAL COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price April 12.		Price Wednesday, April 19.		Rate per Cent. Yielded.	Dividends Due.	Business Done During Week Ending April 19. Highest	Lowest
			TELEGRAPHS.					£ s. d.			
£124,400	100	4%	*African Direct Telegraph 4% Mort. Deb. (red)	101	104	101	104	3 16 11	January and July	..	..
25,000	10	—	Amazon Telegraph	3	4	3	4	—	June and December..	—	—
£125,000	100	5%	Do. 5 per Cent. Debentures	87	92	87	92	5 6 5		—	—
£905,56[illegible]	Stock	15/0	Anglo-American xd	65	68	69	68	5 9 6	Feb., May, Aug., Nov	65¼	6[illegible]
3,047,32[illegible]	Stock	30/0	Do. Preferred xd	118	119	119	11[illegible]	5 8 1	" "	117½	11[illegible]
3,047,550	Stock	18/0	Do. Deferred	14	14½	13	14½	6 13 4	—	14½	13
2[illegible]5,[illegible]1	10	8/0	Brazilian Submarine	15½	16½	15	16	5 7 6	Mar., June, Oct., Dec.	15⅞	15
£75,000	100	5%	* Do. 5 per Cent. Debs. (2nd Series, 1906)	110	114	110	114	4 7 9	June and December	..	—
10,000,000	$100	8½	Commercial Cable Capital Stock	185	195	185	195	4 2 1	Jan., Apr., July, Oct.	—	..
£1,832,52[illegible]	Stock	4%	* Do. 4 per Cent. Debenture Stock	104	106	104	106	3 15 6	" "	103	105½
16,000	10	8/0	Cuba Submarine Ordinary (Deferred)	9	10	9	10	7 0 0	February and August	9½	9½
6,000	10	10/0	Do. Preference 10 per Cent.	18½	19½	19	20	6 0 0	" "	—	—
12,931	5	2/0	Direct Spanish (Ordinary)	4	5	4	5	4 0 0	April and October..	..	—
6,000	5	10/0	Do. 10 per Cent. Cumulative Preference	10	11	9½	10½	4 5 3	" "	—	..
£30,000	50	4½%	Do. 4½ per Cent. Debentures	106%	109%	106	109	4 8 4	January and July		
60,710	20	3/0	Direct United States Cable	12	12½	10½	11½	5 11 1	Jan., Apr., July, Oct.	11$\frac{13}{16}$	11
£120,000	100	4½%	Direct West India Cable 4½% Reg. Deb. (red)	103	106	103	105	4 7 0	June and December..	..	
£4,000,000	Stock	7%	Eastern Ordinary xd	177	182	161	170	4 2 1	Jan., Apr., July, Oct.	175	161
£1,795,000	Stock	3½%	Do. 3½ per Cent. Pref. Stock xd	102	104	100	101	3 7 4	" "	103	101
£[illegible],482,265	Stock	4%	* Do. 4 per Cent. Mort. Debenture Stock (red.)	125	12[illegible]	125	12[illegible]	3 2 9	May and November	123	..
£89,900	100	5%	* Do. 5 per Cent. Debentures, 1899	99	102	99	102	4 18 0	February & August		..
150,000	10	2/6	Eastern Extension	18	18½	1[illegible]	17	4 2 4	Jan., Apr., July, Oct.	18$\frac{3}{16}$	16
£[illegible]20,000	Stock	4%	Do. 4 per Cent. Debenture Stock	125	129	125	129	3 2 3	February & August	125	—
£16,200	100	5%	* Do. 5 p.c. (Austin. Gov. Sub.) Deb. 1900 (reg.)	99	101	99	103	4 17 1	January and July	..	..
£64,400	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	" "	..	—
£35,100	100	5%	*Eastern and S. African 5 p.c. Mor. Deb., 1900 (reg.)	99	103	99	103	4 17 1	" "	—	—
£46,500	100	5%	Do. (Bearer)	100	103	100	103	4 17 1	" "	—	..
£300,000	100	4%	* Do. 4% Mortgage Debentures, 1909	102	105	102	105	3 17 8	February & August	..	—
£100,000	25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101%	107%	104%	107%	3 15 2	May and November	..	—
180,227	10	1/9	Globe Telegraph and Trust	12¾	13½	11½	12½	4 2 0	Jan., Apr., July, Oct.	12¼	11¾
180,042	10	6%	Do. 6 per Cent. Preference	16½	17½	16	17	3 10 7	" "	16½	16¼
150,000	10	5/0	Great Northern of Copenhagen	80	81	80	81	3 4 6	January and July	..	—
£92,600	100	4½%	Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red)	100	103	99	102	4 9 6	..	101	—
17,000	25	12/6	Indo-European	57	60	57	60	4 3 4	May and November	..	—
£100,000	100	6%	London Platino-Brazilian 6 per Cent. Debs., 1904	108	111	108	111	5 8 1	March & September	—	—
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. (red)	105	108	105	108	3 14 5	June and December	—	—
11,839	8	4/0	Reuter's	7	8	7	8	5 0 0	April and October	..	—
3,381	£100 Cert.	6%	Submarine Cables Trust xd	140	145	137	142	4 4 6	"	—	..
15,609	10	—	West African Telegraph	2½	3½	2½	3½	..	December and July.	—	—
£100,000	100	5%	* Do. 5 per Cent. Debentures (red.)	99	102	99	102	4 18 0	March & September	—	—
80,008	2½	—	West Coast of America	½	1	½	1	..	—	—	—
£150,000	100	4%	* Do. 4 per Cent. Debentures	103	106	103	106	3 15 9	January and July	..	—
88,321	10	1/6	West India and Panama	2	2½	2	2½	—	May and November	2$\frac{3}{16}$	2$\frac{1}{16}$
34,563	10	6/0	Do. 6 per Cent. 1st Preference	10¾	11½	11	11½	5 4 4	" "	11$\frac{7}{16}$	11
4,669	10	6/0	Do. 6 per Cent. 2nd Preference	9	10	9	10	6 0 0	" "	..	—
£80,000	100	5%	* Do. 5 per Cent. Debentures	105	108	105	108	4 13 3	January and July	..	—
64,269	15	5/0	Western and Brazilian Ordinary	12½	13½	12½	13	4 11 3	May and November	..	—
33,119	7½	3/9	Do. 5 per Cent. Preferred Ordinary	8½	9	8½	8¾	4 5 8	" "	—	—
33,119	7½	1/3	Do. Deferred Ordinary	4	4½	4	4½	—	" "	—	..
£389,521	Stock	4%	* Do. 4 per Cent. Debenture Stock	106	109	106	109	3 14 1	June and December	106	..
£158,100	100	6%	*Western Union 6 per Cent. Sterling Bonds (red.)	100	105	100	105	5 14 8	March & September	—	..

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ELECTRICAL COMPANIES' SHARE LIST.

Present Amount	Amount of Share	Last Dividend	Name	Previous Week's Price April 12		Price Wednesday, April 19		Rate per Cent. Yielded (£ s. d.)	Dividend Due	Business Done During Week Ending April 19: Highest	Lowest
			TELEPHONES.								
64,000	£5	4/6	Chili Telephone (fully paid)	2½	3	2½	3	6 13 4	August	—	—
374,850	£1 1s.	1½d.	Consolidated Telephone Const. & Manufacturing	1/16	3/16	1/16	3/16	6 7 0	July	—	—
71,000	1	—	Monte Video Telephone Ord.	½	¾	½	¾	5 0 0	October	½	—
84,000	1	6/4	Do. 6% Preference	¾	1	¾	1	..	—	¾	—
490,000	5	3/0	National	4¾	5	4¾	5	6 0 0	February & August	4 13/16	4¾
15,000	10	6/0	Do. 6 per Cent. Cumulative 1st Pref.	11	13	11	13	4 6 9	" "	12	11⅞
15,000	10	6/0	Do. 6% Cumulative 2nd Pref.	11	13	11	13	4 6 9	" "	—	—
250,000	5	2/6	Do. 5% Non-Cumulative 3rd Pref	4¾	5¼	4¾	5¼	4 15 2	" "	4 15/16	4¾
1,?29,471	Stock	3½%	* Do. Debenture Stock 3½% (red.)	99	101	99	102	3 9 4	June and December	100½	99
71,504	1	0/4	Oriental	½	1	½	1	5 0 0	April and October	..	—
58,000	5	6/0	United River Plate	4¾	5¼	4¾	5¼	5 14 3	July	5	—
£151,788	Stock	5%	* Do. 5 per Cent. Debenture Stock (red.)	104	107	104	107	4 18 11	June and December	—	—
			ELECTRICITY SUPPLY COMPANIES.								
100,000	1	—	Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (10s pd.)	¼	½	¼	½	—	—	—	—
?6,000	10	7/9½	Bournemouth and Poole Electricity Supply Ord	13½	13¾	13½	13¾	2 16 10	—	—	—
?6,000	10	4/6	Do. 4½ per Cent. Cumulative Pref.	10½	11½	10½	11	4 1 10	—	—	—
20,000	5	..	Calcutta Elec. Supply Ordinary (£3 paid)	4½	4¾	4½	4¾	3 3 2	—	..	..
50,000	5	5/0	Charing Cross & Strand Electricity Supply Corp.	10½	11½	11	12	3 9 7	February & August	11⅜	11⅛
20,000	5	2/3	Do. 4½ per Cent. Preference	6	6½	6	6½	3 9 3	" "	—	—
£84,000	5	3/6	Chelsea Electricity Supply Ordinary	7½	8½	7½	8½	3 10 7	March	8¼	—
£100,000	Stock	4½%	* Do. 4½% Debenture Stock (red.)	114	116	114	116	3 18 1	June and December	..	..
$1,200,000	$1,000	5%	Chicago Edison 1st Mort. 5% 30 year Gold Bonds (red)	101	105	101	105	4 17 7	April and October	—	—
60,000	10	7/0	City of London Elec. Lighting Ord.	16½	17½	17½	18½	3 4 10	February & August	18½	17
40,000	10	6%	Do. 6% Cumulative Pref.	15	16	15	16	3 15 0	January and July	15 5/16	14⅞
£400,000	Stock	5%	* Do. 5% Debenture Stock (red.)	124	129	124	129	3 17 10	June and December	127½	127
40,000	10	—	County of London & Brush Prov. Ord	11	12	11	12	—	—	11½	10 15/16
?0,000	10	6/0	Do. 6% Cumulative Preference	14	15	14	15	4 0 0	March & September	—	—
19,661	5	3/6	House-to-House Electric Lighting Supply Ord.	8½	9½	8½	9½	3 18 8	—	..	—
17,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	March & September	..	—
15,000	5	10%	Kensington and Knightsbridge Ord.	13	14	13	14	3 13 7	—	—	—
10,000	5	6%	Do. 6% 1st Pref.	7¾	8½	7¾	8½	3 12 9	January and July	—	—
110,000	3	—	London Electric Supply Ordinary	3¾	4	3¾	4	—	—	3¾	3 11/16
48,050	5	3/0	Do. 6% Preference	6½	7	6½	7	4 5 9	—	6½	6 7/16
£?00,000	Stock	..	Do. 4% 1st Mort. Deb.	105	107	106	108	3 14 0	Mch., June, Sept., Dec.	—	—
62,500	10	5/0	Metropolitan Electric Supply Ordinary	17	18	17	18	2 15 7	April and October	17¾	17½
27,500	10	8s. d.	Do. (£7 paid)	13	14	13	14	..	—	..	..
£220,000	Stock	4½%	Do. 4½% Deb. Stock First Mortgage	117	120	117	120	3 15 9	June and December	—	—
6,452	10	6/0	Notting Hill Electric Ordinary	16½	17½	16½	17½	3 8 7	March	17½	—
10,000	5	5/0	Oxford Electric Ordinary	6½	7	6½	7	3 11 5	"	—	..
175,000	1	—	Rand Electric	½	1½	½	1½	—	—	—	—
£125,000	Stock	5%	River Plate Elec. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb	83	93	83	93	5 8 1	—	—	—
160,000	$100	$2	Royal Electric Company of Montreal Shares	165	185	165	185	4 6 6	—	—	—
130,900	100	4½%	* Do. 4½% 1st Mort. Debs.	105	107	105	107	4 4 1	April and October	—	—
31,980	5	9/6	St. James and Pall Mall Electric Ordinary	17½	18½	17½	18½	3 18 5	February & August	17⅞	—
50,000	5	3/6	Do. 7 per Cent. Preference	9	10	9	10	3 10 0	" "	..	..
65,000	5	..	South London Electric Supply Ordinary (£3 paid)	3½	3¾	3½	3¾	—	—	3½	3½
79,900	5	7/0	Westminster Electric Supply Ordinary	15	16	15	16	3 15 0	March & September	15⅜	15 3/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	2	1/2½	Brush Electrical Engineering	1⅞	2⅛	1⅞	2⅛	2 13 5	September	1 15/16	1⅞
?0,000	2	1/2½	Do. 6 per Cent. Pref. Non-Cumulative	2⅜	2⅝	2⅜	2⅝	5 1 1	"	2½	2⅜
£75,000	Stock	4½%	Do. 4½ per Cent. Perpetual Debenture Stock	110	114	110	114	3 19 2	February & August	—	—
£50,000	Stock	4½%	* Do. 2nd Debenture Stock (red.)	103	105	101	103	4 8 0	June and December	—	—
£20,000	5	5/0	Callender's Cable Construction	11¾	13½	12	13	5 2 3	" "	13½	13
£60,000	Stock	4½%	Do. 4½% 1st Mort. Deb. (red)	114	117	114	117	3 17 5	November and May	..	—
100,000	1	9½d.	Castner-Kellner Alkali Co. (fully paid)	1⅝	1⅞	1⅝	1⅞	5 16 5	—	1¾	..
50,000	1	—	Chadburn's Ship Telegraph Ordinary	1¼	1½	1¼	1½	—	—	—	—
50,000	1	7½d	Do. 6 per Cent. Cumulative Pref.	1	1¼	1	1¼	4 16 0	—	..	—
?32,098	3	1/6	Crompton and Co. (Nos. 1 to 32,098)	3½	3¾	3½	3¾	4 0 0	January and July	..	..
£100,000	100	5%	* Do. 5% First Mort. Deb. (red.)	98	101	98	101	4 19 8	—	—	..
99,261	5	1 9½	Edison and Swan United ("A" Shares) (£3 paid)	2	2½	2	2½	7 1 8	February & August	2¼	—
17,139	5	2/9½	Do. (£5 paid)	4	5	4	5	6 1? [illegible]	" "	—	—
£144,028	Stock	4%	Do. 4% Mortgage Debenture Stock (red.)	97	99	93	98	4 2 8	June and December	97½	97
17,400	5	5%	Edmundson's Electric Corporation Ord (fully pd)	5½	6⅛	5½	6⅛	4 6 11	Half-yearly	5⅝	5 5/16
1?2,100	2	1/2½	Electric Construction Co. (Limited)	2⅛	2⅜	2	2½	5 2 3	January & July	—	—
25,000	2	2/9½	Do. 7 per Cent. Cumulative Pref.	3	3¼	3	3¼	4 0 0	July	—	—
£?40,800	Stock	4%	Do. 4% First Mortgage Deb. (red.)	103	106	103	105	3 15 10	January and July	—	—
91,196	1	—	Elmore's Patent Copper Depositing	⅛	¼	⅛	¼	..	—	—	—
15,000	10	20/0	Henley's Telegraph Works Ordinary	25½	26½	25	26	5 7 8	February & August	25¾	25
?8,000	10	7/0	Do. 7 per Cent. Preference	18½	19½	18½	19½	3 11 10	" "	—	—
£?0,000	Stock	4½%	Do. 4½% Mortgage Debenture Stock (red.)	112	115	112	115	3 19 10	" "	—	..
50,000	10	15/0	India Rubber, Gutta Percha, &c., Works	21½	22½	21½	22½	4 8 11	" "	22¼	21 15/16
?00,000	100	4%	Do. 4% First Mortgage Debentures (red.)	101	105	101	105	3 16 2	March & September	..	..
?37,150	12	24/0	Telegraph Construction and Maintenance	85	89	84	88	4 11 9	March and July	84½	84½
?,000	100	..	Do. 4 per Cent. Deb. Bond, 1900	105	108	105	108	3 11 8	..	—	—
£17,400	5	.	Do. Manufacturing Ordinary	9½	10½	9½	10½	—	—	—	..
13,400	5	5/9½	Do. 5% Cum. Pref.	5¾	6½	5¾	6½	4 0 0	—	—	—
£?0,000	5	5/0	Willans and Robinson Ordinary ... xd and x new	11½	11¾	11½	11¾	4 8 9	April and October	10½	10 5/16
£30,000	5	3/0	Do. 6% Cumulative Preference xd and x new	7½	7¾	7	7½	4 0 0	" "	7½	7½
£100,000	Stock	4½%	Do. 4½% First Mort. Debs	106	108	108	110	3 18 0	May and November	—	—
			ELECTRIC RAILWAYS, TRAMWAYS, &c.								
?12,000	10	8/0	Blackpool and Fleetwood Tramways	24½	25½	24½	25½	3 2 6	—	—	—
?0,000	10	7%	Bristol Tramways and Carriage	23¾	24½	23½	24½	2 15 1	February and August	—	—
£100,000	Stock	4%	Do. 4% Debenture	120	121	120	121	3 6 2	—	—	—
20,000	10	12/0	British Electric Traction Ordinary	18½	19½	18½	19	3 3 2	—	18¾	18½
10,000	10	6/0	Do. 6% Cum. Pref. (fully pd. & £1 10s. prm. pd.)	13¾	14½	13½	14½	4 4 1	—	14 1/16	14
£200,000	Stock	5%	Do. 5% Perp. Deb.	126	129	126	129	3 17 7	—	127½	—
40,000	5	1/6½	Buenos Ayres & Belgrano 6% Cum. Pref. (£3 paid)	3⅜	3⅞	3⅜	3⅞	..	..	3½	..
27,500	5	..	Do. do. do. (fully paid)	5½	5¾	5½	5¾	..	..	—	—
£260,000	Stock	5%	Do. do. 5% Deb.	109	112	109	112	4 11 4	..	110⅜	110½
£25,250	10	3/0	Central London Ordinary	9¾	10¼	9¾	10¼	2 18 6	June and December	10	9¾
178,308	10	1/9½	Do. (£8 paid)	7½	8½	7¾	8½	2 13 2	" "	—	..
£?0,000	Stock	2%	City and South London Railway Con. Ordy.	65	70	68	69	3 1 10	January and July	68	67½
22,500	10	..	Do. Ordinary (Nos. 1 to 22,500) (£5 paid)	4¾	5½	4¾	5½	..	—	—	..
9,251	10	5%	Do. 5% Perpetual Preference	14½	15½	14½	15½	3 5 7	January and July	15½	—
187,701	Stock	4%	Do. 4% Perpetual Debenture	133	135	133	135	2 19 7	May and November	—	—
20,000	10	7½%	Imperial Tramways Ordinary	24¾	25½	24¾	25½	2 18 6	March & September	—	..
10,000	10	6%	Do. 6% Preference	16	16½	16	16½	3 12 9	" "	—	—
£100,000	Stock	4½%	Do. 4½% Debenture	118½	119½	118½	119½	3 15 4	January and July	—	..
37,?00	10	4%	Liverpool Overhead Railway Ordinary	10 3/16	10 5/16	10 3/16	10 5/16	3 7 11	February & August	—	—
10,000	10	5%	Do. 5% Preference	14⅛	14⅝	14⅛	14⅝	3 7 3	" "	—	—
?,000	Stock	4%	Do. 4% Debenture	106	108	106	108	3 14 1	January and July	—	—
54,000	5	..	New General Traction Ordinary	..	..	3½	4	..	..	—	—
30,000	5	3/3½	Do. 6% Cumulative Pref	5	5½	5	5½	5 9 1	May	—	..
£540,000	Stock	3%	Waterloo and City Ordinary	109	112	109	112	2 13 7	June and December	—	—

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

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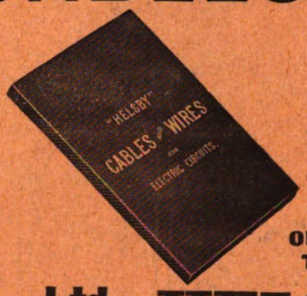

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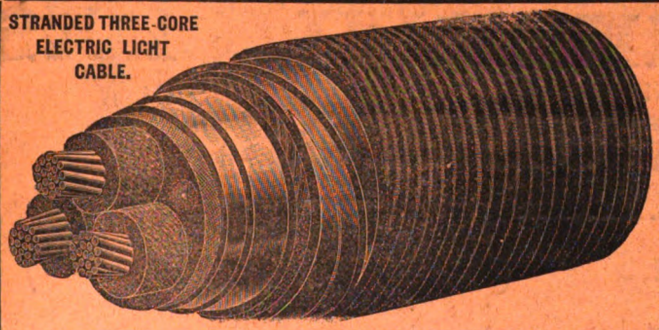

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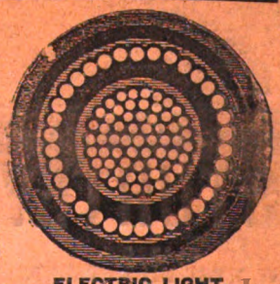

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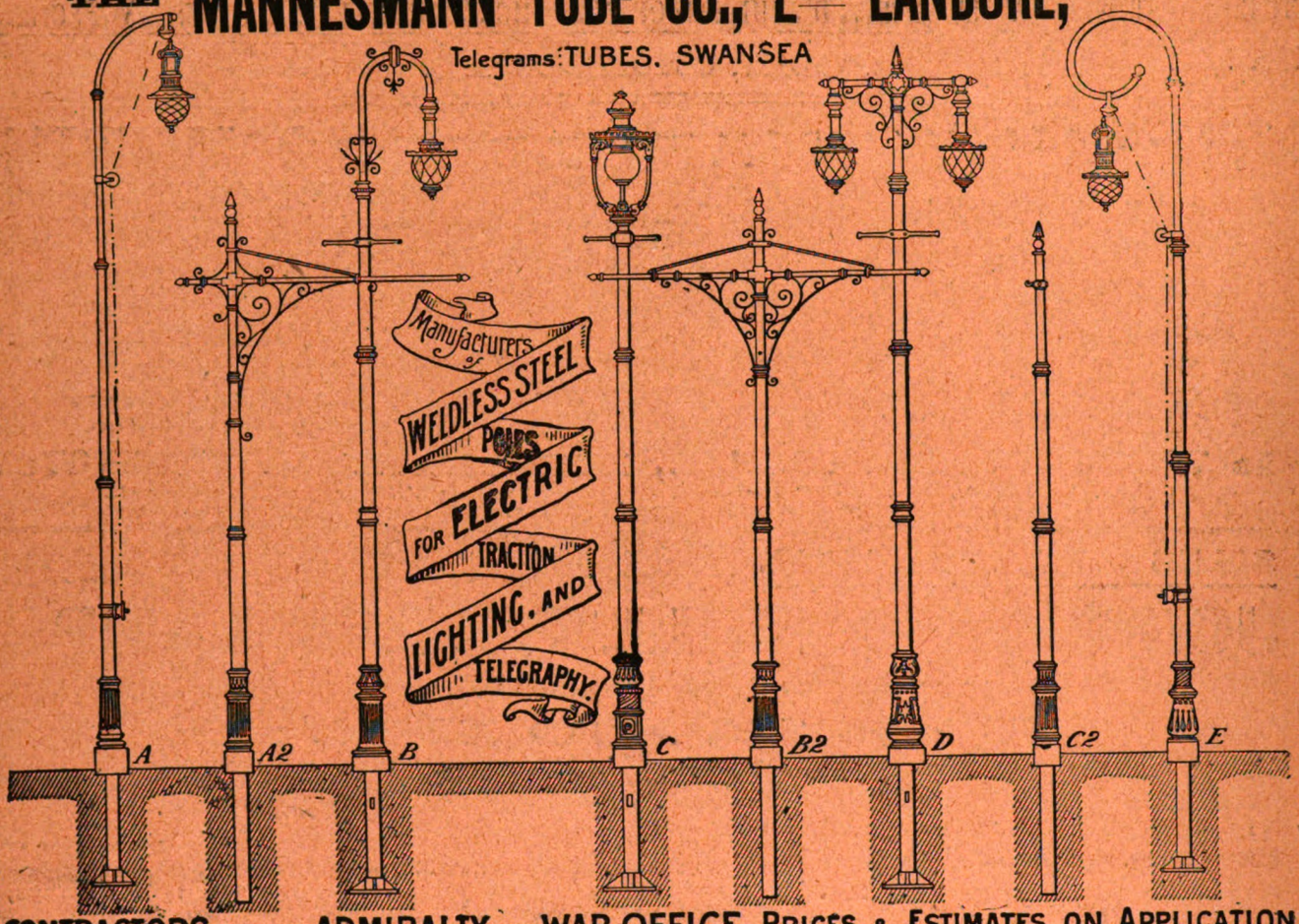

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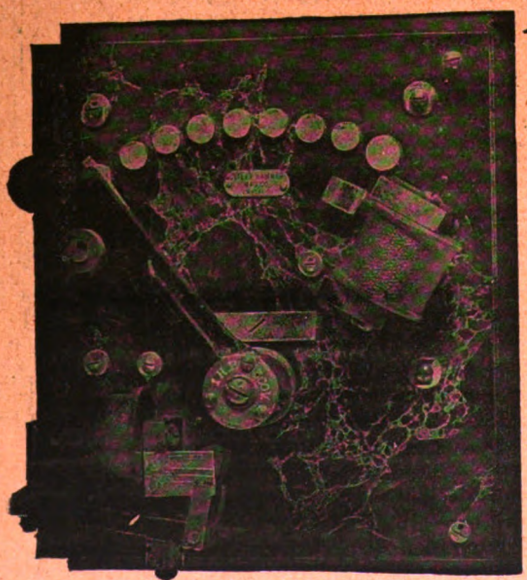

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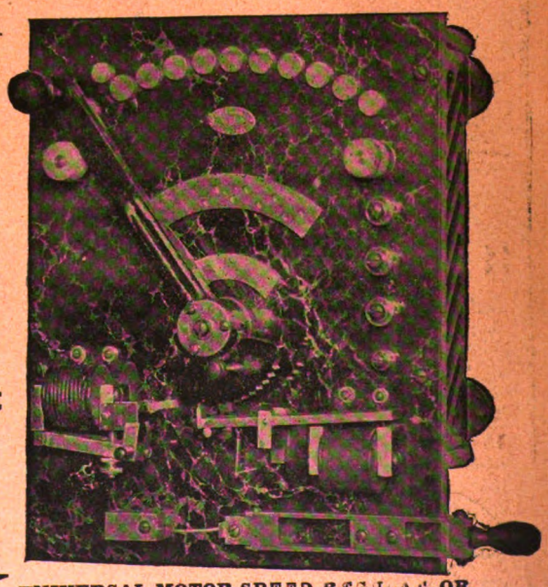

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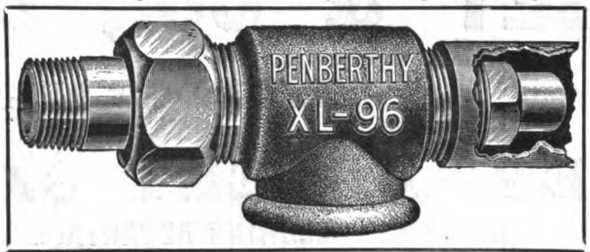

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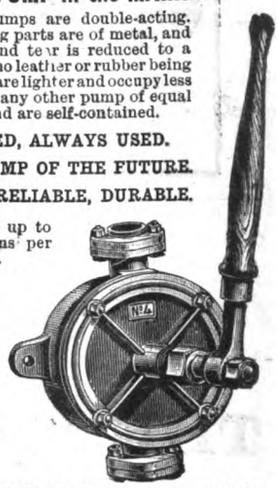

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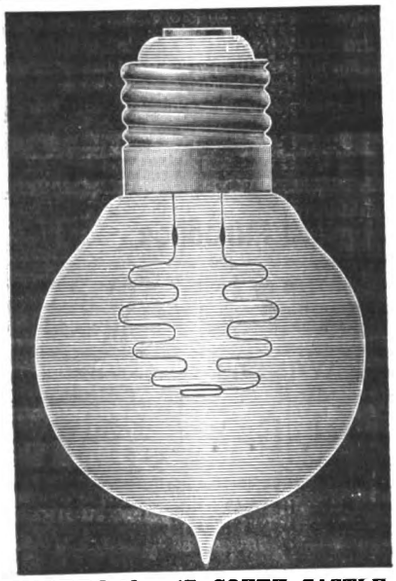

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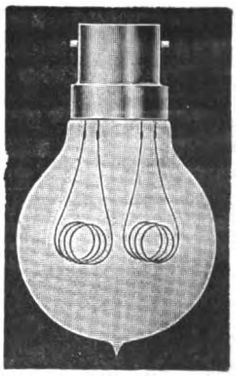

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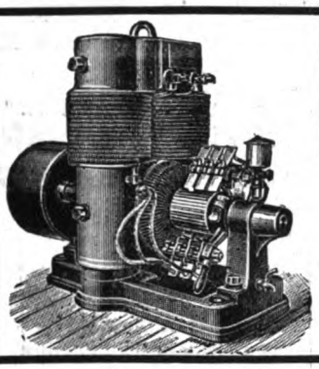

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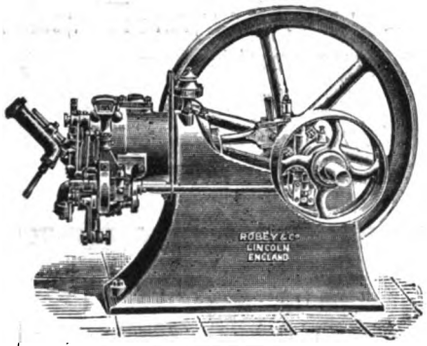

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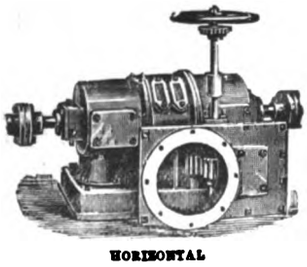

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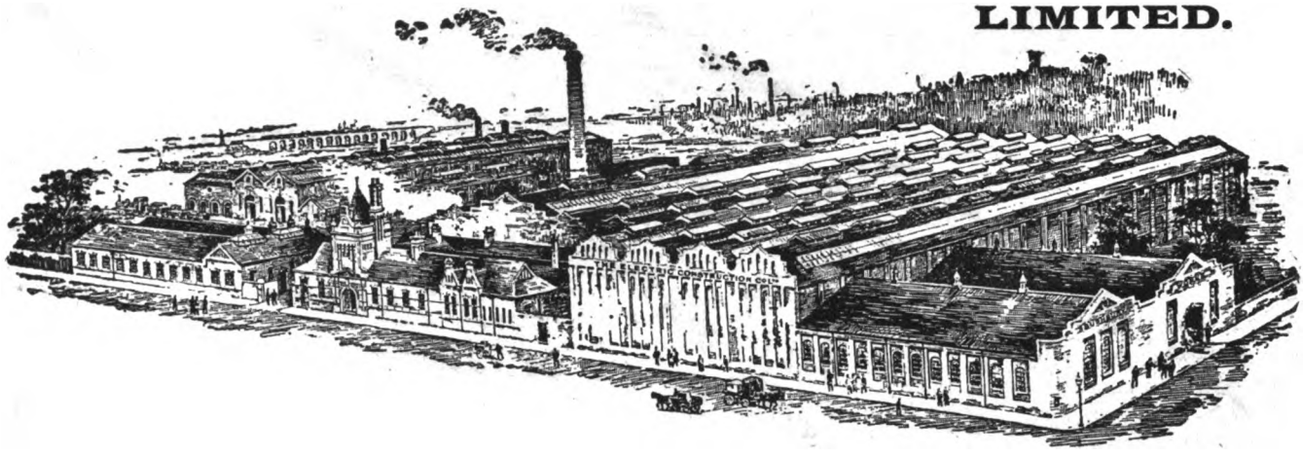

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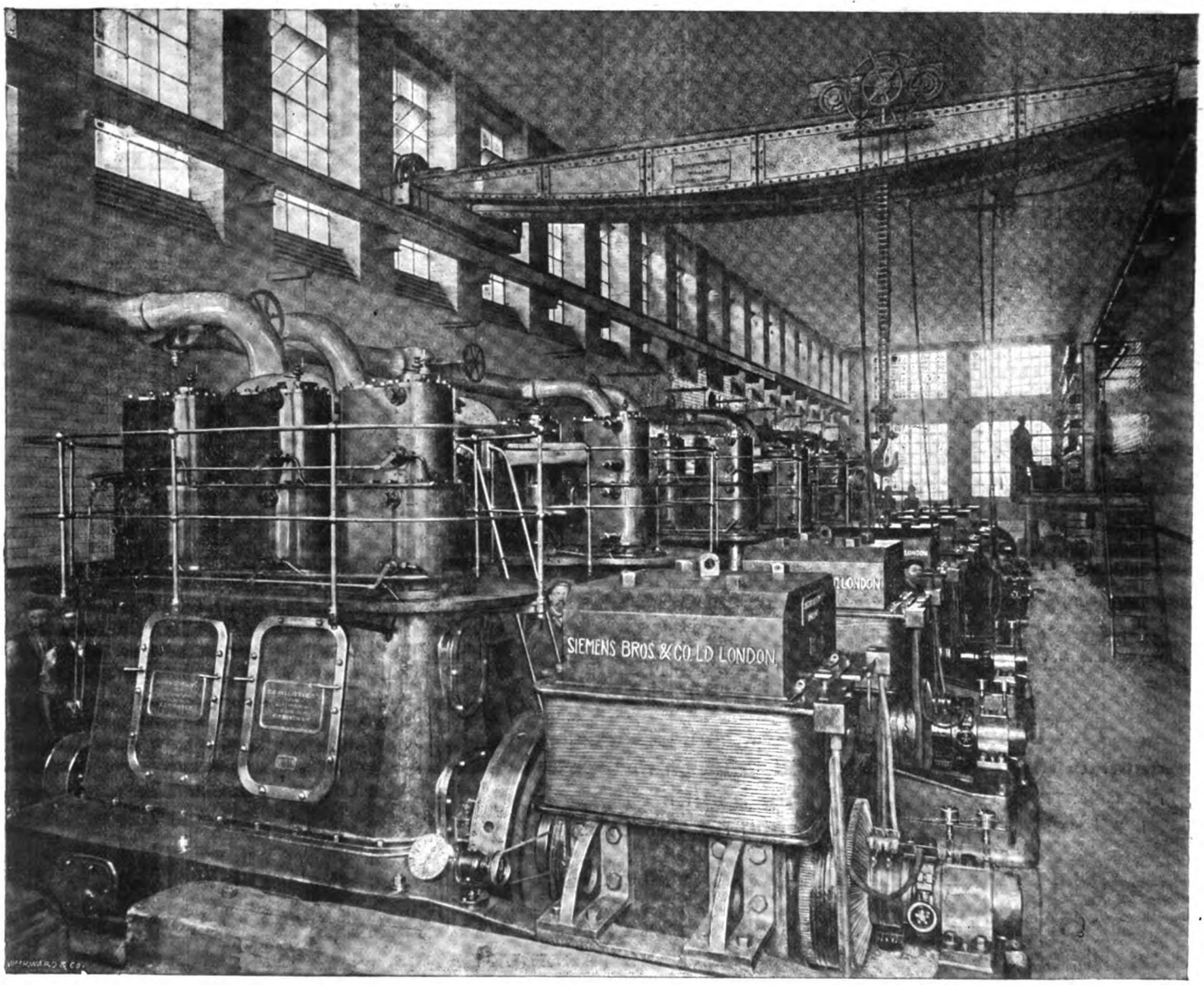

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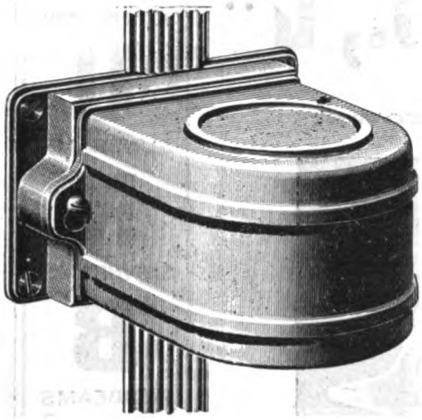

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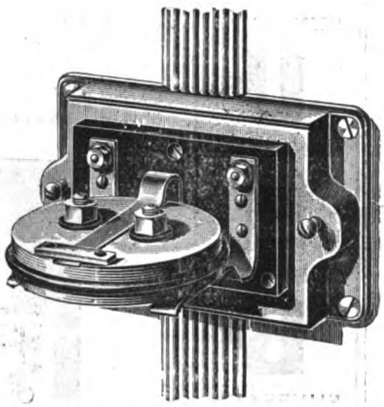

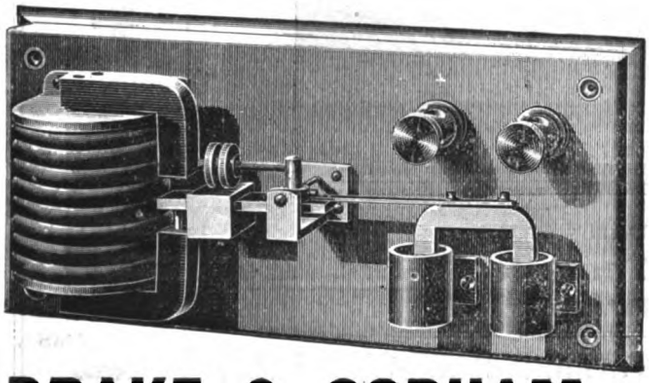

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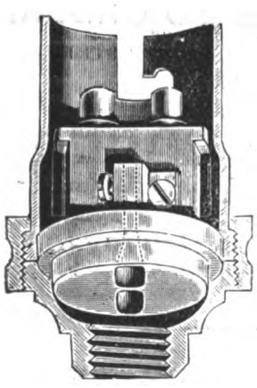

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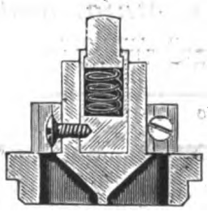

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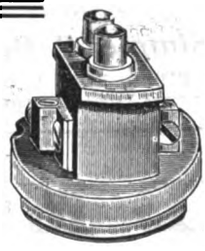

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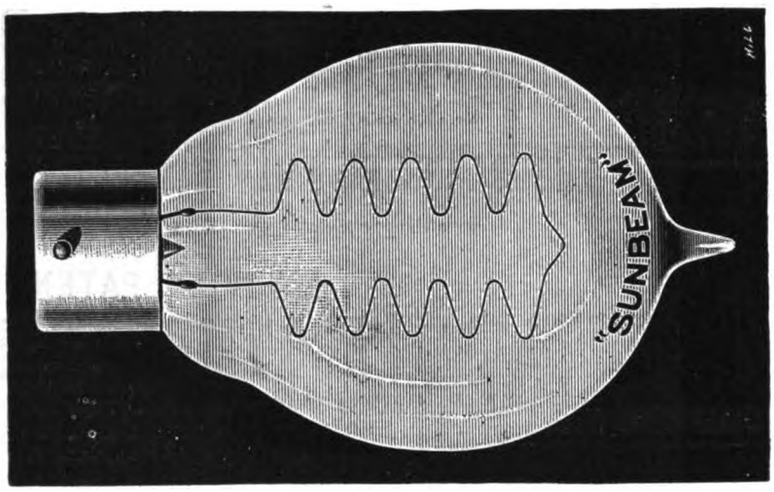

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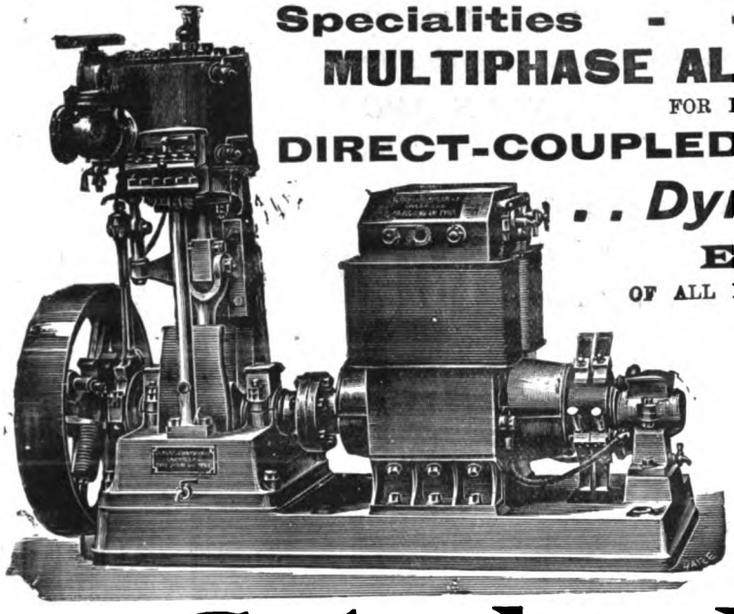

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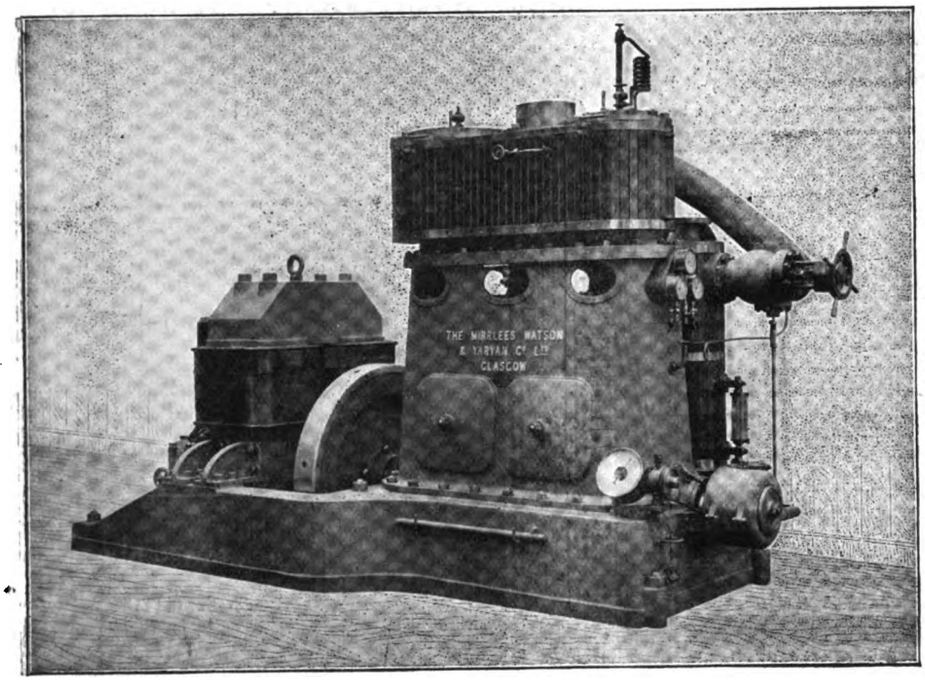

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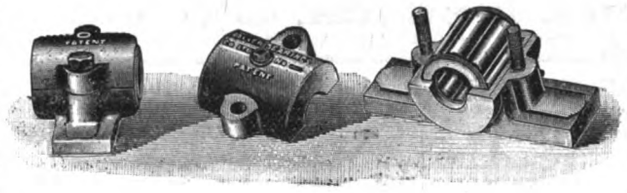

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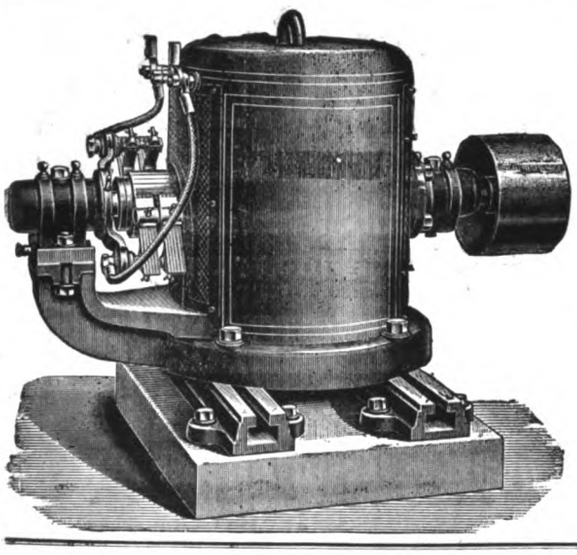

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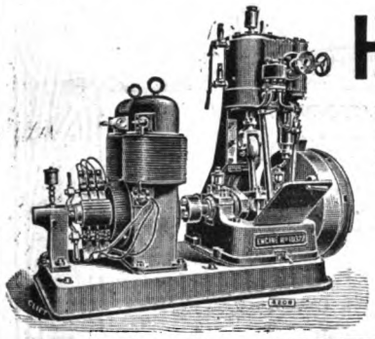

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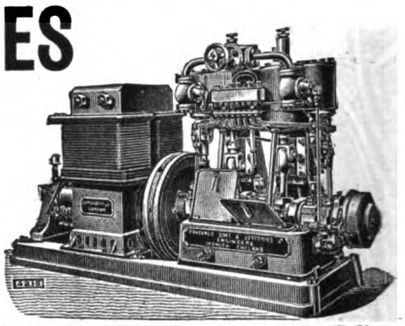

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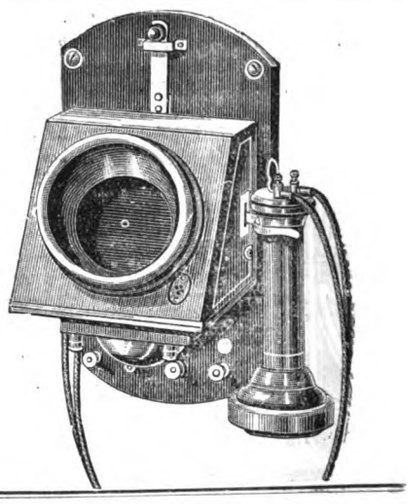

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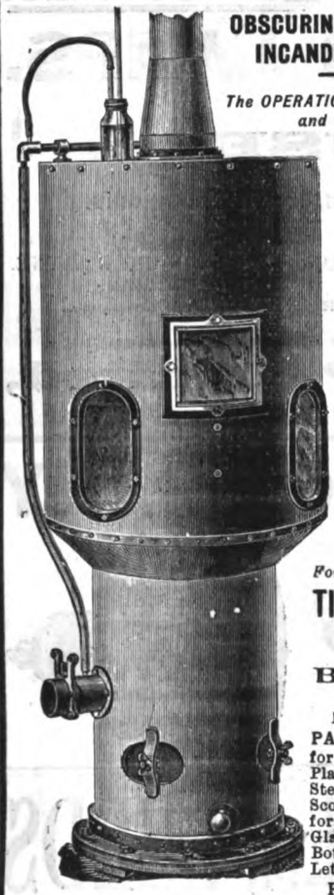

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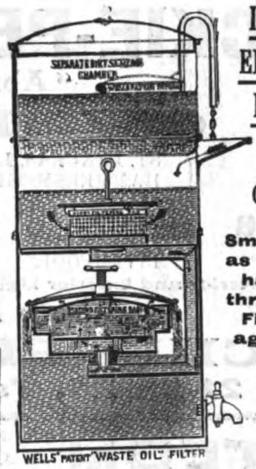

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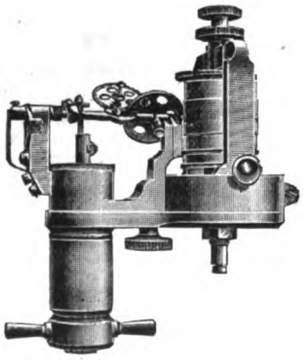

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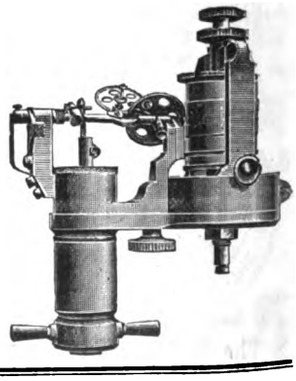

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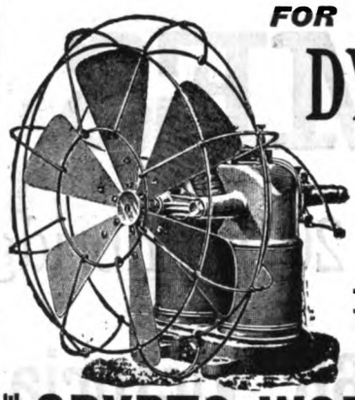

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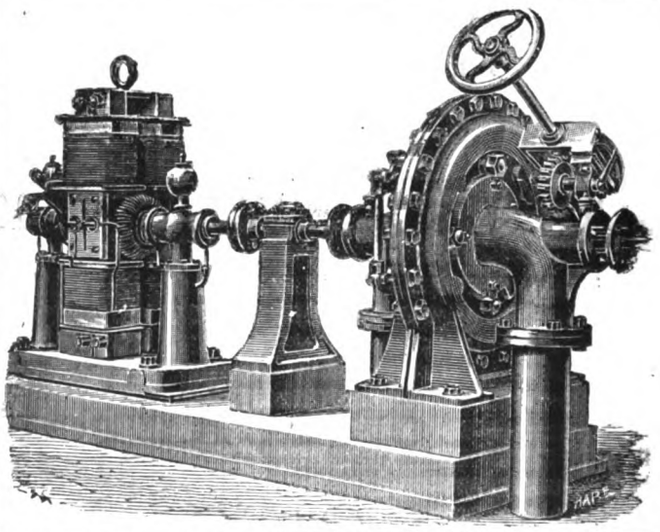

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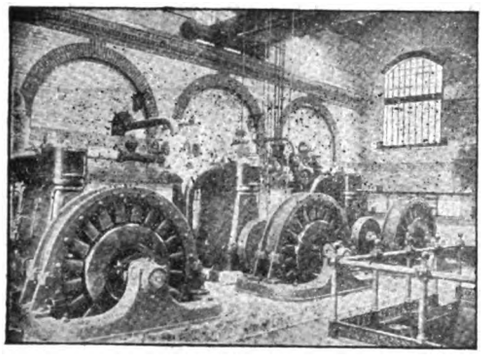

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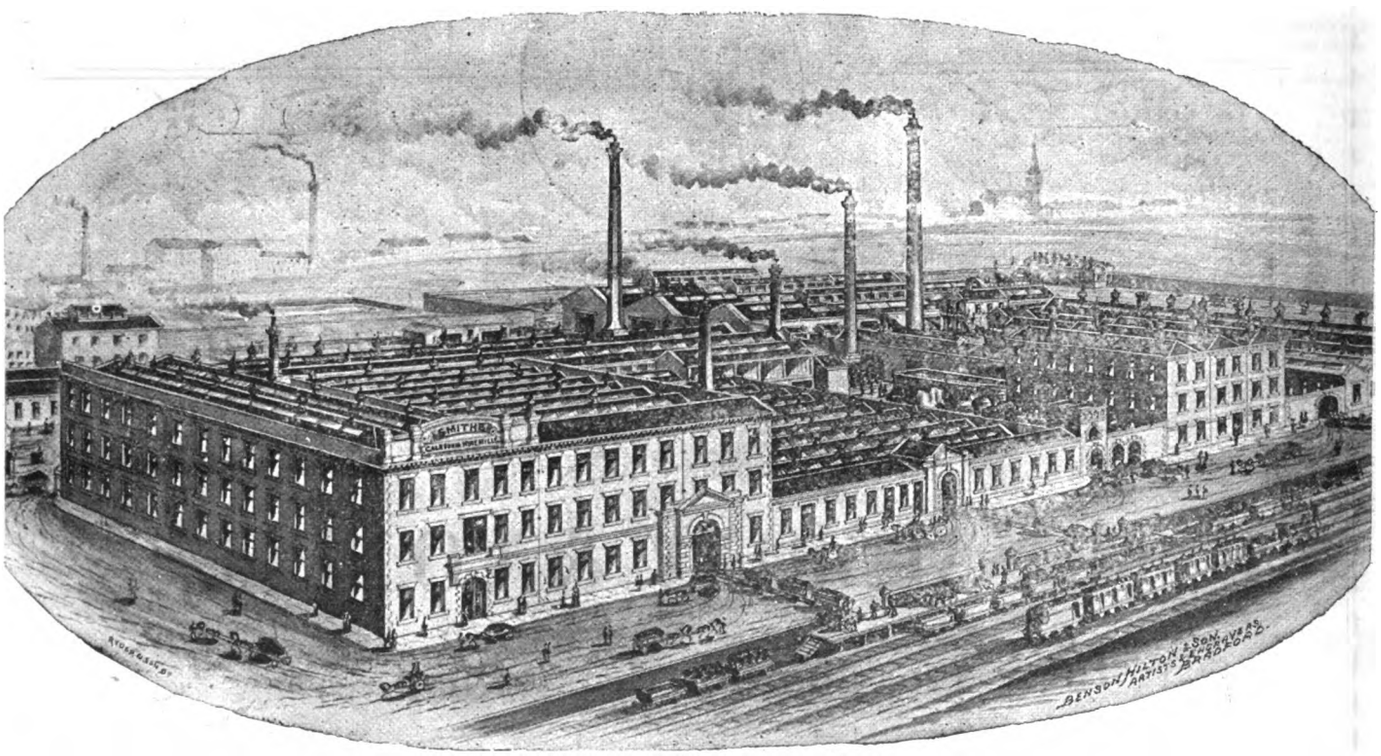

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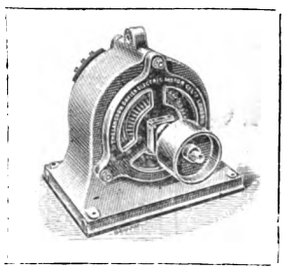

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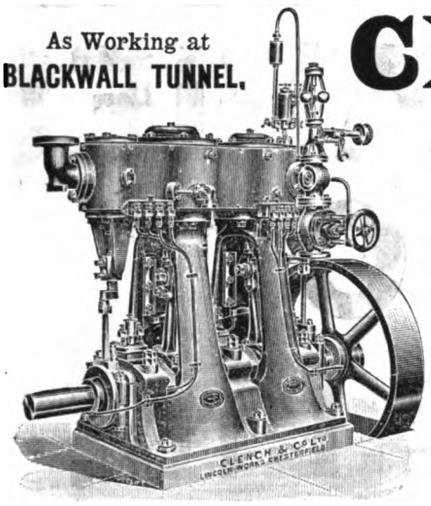

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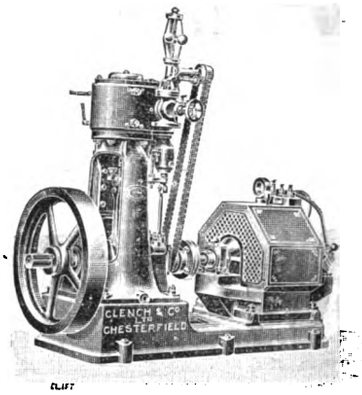

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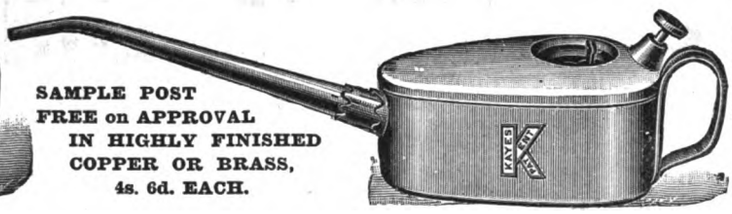

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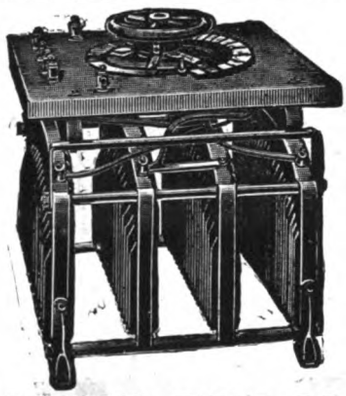

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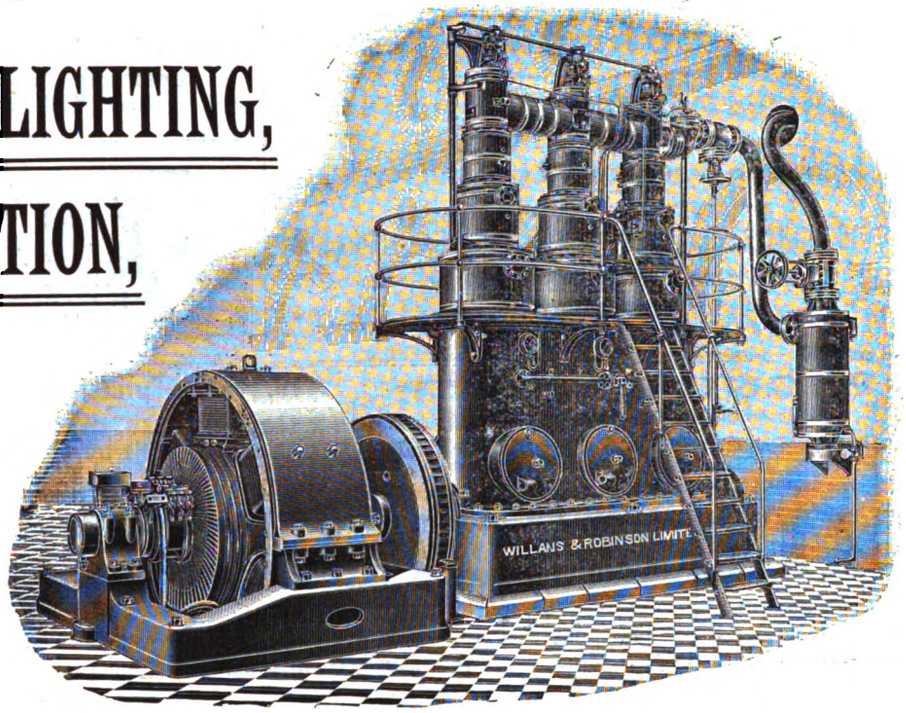

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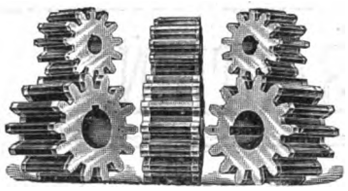

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ENGINEERS. ESTIMATES GIVEN for all APPLICATIONS of ELECTRICITY.

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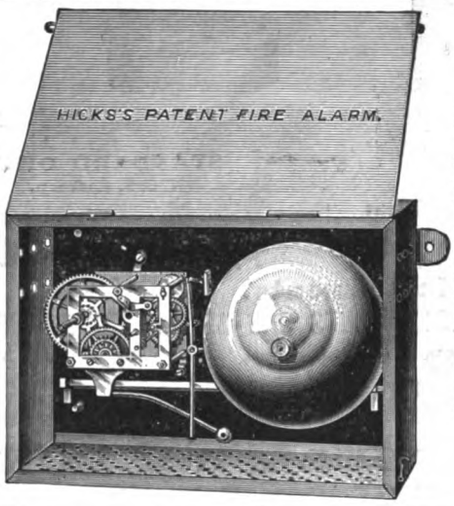

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For Indicating the Temperature in Hotels, Ships, Clubs, Cold Stores, &c. A PERFECT ALARM!

HICKS'S
PATENT
BATTERY HYDROMETERS.

Full Particulars on Application.

FIG. 1 has four different coloured beads, indicating different gravities, and the correct gravity is shown on the bead which floats nearest the centre of the tube. It has a hooked top, so that it may hang inside the accumulator, and is excessively simple and absolutely reliable.

Price only 4s. 6d.

FIG. 2 is loaded with shot at one end, and has the scale clearly marked in its stem. It is made to float in the battery, and is in extensive use by Electric Companies.

Price 2s.

FIG. 3. This beautiful Instrument (designed by Mr. Keating) has a pure white enamel glass stem, which is open at the top, and there is a hole at the bottom of the stem through which the fluid enters as it sinks in the test jar. It therefore differs materially from all other Hydrometers, and gives such a splendid *open scale* that reading is rendered exceptionally easy and distinct.

Price 4s. 6d.

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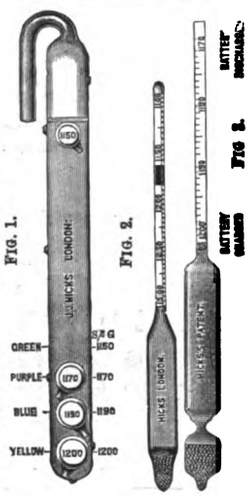

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Pumps for all Services.
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Over 2,000 Pumps In Stock.

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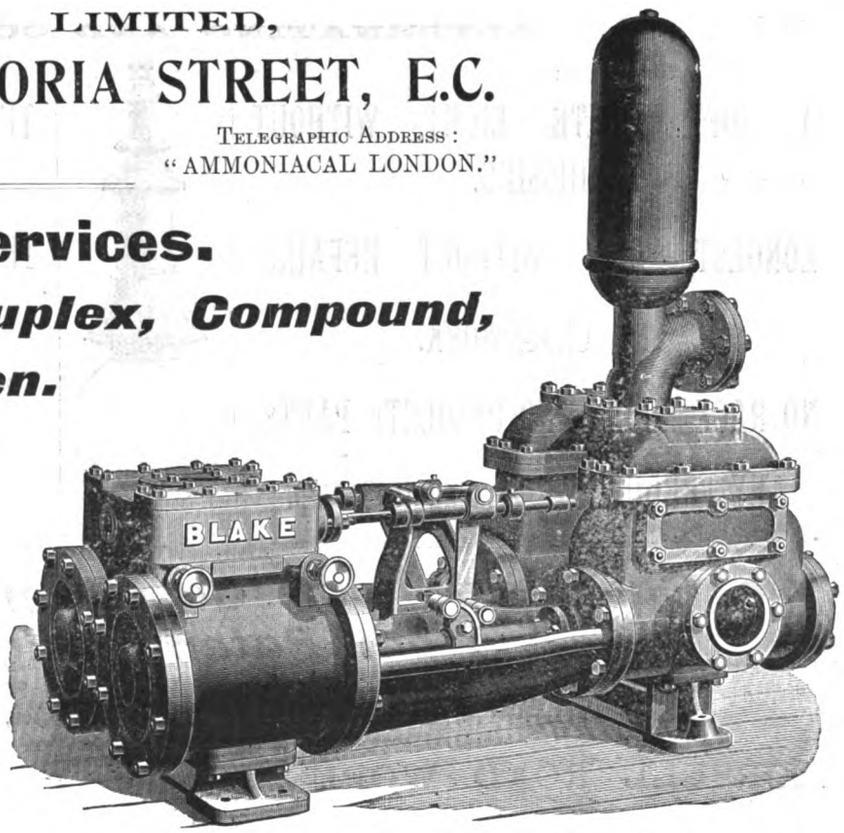

The above is an illustration of two DUPLEX PRESSURE PUMPS, with Improved Patented Valve Motion, supplied to the Belfast Electric Lighting Station. Guaranteed with a Great Economy in Steam Consumption.

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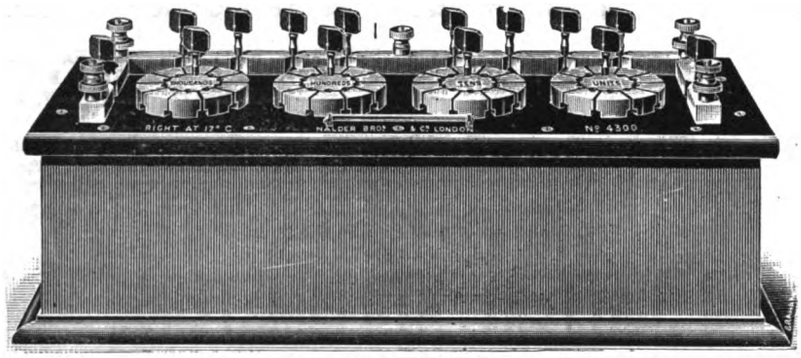

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N. C. S. Pattern.

Obviates all temperature errors. Five accurate reads can be taken within the hour at varying temperatures.

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ANY FREQUENCY. 6 amp to 9 amp.

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The Only Perfectly Enclosed Arc Lamp.
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Has Only One Controlling Device.

We Guarantee our Customers against Liability from Patent Litigations.

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MESSRS. HENRY W. FIGG and SON are instructed by J. F. Lovenny, Esq., the liquidator, to SELL by AUCTION, on the PREMISES, 48, Commercial-street, Whitechapel, E., on WEDNESDAY, November 2, 1898, at one o'clock precisely, the well-assorted STOCK-IN-TRADE of ELECTRICAL FITTINGS, comprising lamps, reflectors, screw-holders, ceiling roses, wall plugs, bells, pushes, a large quantity of opal, enamel, iron, and fancy shades, ball fittings, brackets, arc lamps, &c.—Catalogues of Messrs. Jno. F. Lovenny and Co., 3, Church-passage, Guildhall, and of the Auctioneers and Valuers to the Trade, 37, Upper Thames-street, London, E.C.

TENDERS INVITED.

HORNSEY URBAN DISTRICT COUNCIL.

TO ELECTRICAL ENGINEERS AND OTHERS.

The HORNSEY URBAN DISTRICT COUNCIL are prepared to receive TENDERS for the SUPPLY of ELECTRIC LIGHTING PLANT and its ERECTION at the Council's Central Public Library, situate in Tottenham Lane, Hornsey.

Specifications and Forms of Tender, and all information, can be obtained on application to Mr. E. J. Lovegrove, Engineer to the Council, at the Offices mentioned below, on any morning between the hours of 10 and 12 o'clock, on a sum of Two Pounds being deposited with the Clerk to the Council, which sum will be retained by the Council and deemed to be forfeited if a bona fide Tender is not made by the depositor.

If a Tender is made which is not accepted the sum deposited will be returned, and if a Tender is accepted such sum will be retained by the Council until the contract has been executed by the depositor, and will be forfeited in the event of his or his sureties failing or neglecting to execute such contract or the bond accompanying the same within seven days after he or they respectively shall have been requested to execute the same.

No Tender will be considered except on the prescribed Form.

Sealed and endorsed Tenders to be deposited in the Tender-box in my Department not later than 4 o'clock p.m. on MONDAY, the 7th day of November, proximo.

The Council reserve to themselves the right to decline all, or any portion, of the Tenders so sent in.

By order,
F. D. ASKEY, Clerk to the District Council.

Offices: Southwood-lane,
Highgate, N., 25th October, 1898.

BOROUGH OF MIDDLESBROUGH.

MUNICIPAL ELECTRICITY SUPPLY UNDERTAKING.

LOW TENSION SYSTEM.

The ELECTRIC LIGHTING COMMITTEE of the BOROUGH of MIDDLESBROUGH are prepared to receive TENDERS for the SUPPLY and ERECTION of the following PLANT:—

Section A.—BOILER HOUSE PLANT: Lancashire Boilers and Accessories, Mechanical Stokers, Feed Pumps, Injector, Economiser, Electric Motor.
Section B.—ENGINE HOUSE PLANT: Slow Speed Steam Dynamos and Accessories.
Section C.—CONDENSING PLANT and PIPEWORK.
Section D.—OVERHEAD TRAVELLING CRANE.
Section E.—SWITCHBOARD and INSTRUMENTS.
Section F.—ACCUMULATORS.
Section G.—UNDERGROUND WORK: Trenching, Cables, &c.
Section H.—METERS.

The whole bound up in one Specification. Applicants must state for which Section or Sections they wish to tender, in order that the requisite drawings may be forwarded to them.

Tenderers are at liberty to tender for any Section, but not for part of a Section.

Specifications, with Terms and Conditions and Forms of Tender, may be obtained at the Offices of Mr. Robert Hammond, M.I.E.E., the Consulting Engineer to the Borough, 64, Victoria-street, Westminster, S.W., on and after Wednesday, November 2nd, 1898, on payment of £5. 5s., which sum will be refunded on return of the Specification filled up with a bona fide Tender. Duplicate copies of the Specification £1. 1s. each, not returnable.

Tenders, sealed and marked "Tender for Electricity Works," must be addressed to me at the Municipal Buildings, and be delivered on or before TUESDAY, November 29th, 1898.

The Committee do not bind themselves to accept the lowest or any Tender.

GEORGE BAINBRIDGE, Town Clerk.

Middlesbrough, October 27th, 1898.

BELFAST HARBOUR.

The BELFAST HARBOUR COMMISSIONERS are prepared to receive TENDERS for the SUPPLY of NINE IRON LATTICE-BUILT ELECTRIC LIGHT MASTS, 70ft. high from the ground-line, with suitable base.

Parties tendering must submit drawings to scale giving full particulars of the construction of the Masts and state the earliest date within which they will undertake to deliver the same.

The Masts to be delivered free of all charges on the Quay at Belfast.

Sealed Tenders to be addressed to the undersigned, endorsed, "Tender for Electric Light Masts," and sent in on or before MONDAY, November 14, 1898.

The Commissioners do not bind themselves to accept the lowest or any Tender.

W. A. CURRIE, Secretary.

Harbour Office, Belfast.
October 26, 1898.

STANLEY

2 Gold Medals.

Manufacturer of

DRAWING and SURVEYING INSTRUMENTS

Of Every Description, of the Highest Quality and Finish, at the most Moderate Prices.

— PRICE LIST POST FREE. —

Address: GREAT TURNSTILE, HOLBORN, LONDON, W.C.
Telegrams, "Turnstile London." Telephone, 188 Holborn.

TENDERS INVITED.

THE NATIONAL COMPANY for the DISTRIBUTION of ELECTRICITY by SECONDARY GENERATORS, LIMITED.—In Liquidation.

PATENTS FOR SALE BY TENDER.

The Liquidator of the above named Company invites TENDERS for the PURCHASE of the undermentioned PATENTS for Secondary Generators, belonging to the said Company;

No. 13,333, for Great Britain, dated 1st Oct., 1887, expiring 1901.
No. 18,355, for Great Britain, dated 16th Nov., 1889, expiring 1903.
No. 189,840, for France, dated 9th April, 1888, expiring 1903.

Specifications of the said Patents can be inspected, and further information obtained, on application to the Liquidator, as under, or to Messrs. Campbell Reeves and Hooper, 17, Warwick-street, Regent-street, London, W., the Solicitors to the Liquidator.

Tenders, addressed to the undersigned, will be received up to 12 o'clock on MONDAY, the 28th day of November, 1898.

The Liquidator does not bind himself to accept the highest or any Tender.

Dated this 26th day of October, 1898.

J. H. THORNTON, Liquidator.

2, Warwick-street, Regent-street,
London, W.

COUNTY BOROUGH OF SALFORD.

The ELECTRIC LIGHT COMMITTEE of the above CORPORATION are prepared to receive TENDER for the SUPPLY and ERECTION of the following PLANT:

Sections.	Sections.
1. BOILERS	8. CONDENSERS, &c.
2. ENGINES	9 STEAM & WATER PIPES
3. DYNAMOS	10. CRANES & WEIGHING MACHINES
4. BOILER FEED PUMPS, &c.	11. TANKS, &c.
5. MECHANICAL STOKERS	12. SWITCHBOARDS
6. SUPER-HEATERS	13. BOOSTER
7. ECONOMISERS	

Contractors may tender for one or any number of complete sections.

Specification, with Tender Forms and any further information, may be obtained from the Electrical Engineer, Walness-road, Broughton, on payment of £5, which sum will be refunded on receipt of Specification with bona fide Tender.

Sealed Tenders, endorsed "Electric Plant," and addressed to the Chairman of the Electricity Committee, to be delivered at my office not later than the 1st day of December, 1898.

By order,
SAML. BROWN, Town Clerk.

Town Hall, Salford,
October 25th, 1898.

COUNTY BOROUGH OF BARROW-IN-FURNESS.

ELECTRICITY SUPPLY.

CONTRACT No. 4.

The CORPORATION of BARROW-IN-FURNESS invite TENDERS for the SUPPLY and ERECTION of CAST IRON LAMP COLUMNS, ARC and INCANDESCENT LAMPS, AUTOMATIC SWITCHES and FITTINGS.

Specifications and Forms of Tender can be obtained from the Municipal Offices, Barrow-in-Furness, or at the Offices of the Engineers, Messrs. Kincaid, Waller and Manville, 29, Great George-street, Westminster, on payment of a fee of £3. 3s., which sum will be returned on receipt of a bona fide tender. The contractor will be required to pay not less than the minimum standard rate of wages, for the time being, in each branch of the Trade.

The Corporation do not bind themselves to accept the lowest or any Tender, and the contractor whose Tender is accepted shall enter into a formal agreement, under seal, with sufficient sureties for the due fulfilment of his Contract.

Sealed Tenders, endorsed "Electricity Supply Contract No. 4," must be sent to me at or before noon on MONDAY, the 14th November, 1898.

C. F. PRESTON, Town Clerk.

Municipal Offices, Barrow-in-Furness,
October, 1898.

REDDITCH URBAN DISTRICT COUNCIL.

The above COUNCIL are desirous of obtaining for the customers of the Municipal Electric Lighting Supply, the SERVICES of some FIRM of CONTRACTORS who will carry out WIRING and FITTING WORK for the inhabitants of the district, on some hire-purchase or deferred payment system, to spread the cost of wiring over a considerable period, not longer than seven years.

Applications and proposals with reference to this matter to be made to

J. A. McMULLEN, M.I.E.E.,
Hornchurch, Essex.

APPOINTMENTS VACANT.

COUNTY BOROUGH OF SALFORD.

ELECTRICITY DEPARTMENT.

WANTED, competent man as SWITCHBOARD ATTENDANT; wages 34s. per week.

Applicants must state age, experience, where last employed, and when able to commence duties. Man used to running alternators in parallel preferred. Applications, accompanied by not more than three recent testimonials, to be addressed to the Electrical Engineer, Electricity Works, Walness-road, Salford.

By order,
SAML. BROWN, Town Clerk.

Town Hall, Salford,
October 24th, 1898.

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CHEAP PREPAID ADVERTISEMENTS

relating to SITUATIONS VACANT AND WANTED, MISCELLANEOUS PLANT WANTED, FOR SALE, AND FOR EXCHANGE, *are inserted in* "THE ELECTRICIAN" *at the following special low rates:*

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WANTED an ELECTRICAL ENGINEER, thoroughly conversant with the design, construction and working of dynamos, motors and electrical machinery generally. Age 28 to 30.—Address with references, stating salary required, to "D. M.," *Electrician* Office, Salisbury-court, Fleet-street, E.C.

WANTED, ELECTRICIAN with mechanical knowledge of telephones, to supervise the manufacture, perfecting and sale of an invention.—Apply, by letter only, to "ELECTRICIAN," care of Messrs. Reynell & Son, Advertisement Offices, 44, Chancery Lane, W.C.

WANTED by an Export Mercantile House, an ASSISTANT ELECTRICAL ENGINEER, with experience of mining engineering.—Please write, stating salary required and full particulars, to "D.," care of Messrs. Willing and Co., 17, Royal Exchange, London.

ELECTRICAL WIREMAN.—WANTED a Wireman for general wiring and repairing work. Preference will be given to men having some experience of parallel running of alternators and armature repairs. Permanent situation for suitable man. Applicants to state age, experience, present employment, and wages required.—Apply, THOMAS RICHARDSON & SONS, Hartlepool Engine Works, Hartlepool.

JUNIOR ASSISTANT WANTED for experimental Electro-chemical work.—SWINBURNE, 66, Victoria-street, S.W.

AGENTS WANTED for the "Still" Incandescent Electric Lamp, for all parts of England. Must have good references and an established business. State, when writing, what districts you would prefer to canvas.—STILL & Co., 24, Charles-street, Hatton-garden, London, E.C.

AGENCIES WANTED.—Firm of Manufacturers' Agents and Commission Merchants have excellent show room accommodation in best position in Glasgow, and calling regularly on Electricians and Electric Light Engineers, are now open to take up a few SPECIALITIES from first-class firms.—Best London references can be given.—Address "COMMISSIONS," *Electrician* Office, Salisbury-court, Fleet-street, E.C.

FIRST CLASS CONTINENTAL CABLE WORKS require influential REPRESENTATIVES in all the principal towns, for the sale of india-rubber wires and electrical cables of every kind.—Address, "K. E.," 6,127, care of Neyroud's International Advertising Agency, 14, Queen Victoria-street, E.C.

REPRESENTATIVE REQUIRED, smart and effective, with practical knowledge of motors, and experience in soliciting orders. Good opening for suitable man.—Apply "G.B.L.," *Electrician* Office, Salisbury-court, Fleet-street, E.C.

REPRESENTATIVES WANTED by a leading French manufacturer of INCANDESCENT LAMPS.—Apply to M. A. LARNAUDE, 5, Rue des Mathurins, Paris.

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ELECTRICAL ENGINEER of wide experience as Manager, largest London houses, with highest and unquestionable references, desires responsible POSITION.—Letters, "CRAMP," 31, Doynton-street, Upper Holloway.

WHITWORTH SCHOLAR wants ENGAGEMENT. Competent electrical and mechanical engineer, with first-class scientific attainments.—"S. G.," *Electrician* Office, Salisbury-court, Fleet-street, E.C.

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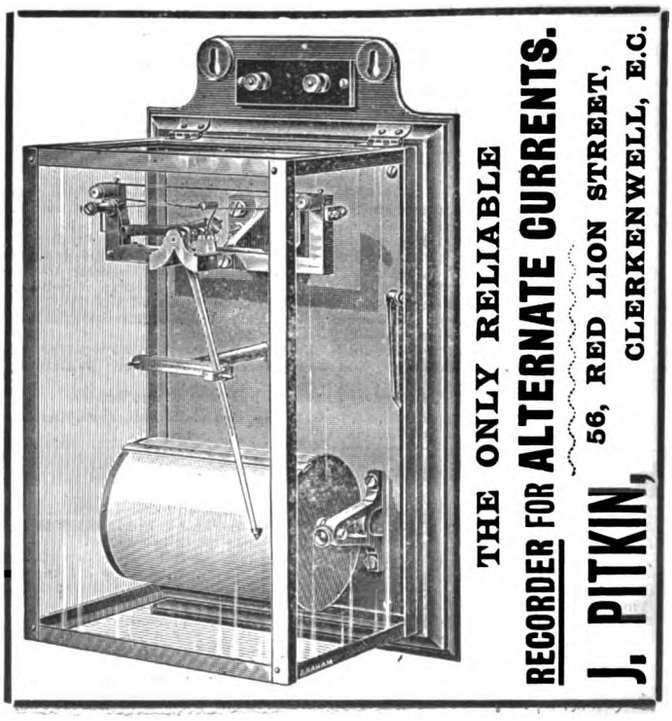

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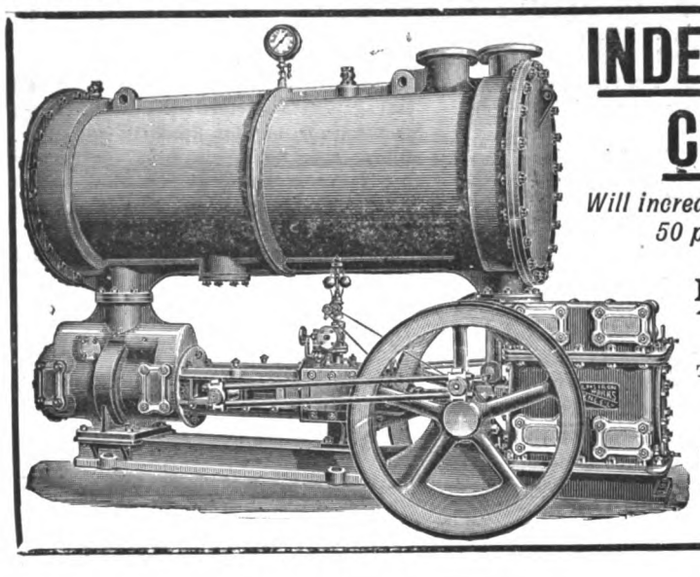

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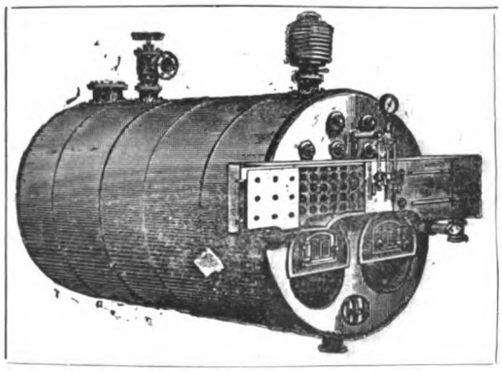

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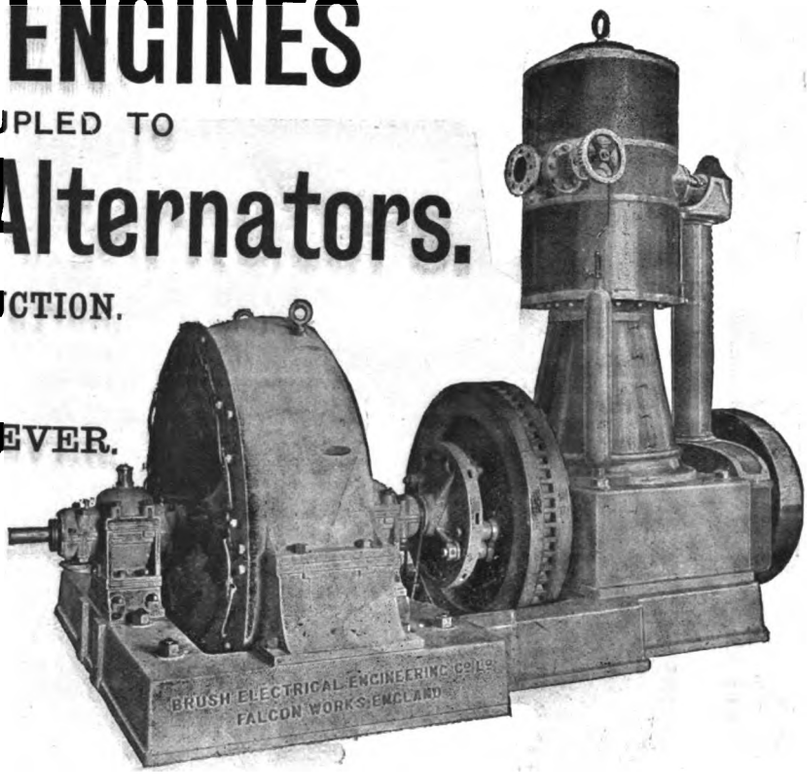

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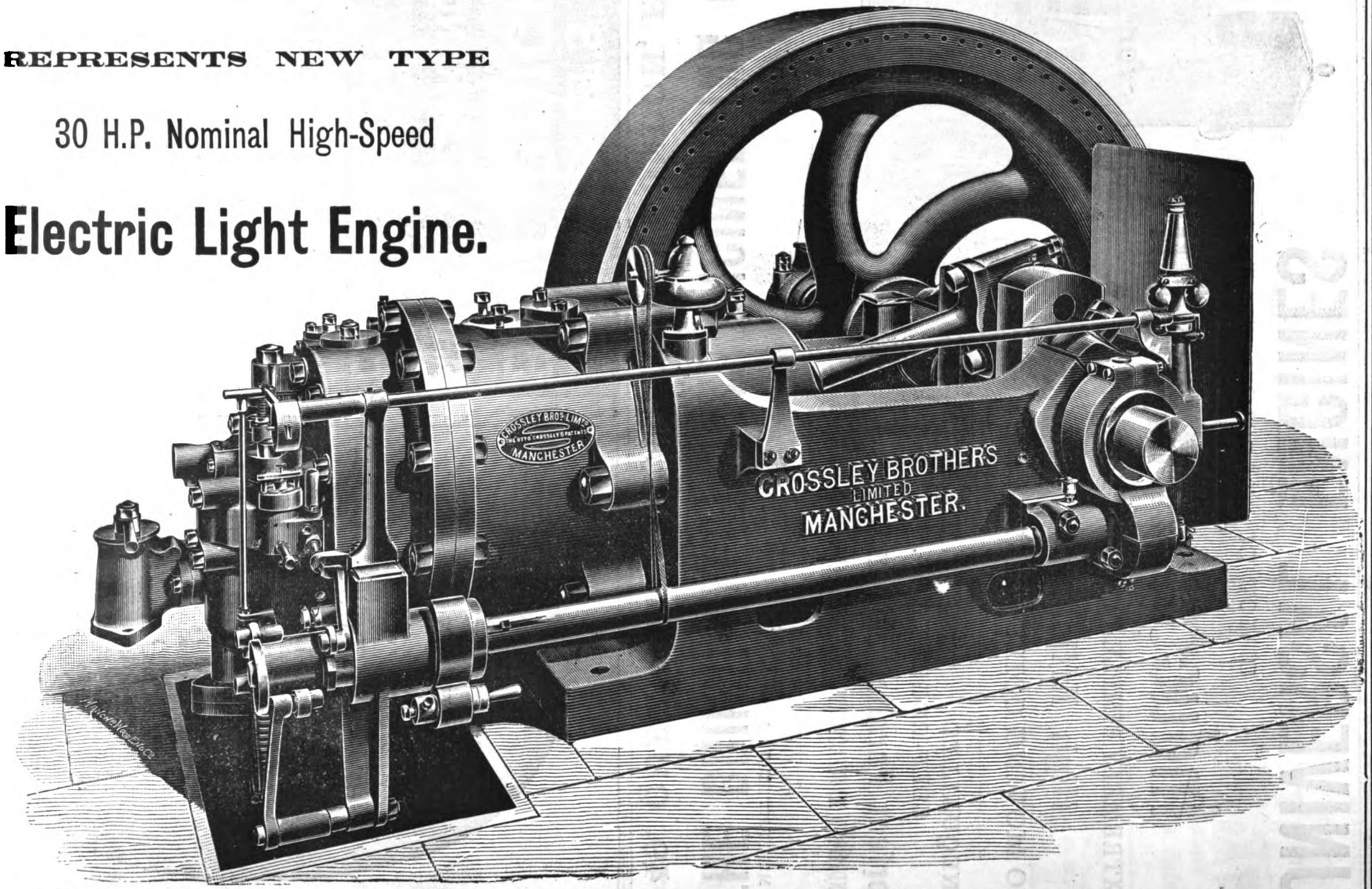

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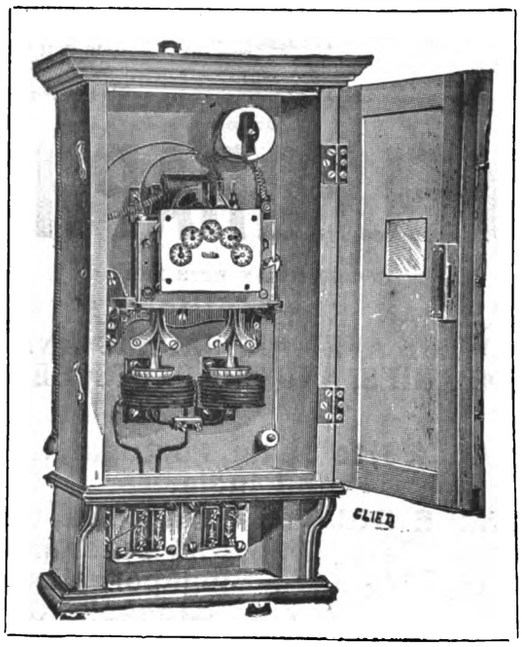

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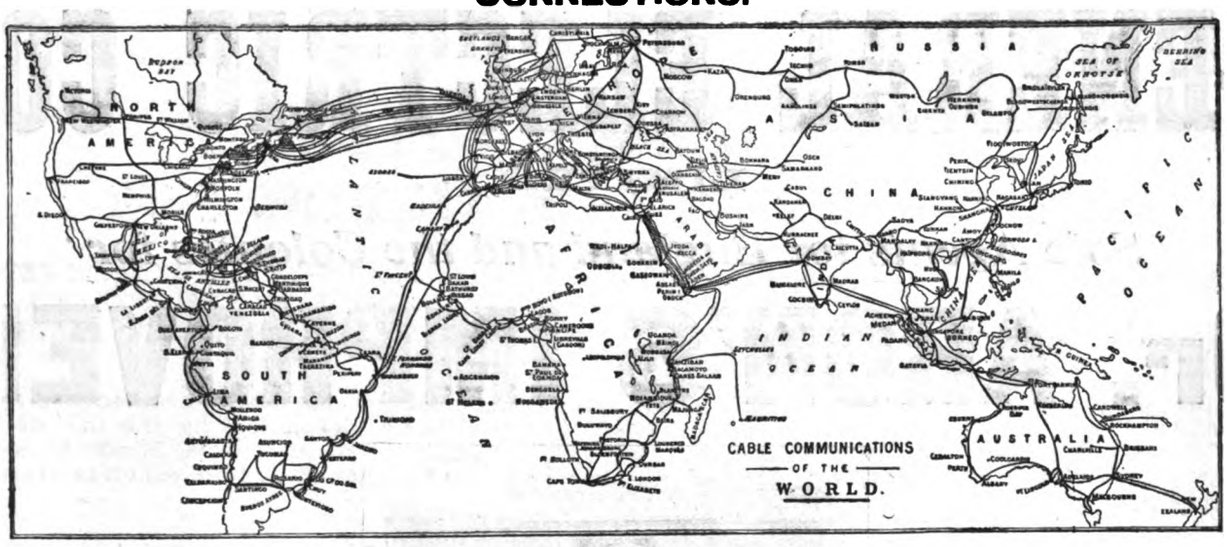

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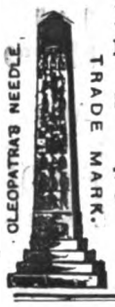

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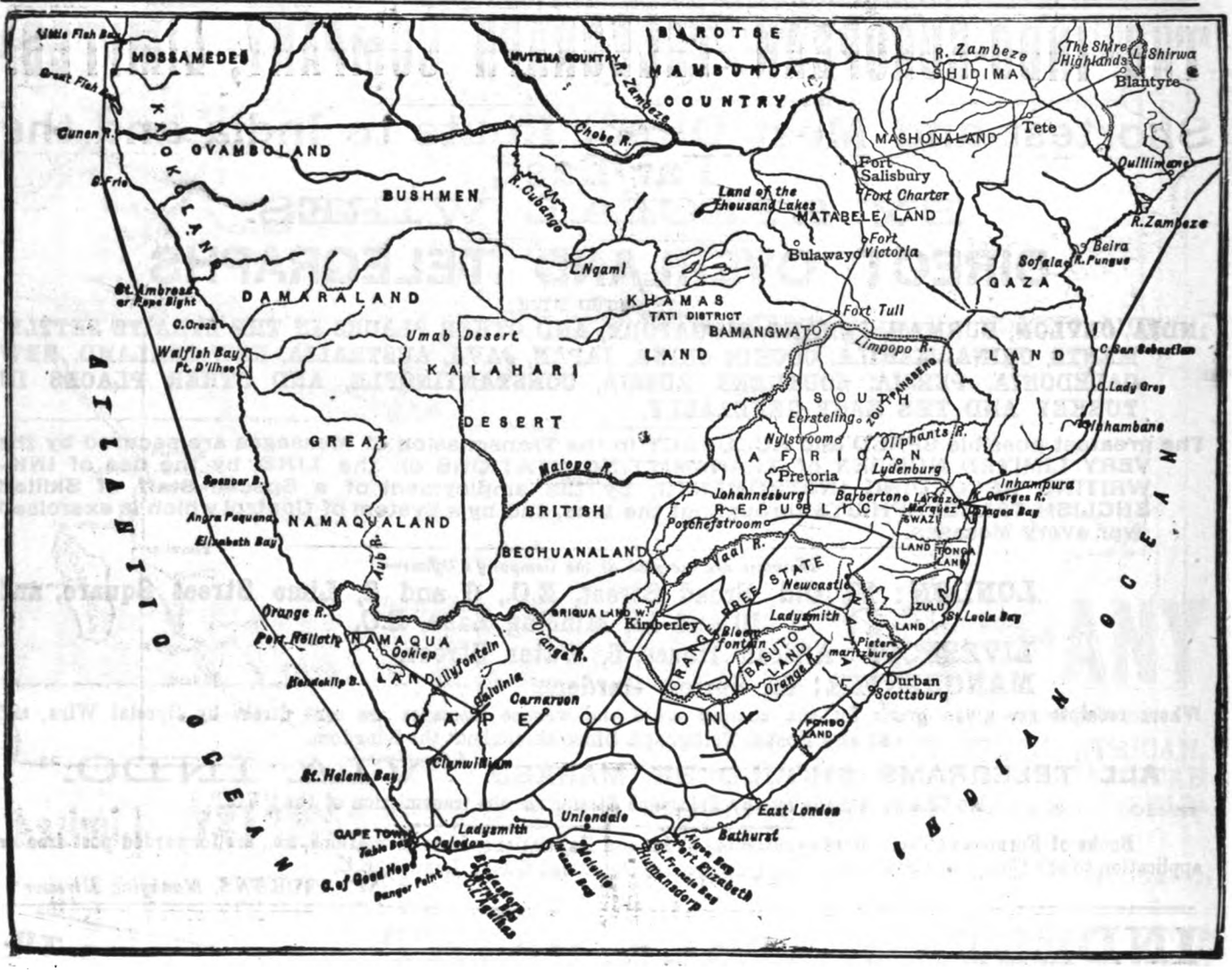

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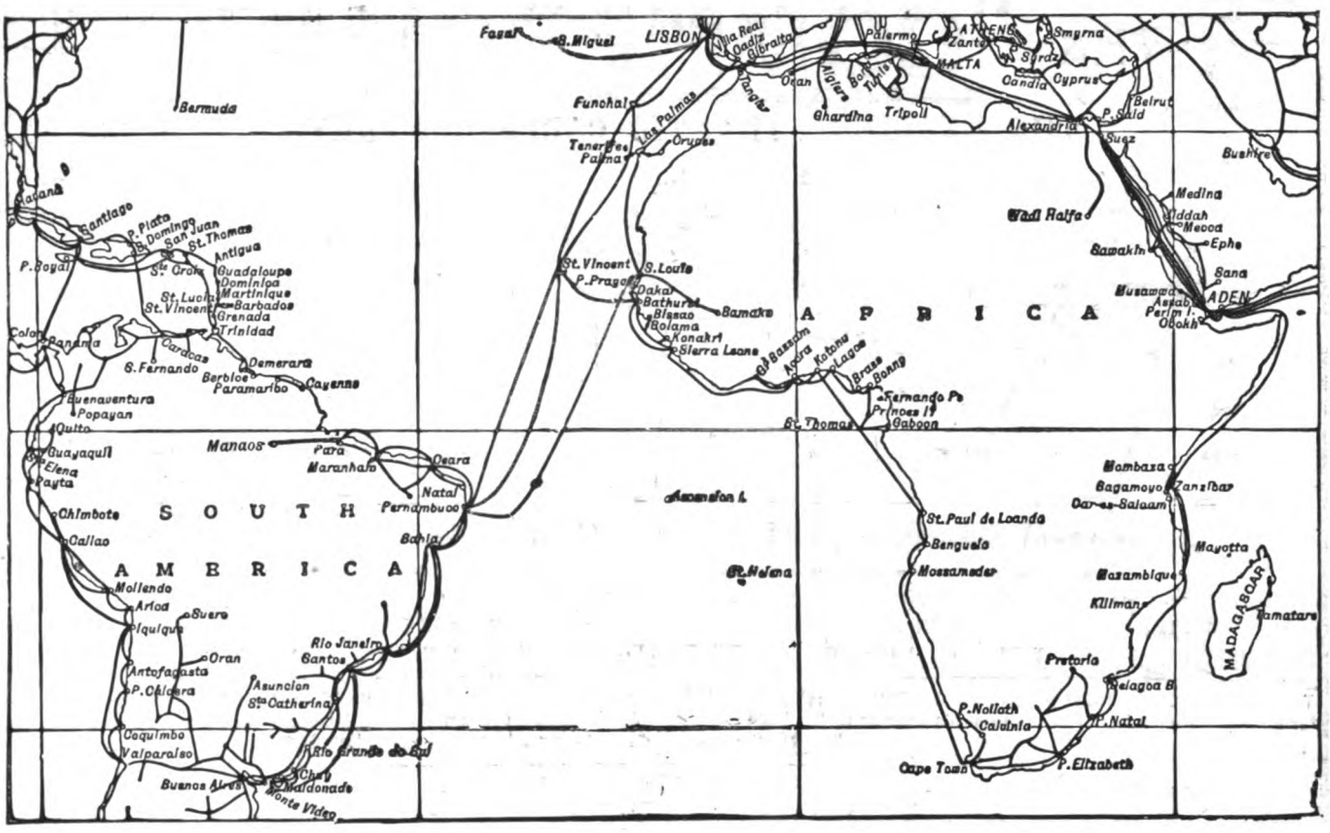

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Bolivia—All Stations	6	2
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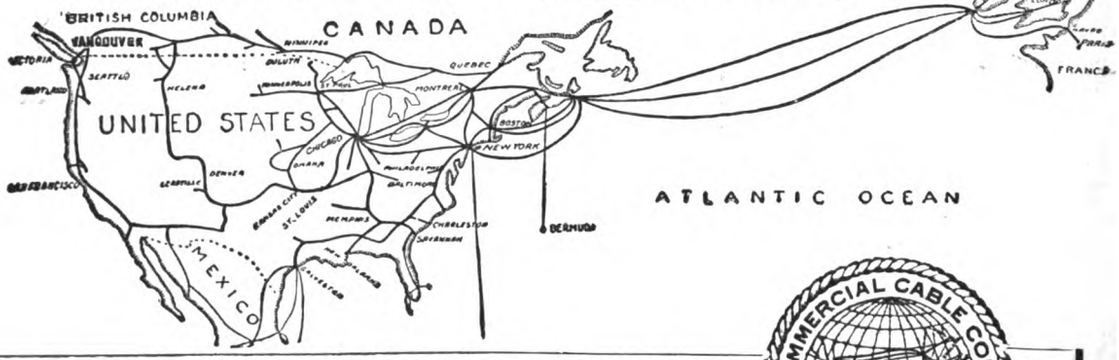

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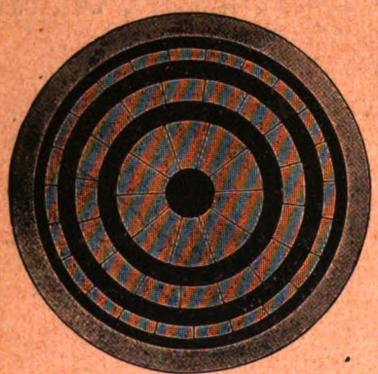

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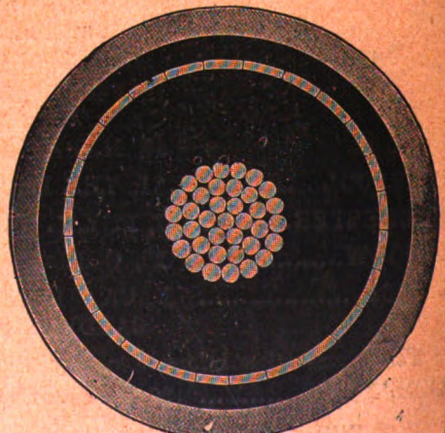

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